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Legend

The magic number seven!

Every abstract has a 7 characters code. This contains information about time and location of the presentation.

First character – Day
1 = Monday
2 = Tuesday
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Second character – Type
P = poster
T = oral presentation
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Third character – Period
1 = morning (for talks 9–11, for posters 11–12)
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Fourth character – Room
A = Lecture Theatre A
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Fifth to Seventh – Slot
This is a number expressed as 001, 002 and so on. It gives the slot for a talk within a session and the poster board number for a poster.

Examples:
1P1M073 is a poster on Monday in the presentation period 11–12 and the poster board is number 73.
3S1A005 is a symposium presentation on Wednesday in the period 9–11 in room A and it is the fifth presentation in the session.

Monday August 24th

Posters

[1P1M001] The time-course of behavioral positive and negative compatibility effects within a trial

Sven Panis and Thomas Schmidt
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The analysis of mean response times using ANOVA can conceil more than it reveils. Here we study the temporal dynamics of behavioral positive (PCE) and negative (NCE) compatibility effects within a trial of the masked (arrow) priming paradigm using event history analysis, a distributional method study the shape of time-to-response distributions which explicitly takes into account the unidirectional passage of time. In Experiment 1 we manipulate prime type (no prime, compatible, incompatible) and mask type (no mask, relevant, irrelevant, random lines) and keep the prime-mask and mask-target SOAs constant. Without a mask a PCE emerges between 120 and 360 ms after target onset. With a mask a NCE emerges between 200 and 360 ms after target onset. In Experiment 2 we manipulate the SOAs and prime type, and keep mask type constant. The results show that the onset of the NCE is time-locked to mask onset, and that it is preceded by a prime-triggered PCE when prime-mask SOA is long. We conclude that the NCE is caused by inhibition of premature response tendencies in response to the mask, and not by the mask activating the opposite response or by backward masking of the prime.

[1P1M003] Weber's law in iconic memory

Asaf Ben Shalom and Tzvi Ganel
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Vision is considered a rich and detailed phenomenal experience. Yet, previous studies showed conscious report is bottlenecked by visual short-term memory [VSTM] and attention. What is the fate of unattended visual information? Is it consciously perceived? Here, we address these issues by comparing perceptual characteristics of VSTM and iconic memory [IM]. IM is considered a larger capacity store with shorter temporal duration, largely unaffected by selective attention. Indeed, when a spatial cue is introduced before IM decay, information can be still transferred to VSTM. We combined a change detection task with classical psychophysical measurements to calculate the JND's for size discriminations elicited IM and VSTM. The results showed spatial resolution differences between the two memory stores; JNDs linearly increased with object size in line with Weber's law and had similar linear slopes. However, when introducing the cue at a time in which information in IM is thought to decay, representation did not obey Weber's law although performance still remained above chance level. These findings suggest that size representations in IM are perceptual and obey general principles of psychophysics. Furthermore, we suggest the information available for size discrimination has similar perceptual properties, regardless of whether it has been selectively attended to.

[1P1M005] Progressively removing high spatial frequencies: the impact on performance when searching for cancer in chest x-rays

Tim Donovan, Peter Walker and Damien Litchfield
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Clinicians are often concerned that their performance may be affected if display quality is sub optimal so for any medical image perception task it is useful to determine the task related parameters of image quality and relate this to observer performance. We determined the effect of removing the high spatial frequencies on cancer detection performance of two groups of observers with different levels of expertise. A test bank of chest radiographs was created using a wavelet packet transform to progressively remove the high spatial frequencies. 149 1st year undergraduate psychology students and 31 3rd year undergraduate radiography students each viewed 20 images from the test bank of 100 radiographs (10 normal, 10 containing a single lung nodule, with 5 levels of decomposition for each image). Receiver operating characteristic (ROC) results demonstrated that it is only with the most blurred image that performance falls to little more than chance for the radiography students, whereas for the psychology students performance across all images irrespective of the degree of blurring was little more than chance. Study findings demonstrate that for those with some expertise in looking at chest radiographs performance in cancer detection is not affected until an image is severely decomposed.

[1P1M007] A likelihood distribution of d′ in a signal detection experiment

Tadamasa Sawada
Higher School of Economics, Russian Federation

The signal detection method of a psychophysical experiment allows us to measure sensitivity (d′) in a deterministic way separately from a response bias. I will show how a likelihood distribution of the real d′ from results of the single experiment (and also a probability distribution of the measured d′ if the real d′ and the response bias are given) can be derived. The derivation is based on assumptions that number of trials in the experiment is finite and the trials are two parallel sequences (signal and noise conditions) of Bernoulli trials. The likelihood distribution allows us to use results of the signal detection experiment efficiently for Bayesian inference. I will also discuss how the criterion affects the measured d′, what to do if the hit or the false-alarm rates are 0% or 100%, and how the proposed method is different from other computational methods deriving some distributions of the d′.

[1P1M009] Avoid Fishing: Data-driven selection of regions-of-interest in EEG/MEG studies that avoids inflating false positive rates

Joseph Brooks, Alexia Zoumpoulaki and Howard Bowman
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Visual phenomena and their neural mechanisms are commonly studied with EEG measurements (e.g., N170 face-sensitive component). In analysis of EEG/MEG data, it is often difficult to know, a

priori, precisely where effects will occur on the scalp and in time and frequency. To overcome this, researchers often identify regions-of-interest (ROIs) for testing, but have been criticized for sometimes using biased, data-driven methods and thereby inflating Type I error rates. Using simulations, we demonstrate an ROI-selection method which is data-driven but nonetheless maintains Type I error rates at five percent. Furthermore, it avoids statistical corrections and reduces the need for precise a priori information. We identify the ROI using the aggregated-grand average (AGA) wave, which is orthogonal to the experimental contrast. Importantly, we show that common methods for computing orthogonal waveforms for ROI selection can inflate Type I error rate and demonstrate how to overcome this with the AGA. Finally, we show that using the AGA has statistical power that can exceed common ROI selection methods that are based on using a priori information from independent studies. Our results demonstrate a simple, unbiased and data driven ROI selection method which is relevant for many visual EEG/MEG studies.

[1P1M011] Likelihood Estimation of Places in Local Environments

Stephan Lancier and Hanspeter A. Mallot
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Place recognition is based on long-term memory codes providing local position information. We propose a Maximum-Likelihood model of place recognition taking into account stored and perceived landmark distances and bearings. Stored landmark distance is assumed to be based on triangulation and is therefore veridical. Landmark distance perceived during homing are assumed to be hyperbolically compressed (Gilinsky, 1951). We evaluate the model with experimental data which was collected from place recognition experiments in a virtual reality setup. Three groups of participants learned a goal location within three different configurations of four distinguishable landmarks (parallelogram, irregular with large distance variation between landmarks, irregular with homogeneous distances). In the following test phase the participants navigated to the goal location, but the environment was now covered by "ground fog" removing all environmental information except the landmarks themselves. Error ellipses were elongated towards the most distant landmark and, in the irregular conditions, showed a systematic bias in the same direction. The model reproduces the ellipse orientations if we assume that distance measurements are less noisy for near distances (from about 30 m) than bearing measurements; it also reproduces the systematic biases due to the hyperbolical compression of perceived distances (Gilinsky's $A = 90$ m).
This work was supported by the Bernstein Center for Computational Neuroscience, Tübingen (BMBF; FKZ: 01GQ1002)

[1P1M013] Perceiving the Ukraine Crisis is a matter of visual depiction

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Last descriptions about the Ukraine Crisis varied from escalating to de-escalating East vs. West scenarios, often accompanied by protagonists of either side (NATO or Russia). We investigated

whether little variations of visual conflict depiction may influence our perception, cognitive evaluation and, finally, attitudes towards the conflict. Therefore, we conducted a 2×2 factorial design in where participants received a description of the actual conflict either added by a picture of Putin or Obama and either titled with "The path to war/or peace". Study 1 ($n = 131$) was performed within two days immediately after the Minsk 2 convention when further procedures of the East/West allies were very precarious. Study 2 ($n = 134$) contained the same design, but was conducted—again within two days—four weeks later when the conflict abated. We found significant gender differences of perceiving the conflict after Obama/Putin or war/peace were displayed. Additionally, attitudes towards the conflict distinguished as a function of the visual changes as well as the time of data collection regarding Study 1 and Study 2. Results show that even very subtle manipulations in the visual depiction of the Ukraine Crisis are sufficient to affect people's mind sets and attitudes regarding this complex conflict.

[1P1M015] The effect of prime-target congruence on subsequent prime perception: An ERP study

Mikhail Sopov and Alisa Aleshkovskaya
Saint Petersburg State University, Russian Federation; Saint Petersburg State University, Russian Federation

The effect of prior experience on congruent stimuli perception (priming effect) was shown in a wide range of experiments (Henson, 2009). Nevertheless, there is lack of data concerning an impact of stimuli presentation on existing memory traces, related or unrelated to these stimuli. The present study was conducted in order to fill in this gap. Thirty-six subjects participated in the experiment. At the first stage we recorded ERPs in response to visual presentation of word stimuli (targets) with primes, related or unrelated to them (supraliminal associative priming). At the second stage we recorded ERPs in response to repeated primes presentation from each prime-target pair. The second stage results showed that repeated presentation of primes from non-associated word pairs is accompanied by increase of ERPs positivity in 400–500 ms temporal window (N400 component), which is supposedly related to decrease of neural activity (Grill-Spector et al., 2006). We explain obtained results within the predictive coding approach (Friston, 2003). Priming effect can be regarded as a prediction error minimization caused by "imposing" a specific prediction upon a subject through prime presentation. Mismatch between such prediction and sensory input causes rearrangement of memory traces associated with the prediction.

The research was supported by the grant of Saint Petersburg State University 8.38.303.2014

[1P1M017] Top-down and bottom-up effects on the visual N1 category differences

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Visual ERPs are modulated by both top-down factors (e.g. attention) and low-level differences (e.g. amplitude spectrum). However, it is not clear how these factors modulate the animal/non-animal

category differences appearing in the visual N1 component. The aim of our study was to examine the role of amplitude spectrum and the effect of categorization task on the N1 component. Stimuli were images of animals and vehicles containing either an "X" or an "O" in the background. The stimulus set was presented in two versions: they were equalised either only for luminance or both for luminance and amplitude spectrum. Thirty-five participants had to categorize whether images depicted an animal or a vehicle or whether they contained an "X" or an "O". The N1 amplitude was larger for vehicles compared to animals but only for the stimuli that were equalised for both luminance and amplitude spectrum. This indicates that amplitude spectrum differences between categories did not affect the N1 category difference. Furthermore, the categorization task modulated the N1 amplitudes for animals and vehicles. Therefore, the results indicate that both top-down and bottom-up processes modulate the N1 category difference. However, the amplitude spectrum does not play an important role in the animal-vehicle categorization.

[1P1M019] The Interplay Between Emotions and Cognitive Task Performance

Gerly Tamm and Nelson Cowan
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Recently, it has been suggested that both visual working memory accuracy and IQ are tightly connected with individual emotional characteristics. However, little is known emotional states change during cognitive tasks. We expected individuals' emotional states to depend on task performance, so that subjects with higher accuracy in cognitive tasks would have more positive emotional state reports. Seven emotional state reports were made during a 2-hour session, along with trait emotion questionnaire, a change-detection visual working memory task, a Raven's Matrices test of fluid intelligence, and additional emotion and aptitude tasks. In our pilot sample ($n = 48$) we find that emotional state characteristics correlate with task performance more strongly than emotional traits. The same levels of valence, arousal, and feelings of control (dominance) were maintained throughout the experimental procedure by high-performing subjects (as measured on either change-detection or Raven's tasks). In contrast, low-performing subjects started out the same emotionally but declined in emotional state and dominance as the working memory task progressed. Their state improved again when the difficult tasks ended. Our preliminary results demonstrate that task difficulty affects emotional valence, arousal and dominance; however, emotional predispositions can contribute to this.
Archimedes Kristjan Jaak Foundation

[1P1M021] Metacognitive sensitivity in visual working memory is determined by more than the integrity of the original memory trace

Christianne Jacobs, Jane Jacob and Juha Silvanto
University of Westminster, UK; University of Westminster, UK; University of Westminster, UK

There is a vast amount of research on metacognition in long-term memory (Koriat, 2007), but not much is known about metacognitive performance in visual working memory. In two experiments we investigated the effect of either response time or contextual congruency on metacognitive performance in a visual short-term memory (VSTM) task. Participants were tested on their

memory for the orientation of Gabor patches over 5 seconds delay periods. After their initial response, participants rated on a 4-point scale either vividness of their memory, or confidence in their response. Metacognitive sensitivity (i.e. the difference between introspective ratings for accurate – inaccurate trials) decreased for conditions in which participants RTs were artificially speeded or delayed compared to baseline, most likely because of the additional working memory load of having to remember an additional task rule. Moreover, confidence ratings showed increased metacognitive sensitivity when the context (i.e. a colored ring surrounding the stimulus) changed compared to when the context at encoding and retrieval remained identical, possibly due to the alerting effect of the contextual change. However, accuracies were unaffected. These results indicate that metacognitive sensitivity in VSTM depends on more factors than just the integrity of the original memory trace.
Supported by European Research Council Starting Grant (336152) awarded to Dr. Juha Silvanto

[1P1M023] Visual recognition memory for aerial photographs

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People are able to memorize a large set of natural scenes and real-world objects (e.g., Konkle et al., 2010), for which there exists a massive stored knowledge base. In comparison, poorer memory performance can be expected for stimuli, such as aerial photographs, with which most people have only little experience. We have examined visual recognition memory for orthogonal (generally, less familiar scenes) and oblique (more familiar scenes) aerial images in expert and untrained groups of participants. The participants first memorized images of urban environments. Afterward, they were shown pairs of images and indicated which of the two they had seen. The results show that experts who use aerial photographs on a daily basis can significantly better extract domain-relevant information than untrained viewers. Moreover, experts not only better remember the gist of the scenes portrayed, but they also more efficiently encode and recall specific details about aerial photographs. The same data pattern was found for all types of land use and for all scene scales. In comparison, there was no significant difference in performance between first-year geography students and first-year psychology students.
Supported by Czech Science Foundation grant (P407/13-28709S).

[1P1M025] Preferential inputs of luminance signals for visual working memory

Maciej Kosilo, Corinna Haenschel and Jasna Martinovic
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Working memory (WM) is the ability to encode and temporarily maintain information. There is some evidence that early perceptual processes make an important contribution to successful WM performance (Haenschel et al., 2007). However, perceptual contributions to WM are not yet fully understood. In several experiments we investigated whether stimuli specifically designed to engage luminance or the cone-opponent chromatic mechanisms in the visual system would differentially influence WM performance. We obtained detection thresholds and contrast thresholds necessary

to remember the stimuli at three WM loads and used this to calculate WM ratios. Participants performed a delayed discrimination task in which they had to remember up to 3 subsequently presented abstract shapes, while we recorded event-related potentials (ERPs). The intensity of the stimuli was fixed at a suprathreshold level based on the baseline measurements of discrimination thresholds. The resulting ratio of load 3 to load 1 contrast threshold was lower for luminance compared to chromatic contrast. Performance on the delayed discrimination task decreased with WM load but this decrease was lower at higher WM loads for luminance isolating stimuli. The results point to the differential contribution of different cone signals to WM performance, highlighting the importance of early encoding in these tasks.

[1P1M027] Effects of noise and scene-target spatial congruence through visual exploration and target identification in a perceptual decision-making process

Boris Quétard, Jessica Guilhe, Mélanie Marcotte, Jean-Charles Quinton, Laura Barca, Giovanni Pezzulo, Michèle Colomb, Martial Mermillod and Marie Izaute
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In visual search, visual exploration and target's identification depend on both noisy sensory input and prior knowledge such as the location of objects in the environment. These processes can be seen as an evidence collection step leading to decide if the target is present. We focused on how these two processes take part in the global decision-making process when searching in real-world visual scenes. We used a mouse-tracking methodology capturing components of the decision-making process through mouse trajectories (Freeman & Ambady, 2010), combined with eye-tracking measures reflecting exploration (scanning time) and identification (verification time). Indoor scenes with additive noise or no noise were presented. They included a target at a probable or an improbable location, or no target. The participants had to respond to the target's presence or absence. Our results indicate degraded response times and mouse trajectories biased toward the "target absent" response for improbable target locations, these effects being mainly mediated by increased scanning times. The degradation of the scene also impaired the response times but this effects was mediated by increased verification times. This illustrates how distinct perceptual processes influence the global decision-making process by integrating differently the available sources of information.
This work was funded by grants from the French program « investissement d'avenir » managed by the National Research Agency (ANR), from the European Union (Auvergne European Regional Development Funds -ERDF- of Auvergne region) and from the « Région Auvergne » in the framework of the IMobS3 LabEx (ANR-10-LABX-16-01).

[1P1M029] Multiple target location learning in repeated visual search: adaptation or new learning?

Efsun Annac, Markus Conci, Hermann Müller and Thomas Geyer
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Repetition of display arrangement enables faster visual search, an effect known as implicit contextual cueing. However, the effectiveness of the cueing effect depends heavily on the consistency between bottom-up perceptual input and context memory: re-locating targets to unexpected locations within an unchanged distractor context completely abolishes contextual cueing, and the gains deriving from the invariant context recover only very slowly with increasing exposure to the changed displays. The present study investigated whether a change of global display (color) features facilitates recovery of contextual cueing to re-located targets. The crucial manipulations were a change of the target location across training and test, in addition to changing the color of the search items. It was found that contextual cueing was almost as large in test as in training with color changes as compared against a baseline condition with no color changes (in which the effect was severely reduced). Additional single-display-analysis showed that transfer of cueing was due to enhanced learning of repeated displays and the adaptation of previous contextual-cueing displays. However, only the latter effect was statistically reliable. We conclude that color changes help recovery of contextual cueing after target location changes by fostering adaptation of old target displays.

[1P1M031] Intensive visual perceptual learning may increase the specificity of task improvement

Stephanie Larcombe, Christopher Kennard and Holly Bridge
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Visual perceptual learning is defined as an improvement in performance of a visual task, following repeated exposure. The extent to which learning is specific to a trained spatial location depends upon task conditions. Here, we aimed to determine the potential for improvement following a single-day training regime. Two groups of participants were trained for 10 sessions in a single visual hemifield on an adaptive motion coherence task. Subjects either completed 2 sessions per day over 5 days (5-day group) or 10 sessions in a single day with brief breaks (1-day group). Both groups were assessed on the motion coherence task before and after training, in both visual hemifields. Across training sessions, both groups showed learning of the motion coherence task, though this occurred earlier for the 1-day group (Session 4 instead of Session 10). At assessment, the 5-day group improved both the trained and untrained visual hemifields, but the 1-day group showed learning specific to the trained hemifield. Thus, there was a significant difference in performance for the untrained, but not the trained, hemifield. These results suggest that condensing learning to a shorter period of time may increase the specificity of learning compared to longer term regimes.
Funding was generously provided by Royal Society, NIHR Biomedical Research Centre Oxford, The Clarendon Fund and St John's College Oxford.

[1P1M033] Effects of Material Appearance on Visual Memory

Takahiko Horiuchi, Norifumi O'Hashi and Keita Hirai
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This study investigates the relationship between the material appearance of images and both long- and short-term visual memory. We collected 20 images with 10 material categories from the

Flicker material database. All images were converted to gray images to eliminate the influence of color. Subsequently, 16 participants with normal vision viewed the 20 images sequentially projected on a screen. Each image was presented for 5 s, and a 5 s mask followed each image. After 5 min, participants viewed a sequence of 40 images, which included 20 dummy images, and answered whether to store each image. The participants viewed the sequence of 40 images after 3 days, which included another 20 dummy images, and answered whether to store each image. Participants also rated eight perceptual qualities of all the test images. Our results showed that material appearance influenced the change in recognition rate between short- and long-term memory. The material categories of foliage and stone revealed interesting results in that performance was significantly better for long as opposed to short-term memory. Additionally, performance in recognizing images with higher perceptual quality ratings of "naturalness" and "prettiness" was better for long compared with short-term memory.

This work was supported by Grant-in-Aid for Scientific Research on Innovative Areas "Shitsukan" (No. 25135706) from MEXT, Japan.

[1P1M035] Inhibitory mechanisms for visual learning in the human brain

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Successful interactions in our environments entail extracting targets from cluttered scenes and discriminating highly similar objects. Previous fMRI studies show differential activation patterns for learning to detect signal-in-noise vs. discriminate fine feature differences. However, fMRI does not allow us to discriminate excitatory from inhibitory contributions to learning. Recent Magnetic Resonance Spectroscopy studies link GABA, the main inhibitory neurotransmitter, to perceptual and learning processes. Here, we test the role of GABA in visual learning tasks. We trained observers to discriminate radial from concentric Glass patterns that were either presented in background noise or were highly similar to each other. We then correlated behavioural improvement in these tasks with GABA measurements in the ventral visual cortex. Our results show a significant positive correlation of GABA with behavioural improvement for the fine feature task, while a significant negative correlation for the signal-in-noise task. These high vs. low GABA concentrations related to learning-dependent improvements may account for decreased vs. increased fMRI signals previously observed for the respective learning tasks. Thus, our findings suggest that learning to discriminate fine feature differences may enhance the tuning of feature selective neurons through inhibition, while learning to see in clutter may entail gain changes in large neural populations.

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[1P1M037] Effects of Using Detailed Illustrations in Textbook Design on Science Learning

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In recent years, an increasing number of textbooks have incorporated illustrations to accompany the text. Although colorful and realistic designs are considered entertaining, some studies have indicated that colors and realistic details in illustrations may be distracting to readers. This study examined the influence of illustrations on reading behaviors and learning outcomes. In Experiment 1, the subjective ratings of participants on learning interests showed a preference for illustrations over simple pictures. In Experiment 2, participants read 8 human anatomy lessons: 4 lessons contained detailed illustrations and 4 lessons contained simple pictures. Participants completed a comprehension test and an evaluation questionnaire after reading each lesson. Eye-tracking data indicated that the participants generally started viewing pictures earlier and spent more time on the detailed illustrations than they did on the simple pictures. However, the participants did not obtain high test results or give high ratings on enjoyment when they read texts with detailed illustrations. By contrast, the participants exhibited high learning outcomes when they spent more time on the simple pictures. Spending more time on detailed illustrations did not cause high learning outcomes. The results suggested that although using detailed illustrations might be visually appealing, a simpler design may facilitate effective learning.

[1P1M039] Unsupervised visual statistical learning in the newborn chick (Gallus gallus)

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Statistical learning is the ability to track probabilistic structures from the sensory input, in order to organize and interpret the environment. For instance, human infants are capable of extracting statistical information from both linguistic (e.g. artificial languages) and nonlinguistic inputs (e.g. streams of shapes). Besides being robust enough to operate across domains and modalities, statistical learning has also been reported in some nonhuman species, reinforcing the idea of a domain-general learning process. In the present study, we exposed visually-naïve newborn chicks to a visual computer-presented stream of shapes whose ordering was defined by transitional probabilities within/between shape-pairs. No reward has been provided to the animals, enabling us to investigate statistical learning as a form of unsupervised learning. Afterward, we tested chicks' discrimination of the familiar sequence from a random presentation (Exp.1) or from a novel combination (Exp.2) of the familiar shapes. In both experiments, chicks recognized their familiar stimulus suggesting that this species presents an early sensitivity to the probabilistic structure underlying complex visual stimuli. Our results provide the first evidence of visual statistical learning in an avian species, highlighting similar abilities with respect to human infants and promoting the idea of statistical learning as the result of convergent evolution.

[1P1M041] Oscillatory mechanisms involved in the coding of temporal errors

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We constantly learn and update our beliefs about when events we cause will occur. Several studies have shown a link between frontocentral theta oscillations and errors. Here, we investigated whether similar mechanisms can be used to code for temporal errors. In each trial, two audiovisual cues were sequentially presented with an interval of 1 s. Participants ($n = 17$) were instructed to produce a third stimulus following the same rhythm, by pressing a button at the moment of their choice. Their action caused the presentation of a tone after a brief delay (50 ms) that was increased after a random trial to 350 ms–750ms and remained constant until the end of the block. Our results showed that the error in the first trial after a delay change was significantly larger than the error in the subsequent trials within each block ($F(5,45) = 100.9$, $p < 0.001$). However, this error rapidly decreased as a function of trials. We found a strong theta power and phase reset in frontocentral electrodes. However, only theta phase-reset significantly reduced as a function of trial (cluster-stat 24.55, cluster-$p < 0.001$). Our results suggest an almost instantaneous adaptation to temporal changes between actions and consequences and a dissociation between phase and power mechanisms in error coding.
FAPESP

[1P1M043] Averaging effects in spatial working memory do not depend on stored ensemble statistics

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Recall from visual working memory shows averaging affects. For example, the recalled position of a memorised item is biased toward the average location of all items in a memory array. A recent suggestion is that averaging reflects an attempt to optimise single-item recall by exploiting ensemble statistics. This proposal predicts that the average location is memorised independently from that of individual items. We compared normal subjects' perceptual estimates of the centre of mass (COM) of three-stimulus dot arrays, COM from recall and single items from recall. Perceptual estimates of COM showed a systematic bias toward the array's incenter, COM recall did not show this bias. The precision of COM recall was lower than COM perceptual estimates and higher than single item recall. In a right hemisphere patient with left hemianopia and neglect, COM perceptual estimates were systematically biased contralesionally, while COM recalls were biased ipsilesionally, confirming the dissociation between perception and recall. These findings suggest that COM is recalled by averaging the memorised items' positions rather than by retrieving its memorised perceptual estimate. Averaging in spatial recall may arise instead from a reference frame transformation, ensuring that the relative position of the item in the sample array is recalled.

[1P1M045] Lateral Presentation of Faces Alters Overall Viewing Strategy

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Previous work on expression categorisation has typically used centrally presented images (Eisenbarth & Alpers, 2011; Guo, 2012; Pollux, Hall, & Guo, 2014), often accompanied by a central fixation cross; the bias toward the centre of the image that is introduced by this method is corrected for by removing first fixations from analysis; However this correction may not be sufficient, as evidence from natural scenes demonstrates a screen centre bias, significantly increasing the number of fixations to the centre of the screen regardless of image location (Bindemann, 2010). The current study provides evidence that laterally presenting faces demonstrates an overall shift to viewing strategies used by participants, significantly reducing fixations to the nose and increasing fixations to the eyes and mouth, in a way that is not accounted for by first fixations alone. It is suggested that this shift in viewing pattern is more similar to a natural viewing pattern that is not distorted by a screen centre or central fixation cross bias.

[1P1M047] Responses of ERPs and eye movements to the recognition of clusters of facial expressions

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To detect human emotional activity using event related potentials (ERPs) and electro-oculograms (EOG) as measurements of eye movement, these two metrics were measured in response to images of 7 typical facial expressions that are all part of a JACFEE database (Matsumoto & Ekman, 1988). Two emotional clusters were created using ratings of emotional impressions based on the Affect Grid scale (Russell et al., 1989). Biological indices were also compared in clusters. The differences in ERP waveforms were observed between 132.5–195.0 ms in the central area (Cz) and between 142.5–192.5 ms in the frontal area (Fz). The cross power spectrum density (CPSD) of two dimensional eye movements were analysed, and these magnitudes were compared between the two clusters at several time bins, which were from 160 ms to 100 ms before stimulus onset at 540 ms. Differences were observed from a time point 60–220 ms after stimulus onset, while the differences in frequency ranges, such as powers of frequency range factors (1.9–2.5 Hz and 3.1–3.8 Hz) gradually increased across consecutive time bins. These results suggest that both ERPs and EOGs can be indicators of the progress of recognising image clusters of facial emotions.

[1P1M049] Cross-cultural differences of fixation patterns in the perception of human faces

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Photos of faces of Caucasoids (Russians) and Mongoloids (Tuvans) were presented on a monitor. The subjects were instructed to read psychological characteristics from the photos. Exposure time was 3 seconds. The subjects' gaze direction was registered using SMI RED-M tracker. Number and duration of visual fixations on "Top / Middle / Bottom" and "Left / Right" facial zones was calculated. Fixations were detected using LowSpeed algorithm: min. fixation time 50 ms; max. variance 1°. Subjects: 22 Russians (Moscow) and 26 Tuvans, residents (Kyzyl, Tuva Republic). The following statistically significant differences were found: the Russian sample demonstrated a longer average fixation time when viewing faces of both races in the left half of the face and the middle zone; a greater number of fixations in the right half of the face and the upper zone when viewing European faces. In Tuvan sample the number of fixations in the left half of the face and the middle zone when viewing faces of both races was significantly greater than that of Russian subjects.
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[1P1M051] deleted

[1P1M053] Face and background colour effect on facial expression perception

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Facial colour varies depending on emotional state. Our previous study showed that facial colour affected perception of facial expression. On the other hand, Young, Elliot, Feltman, and Ambady (2013) reported that red (background) colour enhanced the perception of anger expression. In this study, we compered the face and background (BG) colour effects on the facial expression identification. The fear-to-anger morphed faces were presented in face and BG colour conditions (face conditions: gray BG with bluish or reddish-coloured face; BG condition: red or blue BG with neutral-coloured face; control: gray BG with neutral-coloured face). Participants identified a facial expression between fear and anger regardless of its face and BG colour. Our results showed that expression identification was influenced by both face and BG colours. The intermediate morph of reddish-coloured faces or red BG had more tendency to be identified as anger expression, while that of bluish-coloured faces or blue BG identified as fear expression. Facial colour effects were significantly greater than those in the BG condition though color saturation of the face was lower compared to that of BG colour. These results suggested that facial colour is intimately related to the perception of facial expression in excess of simple colour.
This work was supported by JSPS Grant-in-Aid for Research Activity Start-up Grant Number 26880026

[1P1M055] Attribution of emotional state of mind modulates the size of facial expression aftereffects

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Aftereffects following adaptation to facial expressions are well documented, but less is known about the influence of the perceived emotional state of mind of the adapted actor on these aftereffects. To investigate this further, we tested participants' adaptation to both genuine and faked facial expressions of joy and anger that were matched for intensity. On each trial, participants first assessed whether a facial expression was faked or genuine. They received feedback about their judgement ensuring they held the correct belief about the emotional state of mind of the actor. Participants next adapted to this facial expression for either 500 ms, 5 s or 8 s, in a between-subject design. Responses to the neutral test expression of the same actor were measured on a 5-point Likert scale (including neutral). Following 5 s and 500 ms adaptation, aftereffects to genuine expressions of joy and anger were significantly larger than those to faked expressions of joy and anger. This 'advantage' for genuine expressions disappeared following 8 s adaptation, where equally strong aftereffects were obtained. These findings suggest that adaptation to facial expressions is influenced by emotional state attribution, but that this effect is short-lasting.

[1P1M057] The effect of disfiguring features on covert and overt attention to faces

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It is well documented that facial disfigurements can generate avoidance responses in observers towards the afflicted person, yet less is known about the effect of a facial disfigurement on attention to and perception of faces. In two experiments we studied overt and covert attention to laterally presented face stimuli when these contained a unilateral disfiguring feature (a simulated portwine stain), an occluding feature, or no salient feature. In Experiment 1, observers' eye movements were tracked while they explored laterally presented faces which they had to rate for attractiveness. Overt attention, as measured by the patterns of fixations on the face, was found to be significantly affected by the presence of a facial disfigurement or an occluder. In Experiment 2, we used a covert orienting task with bilaterally presented target and distractor to measure the interference effect induced by a distractor face (disfigured, occluded, or normal) on a nonface target discrimination task. The presence of a face increased response times to the target stimulus, but this interference was not modulated by the presence of a salient feature (disfigurement or occluder). Together, these results suggest that the presence of salient features affect overt but not the covert processing of faces.
Experimental Psychology Society (UK)

[1P1M059] Facial glossiness and age estimation

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Our goal of this study is to investigate the mechanism of human age perception from the skin texture. In experiment 1, a facial image of a female (age 20's) was selected as having average

skewness of image statistics of overall 38 faces. Those 38 images were constructed by various age groups, in their 20's to 60's. The PSE of brightness was calculated by method of adjustment for each subject where skewness on test facial images was changed. In experiment 2, we made two stimulus groups, standard stimuli and test stimuli, from those selected skewness baseline of 19 images, then changed skewness of test stimuli towards plus and minus. In each trial, subjects selected an elderly face in 2AFC task where two faces were displayed simultaneously. Our results showed that participant tended to perceive faces with lower image skewness (which image histogram was skewed to the right) as older than faces with higher skewness. The results suggest that a facial image having matte skin was perceived as elderly person than a facial image having gloss skin, and it shows a similar tendency to previous study on general objects such as vegetables.

[1P1M061] Motion makes fearful facial expressions more detectable

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The relative importance of dynamic and static emotion signals from facial expressions was evaluated using a temporal two-interval forced-choice paradigm. Stimuli were black and white images of faces with a happy or fearful expression. A range of signal strengths (0–100%) of expressions were created by morphing neutral and expressive images. Dynamic stimuli were generated using a sequence of frames each containing an increasingly expressive image. One interval contained the comparison face (50%) and the other contained the test face (varied from 20% – 100%). Observers indicated the interval that contained the image that was more expressive. The percentage of times the test face was judged as more expressive increased as signal strength increased. Psychometric functions describing performance with dynamic fearful stimuli are shifted to the left of functions describing dynamic happy stimuli. This suggests that emotion signals conveyed by dynamic fearful faces are more salient than signals conveyed by dynamic happy faces. Dynamic stimuli with a fast rate of change at stimulus onset are shifted to the left of those with a slow rate of change. This suggests that 'fast' dynamic stimuli are more salient than 'slow' dynamic stimuli. Static fearful and static happy emotion signals are equally salient.

[1P1M063] Adaptation to natural dynamic facial emotional expressions

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Visual adaptation to computer-animated dynamic facial emotional expressions shifts perception of subsequent briefly presented ambiguous expression away from the adaptor (de la Rosa et al., 2013). We explored adaptation aftereffect on ecologically valid human-posed dynamic expressions. Using high-speed videocamera, we recorded female model performing transitions from happy to sad expression and vice versa. In Experiment 1, participants adapted (5000 ms) to first and last static images of both transitions, depicting intense recognizable expressions, followed by interstimulus interval (100 ms) and one of ten intermediate ambiguous images from the same transition (50 ms). In Experiment 2, adaptors were video sequences starting from the image

perceived as happy in 50% trials in static condition, and ending on either happy or sad end of transitions. Thus, half of the dynamic adaptors were time-reversed. In Experiment 3, adaptors were full dynamic transitions from one intense expression to another, both forward in time and time-reversed. The aftereffect was obtained in static and half-dynamic conditions, but not in full-dynamic, suggesting no advantage of dynamic over static expressions and no effect of time-reversal on adaptation. These results extend previously reported primary role of the overall emotional context in adaptation to naturally expressed dynamic transitions between basic emotions.
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[1P1M065] Dissociation of detection and evaluation of facial expressions in adolescence

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Holistic face perception, i.e. the mandatory integration of featural information across the face, has been considered to play a key role when recognizing emotional face expressions (e.g., Tanaka et al., 2002). However, despite their early onset holistic processing skills continue to improve throughout adolescence (e.g., Schwarzer et al., 2010) and therefore might modulate the evaluation of facial expressions. We tested this hypothesis using an attentional blink (AB) paradigm to compare the impact of happy, fearful and neutral faces in adolescents (10–13 years) and adults on subsequently presented neutral target stimuli (animals, plants and objects) in a rapid serial visual presentation stream. Adolescents and adults were found to be equally reliable when reporting the emotional expression of the face stimuli. However, the detection of emotional but not neutral faces imposed a significantly stronger AB effect on the detection of the neutral targets in adults compared to adolescents. In a control experiment we confirmed that adolescents rated emotional faces lower in terms of valence and arousal than adults. The results suggest a protracted development of the ability to evaluate facial expressions that might be attributed to the late maturation of holistic processing skills.

[1P1M067] Limited processing capacity for extracting mean emotion from multiple faces

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Previous studies have demonstrated that humans have the ability to extract the mean emotion from multiple faces (Haberman & Whitney, 2007). However, the boundaries of multiple facial expression processing are largely unknown. In this study, we tested the processing capacity of mean emotion representation by using the simultaneous-sequential paradigm. Each set consisted of 16 faces conveying a variable amount of happy and angry expressions and was presented for 100 ms. Participants were asked to judge on a continuous scale the perceived average emotion from each face set. In the simultaneous condition, the 16 faces were presented concurrently; in the sequential condition, two sets containing each 8 faces were presented successively. Results showed that emotion intensity judgments varied parametrically with changes in the happy vs. angry faces ratio. Importantly, performance in the sequential was better than in the

simultaneous condition, even when the duration was extended to 500 ms or the set size decreased to 8, revealing a limited-capacity processing. Accordingly, we conclude that participants can extract the mean emotion from multiple faces shown concurrently, but this process is capacity limited and as such it differs from the processing of lower visual features, including the size for example (Attarha, Moore, & Vecera, 2014).

[1P1M069] Face-shape facilitates detection of fearful facial expressions

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The contribution of face-shape information to the detectability of happy and fearful facial expressions was evaluated using a temporal two-interval forced-choice paradigm. Stimuli were greyscale images of faces with happy or fearful expressions matched for luminance. Neutral and expressive images were morphed to create a range of intensities (0–100%). All images were manipulated so that only the internal features of the face were visible. The shape of the face was either preserved or removed. Face-shape was preserved using a mask that followed the natural outline of the face. Face-shape was removed using an oval mask. Stimuli were presented for 200 ms. One interval contained the neutral (0%) face and the other the expressive face (ranging from 0–100%). Observers indicated the interval that contained the image that was more expressive. Accuracy increased as intensity increased for both shape-masked and oval-masked faces. Psychometric functions describing performance with shape-masked faces were steeper than, or shifted to the left of, those describing oval-masked faces for fearful expressions. This suggests that face shape facilitates the detection of fearful facial expressions. Future research is aimed at understanding the relative importance of external features (e.g. face shape) and internal features (e.g. eyes and mouth) in emotion recognition.

[1P1M071] The effect of head orientation on face detection in natural images as evidenced by fast periodic visual stimulation

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The speed and accuracy of face detection may depend on higher-order variations, e.g., head orientation. Using fast periodic visual stimulation (FPVS; Rossion et al., 2015), face-detection responses at high-level cortical areas were compared for full-front vs. 3/4 head views. High-density electroencephalogram (EEG) was recorded from 16 observers presented with 12 40-s sequences containing natural images of objects flickering at 12.0 Hz (F). Natural face images were introduced at F/9 = 1.33 Hz ('oddballs'). In Conditions 1 and 2, faces were posed all full-front, or all at 3/4 views, respectively. In Condition 3, the oddball alternated between full-front and 3/4 views (F/18 = 0.67 Hz). In all conditions, significant responses were recorded at 1.33 Hz and its harmonics, mainly over the right occipito-temporal cortex, confirming high-level face-detection responses. Interestingly, Condition 3 also showed significant responses at 0.67 Hz and its harmonics over the same cortical region, implying differentiable face-detection responses to full-front vs. 3/4 views. Time domain analysis revealed a sequence of face-selective components, with peak latencies ~12 ms earlier for full-front than 3/4 views, emerging at 130–150 ms. These

findings indicate that a full-front view presents an advantage in face detection, arising partly from a faster high-level brain response.
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[1P1M073] Gender difference in 3D face recognition

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Considerable evidence reveals that women outperform men in face recognition, while numerous studies also show that men excel women in the cognitive ability of three-dimensional mental rotation. This study addresses the gender difference by examining the performances of different genders in face recognition where 3D mental rotation is required. In four experiments, participants are required to match a front-view face to its corresponding depth-rotated (90 degree) image. Four different kinds of stimuli were used respectively. Experiment 1 uses hand stimuli to obtain the baseline of mental-rotation ability between men and women. Experiments 2 to 4 adopt face profile, face silhouette, and negative faces images, respectively, to explore the 3D face representation between males and females. The results show that women are better in recognizing the depth-rotated profiles then men. However, the gender differences disappear when depth-rotated silhouettes are used. The performance of men and women are comparable when they are required to match the front facts to their depth-rotated silhouettes. It suggests that the advantage of mental rotation ability in males vanishes when stimuli are favorable to females. The results draw doubts to the predominant notion that males are generally better then female in the ability of 3D mental rotation.

[1P1M075] Intensity of the facial expressions influences the aftereffect of facial expressions

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Previous studies have shown that adaptation to a facial expression leads to impairment of recognition of the same expression. In two separate studies, we investigated whether facial expression aftereffects depend on their intensity. Across experiments participants were presented an adaptation stimulus for 5 seconds, followed by 100 ms blank and 200 ms test stimulus. Adaptation stimuli consisted of expressions (anger, fear, sadness, and happy) at three intensity levels (low, medium, and high) and test stimuli consistently portrayed low intensity expressions. Intensity levels were produced by morphing expressive and neutral images of the same individual. Participants were asked to categorize the expression of the test stimulus. In experiment 1 identity was consistent across adaptation and test stimuli, whilst in experiment 2 identity was changed between the adaptation and test phase. Results replicated that expression leads to impairment when intensity levels are maintained across the adaptation and test phase, even when intensity levels are low. More importantly we indicate that higher expressive intensity increased impairment for recognition of the test stimuli. This suggests that expressive intensity is

critical to recognizing facial expressions, and that the impairment is not caused by contrast of the intensities of adaptation and test stimuli.

[1P1M077] The development of face and object processing in childhood

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There has been much debate over whether face and object recognition develop at a different rates during childhood. Some researchers suggest that face processing is not mature until the early teenage years, far later than object recognition; others suggest that face recognition is mature relatively early (by 5 yrs), and subsequent improvements reflect more general cognitive development. Recently, it has been suggested that both ideas are correct, but that face memory and face matching develop at different rates. This study addressed this hypothesis by examining face and object (bicycle) matching and memory in primary school children (5–11 yrs). In the memory test, children were asked to learn 4 or 6 faces and bikes; in the matching test, children completed a 3AFC simultaneous matching task. Both memory ($N = 134$) and matching ($N = 432$) showed significant improvements with age, but neither task showed an interaction between age and object – that is, memory and perception of faces showed a similar developmental trajectory to general object memory and perception. This suggests that both face memory and face matching are mature early in childhood (<5 yrs), and subsequent increases in performance are related to general cognitive development rather than face-specific processes.

[1P1M079] How well is Emotion recognized in faces 15degrees in the periphery, and where do people look when allowed to fixate the face?

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Twenty participants were presented with Ekman and NimStim emotional faces centrally and 15degrees in the periphery in 4 locations around fixation. The face emotion was verbally named out of seven emotions, while fixation was maintained, so the face was in the periphery. Participants were permitted to free view the face and fixate where they liked and change their named emotion if they wished. Eye movements were monitored with ASL eye tracker. Accuracy for emotion discrimination in the periphery was around 60% and was around 80% for central viewing. Happy was always well recognized while Fear, Surprise, Anger, Disgust, Sadness and Neutral tended to be confused. When participants were allowed to look at the face directly they mostly tend to fixate first fairly centrally and then look to the eyes or mouth depending on the Emotion. These finding concur with those of Bayle, Schoendorff, Henaff, & Krolak-Salmon (2011) and Palermo and Coltheart (2004).

[1P1M081] Can Taiwanese political parties be categorized by face, even without external contour and mouth?

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Rule and Ambady (2010) found that Republicans and Democrats can be differentiated by face. The present study aims to replicate and extend. In Experiment 1, university students differentiated 100 gray-scale full-face photos of candidates of the two major political parties in Taiwan, the Kuomingtang (KMT) and the Democratic Progressive Party (DPP), 50 each; meanwhile the responses on candidates they had known the party of were removed. An open question "How did you guess?" was asked at the very end. Experiment 2 recruited participants aged between 25 and 55 with identical stimuli. Experiment 3 tested another group of university students with cropped-face photos, Experiment 4, with photos devoid of the mouth and chin area. Based on d′-corrected accuracy, the present study found that 1) KMT and DPP could also be differentiated by face, but 2) cropping the face made it difficult; 3) removing the mouth and chin area had no effects; 4) "Good guessers" made face-to-trait inferences from sociopolitical heritage, while "bad guessers" resorted only to observable features such as gender, age, and smile. 5) Only good guessers benefited from age. In sum, Rule and Ambady's results were replicated, and aspects about identifying perceptually ambiguous social groups were being discovered.
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[1P1M083] The Own-Race Bias for Face Recognition in Malaysians and Whites

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The own-race bias (ORB) is the phenomenon whereby people's ability to recognise faces from their own race is better than for faces from other races. Studies of this phenomenon (Meissner & Brigham, 2001) have mostly employed White and Black participants and stimuli. We explored the ORB in Malaysian and White observers by comparing their recognition performance when performing an old/new face recognition task involving own- and other-race faces. Participants viewed a number of faces to remember during the learning phase and then subsequently viewed half of the previously presented faces intermixed with distracter faces. During the recognition phase, participants were required to determine whether each face had been seen in the learning phase. 94 young adults' (26 Malaysian Chinese, 23 Malaysian Malay, 22 Malaysian Indian, and 23 Western Caucasian) recognition accuracy, sensitivity and response bias were measured to examine their face-processing ability. Broadly in line with findings from previous studies on ORB, the results generally showed that young adults had superior face recognition performance for own-race faces across different ethnic groups. However, faces of Indian Malaysians did not seem to produce an ORB, whereas the Chinese-White ORB was particularly pronounced.

[1P1M085] Impaired identity discrimination in developmental prosopagnosia as measured with steady state visual evoked potentials in an oddball task

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Individuals with developmental prosopagnosia (DP) have severe face recognition deficits, without any history of neurological damage. A reduced ability to discriminate between different faces could suggest that this deficit is in part due to a disruption of face processing at the level of the structural encoding of face identity. To test whether DPs have impaired identity discrimination of unfamiliar faces, a fast oddball paradigm was used to see if periodic changes of identity elicited steady state visual evoked potentials (SSVEPs) as recorded with EEG. Faces were presented at a frequency of 5.88 Hz in 60 second sequences. At every fifth face in the sequence the identity of the face changed, thus the identity oddball discrimination frequency was 1.18 Hz. EEG frequency analysis at occipito-temporal electrodes demonstrated increased power the 1.18 Hz oddball frequency and it's harmonics in the control group, suggesting that identity changes were discriminated. DPs demonstrated a significantly attenuated oddball discrimination response at the same electrode sites, suggesting reduced detection of the identity changes. The presentation rate of the faces (approximately 170 ms) and the topography of the discrimination response suggests that this identity change discrimination impairment occurs at early structural encoding stages of the faces processing hierarchy.
Economic and Social Research Council, UK

[1P1M087] Processing of Depth-Inversion Illusions: The special case of faces

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For the class of depth-inversion illusions (DII), perceived depth is opposite to stimulus physical depth – distant points on the stimulus appear closer than near points; thus convexities/concavities are perceived as concavities/convexities. Examples: hollow masks, "Termespheres" and reverse-perspectives, where painted scenes elicit a 3-D percept whose depth is opposite to the 3-D painted surface [Papathomas; Spatial Vision, 2007]. Possible explanation for DIIs: top-down influences, either specific knowledge of objects (such as 3-D faces), or general knowledge embodied as rules (such as perspective, or bias for convexity), influence the final percept [Gregory; Phil. Trans. R. Soc. B, 2005]. Interesting question: Can humans overcome such top-down influences and obtain depth-inverted percepts for stimuli in which top-down influences impede, rather than facilitate, depth inversion? Examples of such stimuli are normal, convex 3-D faces and "proper-perspectives", in which the depicted perspective cues are consistent with the depth of the physical surface. Answer: Humans can overcome such top-down influences for proper-perspectives and Termespheres, but not for human faces. Together with evidence that human masks display a stronger inversion effect than perspective scenes [Papathomas, Bono;

Perception, 2004], these results argue that 3-D faces are represented and processed differently than non-face 3-D stimuli.

[1P1M089] Differential effects of task anticipation on liking of familiar surfaces

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Repeated exposure to a stimulus results in an increased affect towards the stimulus (the mere exposure effect). However effects of task anticipation during exposure are not well known. Furthermore, although the mere exposure effect has been shown to occur for a variety of stimulus types, it has not been shown for surface images. We investigated the influence of anticipating two different tasks during repeated exposure to photographs of wood surfaces as stimuli. Prior to stimulus exposure, half of the subjects were instructed to expect a recognition task, and the other half to expect a liking rating task. All subjects were then exposed to the stimuli. Subsequently, subjects were asked to give liking and recognition confidence ratings to novel stimuli and stimuli that they viewed once, three times or nine times. Preliminary results showed that stimuli were liked more and recognized better as they were seen more often. Furthermore, the results suggest that for the novel images, liking ratings of the two groups did not differ. However, for images seen only once, the group anticipating a recognition task revealed less liking than the group anticipating a liking task. This difference disappeared with increased exposure. The implications of the results are discussed.

[1P1M091] Average faces: Skin texture more than facial symmetry predicts attractiveness perceptions of female faces

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It is well documented that average faces (composites) receive higher attractiveness judgments compared to the original faces, from which they were created. The objective of this study was to determine whether and to what extent a more even skin texture or a higher facial symmetry (both mediated by averaging faces) affect the attractiveness judgments of a female composite. Furthermore, we were interested in understanding the microgenesis of attractiveness assessment processes. Facial stimuli were displayed with varying in presentation time (32 ms, 65 ms, 200 ms and undefined time). One hundred participants (60 females) between 18 to 39 years assessed 16 original faces, the manipulated faces related to skin texture and symmetry, plus an all-in-all-composite version comprising all 16 original faces on 4 variables: attractiveness, prettiness, sexiness and age. We revealed that skin texture, but not facial symmetry, significantly predicted attractiveness-, prettiness-, sexiness-, as well as age judgments of the all-in-all-composite face. We also observed an interesting effect regarding presentation time: whereas original faces were devaluated the longer the presentation time, the all-in-all-composite benefitted from increasing presenting time. The overall results indicate that the process of facial

attractiveness appreciation (i) is mainly triggered by skin appearance, and (ii) shows clear microgenetic development.

[1P1M093] Effect of viewpoint and face visibility in whole body expression recognition

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Appropriate understanding of other's emotion is crucial for guiding our social behaviour, yet it is unclear what the relative importance is of facial and bodily cues and to which extent this relationship is influenced by viewpoint. In this study participants viewed images of actors expressing different emotions from three different view-points (frontal view, mid-profile, profile) with the face either visible or masked whilst eye-movement were recorded. Behavioural data revealed emotion and viewpoint-specific advantages in accuracy. Regardless of emotion and face visibility, head and body were viewed more than arms, hands or legs, although the relative proportion of gaze allocation at each body region varied with view-point. Unlike facial expression, our findings suggest no view-point invariance in body expression perception. Instead, the results seem more consistent with the use of viewpoint dependent holistic gaze strategy for extracting emotion-specific postural cues.

[1P1M095] Individual differences in the rewarding nature of faces

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Faces can be an inherently rewarding stimulus and adults will exert effort to view them (Aharon et al., 2001). Recent research has indicated that facial expressions and attractiveness can powerfully influence this reward value.For example, attractive faces are generally more rewarding, but the appearance of negative angry expressions reduces their elevated reward value (Jaensch et al., 2014). Importantly the reward value of faces may critically influence the development of face processing expertise, by being the force that predisposes us to attend to and engage with these stimuli from early infancy (Chevallier et al., 2012). Face-processing expertise is by no means a uniform ability, with a normal distribution of expertise in the general population that runs from individuals with developmental prosopagnosia (i.e., very poor face abilities) to super-recognizers (exceptional face abilities). Here, a large group of males ($n = 45$), completed both the Cambridge face recognition test (Duchaine & Nakayama, 2006) to benchmark their face-recognition ability and a key-pressing task, which provided a behavioural indicator of how willing participants are to work for individual faces: a proxy measure of the reward value of these stimuli. Results indicate a clear relationship between face perception abilities and the degree to which faces are rewarding.

[1P1M097] The rewarding value of attractive faces: modulating effects of emotion, eye-gaze and empathy

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Human faces convey important social and biological signals, and people work to control their exposure to them in motivated viewing paradigms (Aharon et al., 2001). Attractive faces are generally more rewarding than non-attractive ones but this is tempered by negative emotions that typically signal avoidance behaviour. Specifically angry attractive faces, though rated as aesthetically pleasing, are treated like unattractive faces with reduced viewing times and lower associated reward (Jaensch et al., 2014). Here we explore the modulating effects of other emotion categories (happy, fear and anger) for faces with direct and averted gaze. Eye-gaze can signal potential threats/interests in the environment and offers insights into the intentions of others and therefore modulates the typical approach vs. avoidance response in the perceiver. Results ($N = 28$ heterosexual males) indicated that a happy expression on an otherwise unrewarding unattractive face rendered it more rewarding than attractive faces with negative expressions despite being rated as less attractive than all attractive faces. Eye-gaze manipulations resulted in the anticipated pattern with positive emotions and direct eye-gaze, and negative emotions and averted eye-gaze more rewarding respectively than their opposing combinations. Finally we found intriguing associations between empathy, aesthetic assessments and motivated viewing behavior across conditions.

[1P1M099] Perception of emotional body expressions depends on concurrent involvement in social interaction

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Many theories about perception of emotions from body movements hypothesize a joint activation of brain structures involved in emotion perception and motor execution during social interaction (Wolpert, 2003; Wicker, 2003). This implies that bodily emotions should be perceived as more expressive when observers are involved in social motor behavior. METHODS: To test this hypothesis, participants judged the emotional expressiveness of an avatar (shown on an HMD) that reacted to their own motor behavior, comparing these judgments with the ones for simple observation without motor involvements within a balanced design. Expressiveness of the movements (10 angry and 10 fearful examples) was controlled by morphing (5 steps), using a probabilistic generative model (Taubert, 2012), optimizing morphing levels individually for each actor. RESULTS: Emotional expressiveness of the stimuli was rated higher when the participants is involved in the action, as compared to pure observation ($F(1,17) = 8.701$ and $p < 0.01$, $N = 18$). This effect was particularly prominent for anger expressions. CONCLUSION: Consistent with

theories about embodied perception of emotion, the involvement in social motor tasks seems to increase perceived expressiveness of bodily emotions.

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[1P1M101] The Influence of Fear-Inducing Stimuli on Learning of Visual Context

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Fear-inducing visual stimuli (e.g., spiders) capture visual attention. The present study examined the influences of fear-inducing stimuli on learning of visual context. Participants searched for a landolt square defined by color and gap location (e.g., a red square with a gap on the left or right). Within each landolt square, an image of spider (fear-inducing) or mushroom (fear-irrelevant) was presented. For half of the visual arrays, the locations of the target and the distractors, as well as the images within them, were fixed across trials; for the other half, they were determined randomly on each trial. Search time was shorter when the target contained a fear-inducing image than when it contained a fear-irrelevant image, and when the distractors contained fear-irrelevant images than when they contained fear-inducing images, indicating strong attention capture by fear-inducing stimuli. Search time was also shorter when search array was fixed than when it was random, yielding a contextual cuing effect. However, the effect depended on whether the images within target and distractors were of the same kind, not whether they were fear-inducing. Therefore, fear-inducing stimuli have little influence on implicit learning of visual context.

[1P1M103] (No) Role of emotions in Emotion Induced Blindness

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Attentional Blink (AB) is the impairment in reporting the second of two targets (T2) when they are presented in RSVP. AB, however, is not observed when T2 immediately follows the first target (T1) and is called lag-1 sparing. Lag-1 sparing does not occur in Emotion Induced Blindness (EIB), which uses a very similar paradigm as AB with differences in the type of stimulus used (pictures instead of letters/words) and number of targets (Only T2, which is preceded by an emotional picture). Lag-1 sparing is theoretically important in understanding the temporal limits of attention. Systematically comparing EIB and AB would offer insights into the mechanisms underlying lag-1 sparing. In three experiments, we tried to systematically eliminate the differences between the AB and EIB paradigms. First, we replicated the standard EIB effect; then made the emotional distractor a target (T1); and finally, both T1 and T2 were made non-emotional. There was no significant difference in accuracies between the three experiments suggesting that EIB is just AB with pictures and that this use of pictures instead of alphabets is critical for the absence of lag-1 sparing. Emotion does not have a special role in EIB.

[1P1M105] The menstrual cycle influences attending to evolutionary-relevant visual stimuli. An eye-tracking study

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Due to variations in hormone levels during the pre-ovulatory (follicular) phase women are more sensitive to reproductively-relevant stimuli, while in the post-ovulatory (luteal) phase they are sensitive to stimuli related to risk of pregnancy termination. Female participants ($N = 20$) were tested in the luteal and in the follicular phase. Progesterone level was measured from saliva sample. Images from six categories were presented: Threat, Disgusting objects, Children, Erotic scenes, Low-calorie food and High-calorie food. Images were segmented to ROI (e.g., aggressor in a Threat image) and background. Number of fixations in ROI (capture of attention) as well as first-pass durations (hold of attention) were compared in the two menstrual phases. In the luteal phase first fixation fell more often in the key regions of Children ($t(19) = 2.4$, $p = .026$) and Threat images ($t(19) = 3.0$, $p = .007$) than in the follicular phase. This tendency was sustained during following fixations in case of Threat; $t(19) = 2.2$, $p = .042$. First-pass duration was shorter for Disgusting objects in the luteal phase than in the follicular phase; $t(19) = 2.18$, $p = .042$. Thus, phase of the menstrual cycle influenced automatic and rapid capture of attention, showing that top-down processes can influence even first fixations.
This work was supported by the Polish National Science Centre (grant number 2012/07/E/HS6/01046).

[1P1M107] I know what you're doing!: Awareness of other people's intentions interfere with cognitive task performance

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In shared environments it can be advantageous to have an awareness of the goals and intentions of others. Recent research has found that co-actors form a representation of each other's tasks even when neither necessary nor beneficial to their own performance. The current study used a novel method to investigate task interference between individuals who have differing intentional relations to a jointly attended stimulus. Pairs of participants were shown the same stimulus (a letter surrounded by two squares of different colours, superimposed at 0 and 45 degrees) on a shared display. Each participant was given their own instruction set asking them to indicate whether a specific conjunction of features was present in the stimulus. Both co-actors were looking for a vowel (shared criterion) in addition to an individually assigned colour present in either of the squares (non-shared criterion). Reaction times and error rates were influenced by which of the co-actor's target features were present in the stimulus, despite being irrelevant to task goals. Importantly, this was only the case when participants were explicitly aware of their co-actor's instructions. These findings provide evidence that it is difficult to suppress irrelevant representations of a co-actor's task, even when detrimental to individual performance.
Economic and Social Research Council (ESRC)

[1P1M109] Burke's fallacy: Is there a male gaze in empirical aesthetics?

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Edmund Burke (2008/1757) described two types of aesthetic appreciation: Beauty evokes tender feelings of affection and the sublime inspires us with delightful horror. For Burke the sublime is per se the more powerful aesthetic experience. However, literature on gender differences in aesthetic appreciation suggests that women are generally less susceptible to the sublime. We tested this hypothesis using 60 picture details from a triptych by Hieronymus Bosch. 150 participants rated these stimuli in terms of threat (respectively safety) and liking. Moreover, state and trait anxiety as well as state depression were assessed. Across all participants safety and liking were positively correlated (R = .45). Yet, this correlation was higher for women (R females = .70) than for men (R males = .22). Gender differences were particularly pronounced among participants in a good mood. We conclude that Burke's dichotomy of the beautiful and sublime is in fact confounded with gender-related aesthetic preferences and that his proclivity for the sublime reflects a "male gaze" (Mulvey, 1975). Burke's fallacy is discernible in empirical aesthetics today: Although women display a greater openness to aesthetics (Costa, Terracciano & McCrae, 2001) and tend to prefer simple artworks with untroubled subjects (Chamorro-Premuzic et al., 2010), empirical aesthetics focuses on complexity, cognitive mastery, and aesthetic awe.

[1P1M111] Visual Preference for Curvature and Art Paintings: Some Data

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The visual preference for curvature is a human phenomenon that has been found on numerous studies. After the success of Bar and Neta (2006) on finding the preference for curvature using sharp-angled and curved versions of the same object, our research group replicated those results using the same stimuli but with a forced choice task in an approach-avoidance framework. With this new task, the effect of preference for curvature was also found in short exposure times: 40 and 80 miliseconds. Next we decided to apply the same paradigm but using art paintings. Pairs of similar abstract art images –a curved version and a sharp-angled one- were created. We used both color and black and white paintings. Only a weak effect was found in the color pairs with 40 ms exposure time. After these results we have revised the paradigm: (a) modifiyng some edges in sharp-angled images to have a more analogous set of curved images and (b) using a Likert scale with the aim to simulate art appreciation.

[1P1M113] Blue color enhances the performance in creativity tasks

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The effect of color, especially red and blue, on perceptual/cognitive process has been controversial (e.g. Mehta & Zhu, 2009). The present study investigated if red or blue color affects human cognitive performances. METHODS: 66 students with normal color vision participated in the experiment. They were randomly assigned to either red or blue color condition. In a standard classroom, participants engaged in a series of cognitive tasks; word memory task, anagrams, a proof reading, verbal association, figure association, and color preference questionnaire. The tasks and the stimuli were presented on a 2 m $\times$ 1 m screen by a LCD projector (EIKI, LC-XB41), with a background color either of red (47.0 lx, $x = 0.59$, $y = 0.37$) or blue (56.5 lx, $x = 0.14$, $y = 0.06$). The responses to the tasks were all written on an answer sheet. RESULTS: The performance was not consistent between red and blue conditions; e.g. the percent correct in memory task was better in red condition ($p < .1$), while responses in verbal association were obtained more in blue condition ($p < .05$). To examine qualitative properties of responses, the creativity of responses in the two association tests was evaluated by third parties. Then, the obtained scores of creativity were consistently higher in blue than red condition.
JSPS Challenging Exploratory Research, No.26590131

[1P1M115] The Importance of Diagonal Axes in Aesthetic Appreciation

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Balance as an important factor contributing to the aesthetic preference is supported by previous empirical evidence. The dynamic balance with respect to the various axes was manipulated in this research to evaluate the contribution of each axis and combination of axes. The material invented by Wilson and Chatterjee (2005), composed of circles with unequal sizes, was used in this study. In the first experiment, participants gave their ratings about the aesthetic preference to a set of patterns randomly generated by the computer. The results show that the two diagonal axes are important. In the second experiment, according to the axis of balance, there were four single-axis (vertical, horizontal, two diagonal) conditions, two double-axes (vertical-horizontal, diagonal) conditions, and two control (low balance, medium balance) conditions. The results show that the double-axes/diagonal condition had higher preference scores compared to the control conditions. In contrast, the double-axes/vertical-horizontal condition cannot have the similar advantage. This result is consistent with that obtained in the first experiment. The single-axis/vertical condition also has higher scores than control condition, implying its unique importance. Overall, the results implicate the importance of diagonal axes in aesthetic preference that may be explained by the expression power of dynamics.
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[1P1M117] Could a red pen really lower maths test scores? An investigation of colour driven cognitive effects

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The influence of colour on cognition has been long-studied (e.g. Pressey, 1921) but contradicting claims surround the effects of colour on performance. Elliot, Maier, Moller, Friedman and Meinhardt (2007) proposed that in an achievement context (e.g. maths test) the perception of red impedes performance by inducing avoidance motivation. However, replications of the effect are scant, especially in the UK and some suffer from a lack of stimulus colour control. We report five experiments that attempt to replicate the red-effect in an achievement context across a range of settings: online; in school classrooms; and in the laboratory. In each experiment, stimuli were carefully specified and calibrated to ensure that they varied in hue but not luminance or saturation. Only one experiment replicated the red effect – participants who were primed with a red stimulus (relative to white) for 5 s scored worse on a subsequent verbal task. However, replication and extension of this experiment failed to reproduce the effect. Explanations for the findings are discussed including: the effect is not present in a UK population; the effect requires very specific methodology; the effect does not generalise to applied settings; and/or the original body of work overestimates the prevalence of these effects.
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[1P1M119] Eye-tracking of primate's preference for curvature

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There is growing evidence that human visual preference for curvature is a universal trait that can be traced back to our biological heritage. Said preference has been hypothesized to result from sharp transitions in contour conveying a sense of threat (Bar & Neta, 2006). While the evolutionary nature of this preference has not been properly explored, a modified two alternative forced choice task (Munar, Gómez-Puerto, & Gomila, 2014) has allowed us to find preference for curvature in a non-Western population (Gómez-Puerto, Munar, Acedo, & Gomila, 2013) and among captive chimpanzees and gorillas (Munar, Gómez-Puerto, Call, & Nadal, submitted). To further explore the nature of said preference, we analysed the gaze pattern of five primate species (human, chimpanzee, bonobo, orang-utan, and gorilla) when presented simultaneously with curved and sharp contoured versions of the same stimuli. Preliminary analyses reveal that curved stimuli were looked at longer, and fixated faster, than their sharp counterparts. These results go against what would be expected if sharp contours were perceived as threatening; which leads us to believe that, in accordance with recent findings (Palumbo, Bertamini, Gheorghes, & Galatsidas, 2014), it might be attraction for curvature, and not aversion of sharpness, which determines primate preference for curvature.
This study was supported by the project FFI2010-20759 funded by the Ministerio de Economi a y Competitividad (Spanish Government).

[1P1M121] Either of vertical or horizontal stripes on clothing makes the wearer look slimmer

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There is a widespread belief that wearing horizontal stripes makes individuals look fatter. Thompson and Mikellidou (2011) showed that the Helmholtz and Oppel-Kundt illusions persist when used on cylinders and pictures of a body, suggesting that the belief is wrong. Swami (2012), however, reported that the body size was recalled larger when wearing horizontal stripes. We would like to investigate how stripes affect judgements about body size when bodies are being presented in a real space. Observers (n = 197 and 407 for Exp. 1 and 2, respectively) watched mannequins dressed either in horizontal, vertical, or diagonal stripes. We asked observers to rank the order according to perceived slimness. In experiment 1, the mannequin appeared the slimmest for horizontal stripes and looked less slim for diagonal stripes than for other stripes. In experiment 2, where the no-stripe condition was included, the mannequins in striped clothing looked slimmer than the mannequin in uniform grey clothing. The results suggest that any stripes on clothing make the wearer look slimmer. This could be because the curves of the stripes on a body serve as a cue to depth perception, enhance the perceived depth of a body, and lower the relative body width.

[1P1M123] How do emotions affect visual semantic search?

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The influence of the emotional valence of words on the search among the apparently meaningless sets of elements was investigated. The subjects (n = 28) were to identify and name lexical units which were located in the matrix (15x15) filled with letters. The hidden words were emotionally positive, negative or neutral (the emotional valence of the words was established in the preliminary study). Each matrix contained 10 words with close emotional valence. The order of the matrices varied, and the subjects didn't know the emotional status of the matrix in advance. The number of correctly named words, errors, and basic indicators of the eye movement were recorded. The results show that the positive emotional coloring of words enhances the effectiveness of the search: on average, subjects found one word more in an emotionally positive matrix. It was also found that the dwell time on the relevant areas of interest was longer as well as the total number of fixations and number of regressive saccades was higher when dealing with positive matrices rather than with negative and neutral ones. Evidently, the finding of the first word created the emotional priming effect that affected the organization of the further search.
This study was sponsored by the Russian Foundation of Basic Research (№14-06-00371).

[1P1M125] Kitsch: Is it better than its reputation? Comparing explicit and implicit aesthetic processing

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Explicit and implicit attitudes coexist in the human mind (Wilson, Lindsey, & Schooler, 2000). Due to impression management and social desirability conscious and unconscious representations may differ (Crowne & Marlowe, 1960). Discrepancies are particularly likely for judgmental or

controversial constructs, e.g. kitsch. The word "kitsch" is used to scorn something as sentimental, simplistic and aesthetically worthless (Kulka, 1996). A study (N = 31) was conducted to compare implicit and explicit kitsch judgements: Participants explicitly rated 20 pictures showing either richly decorated cups or plain bowls on three dimensions: kitschy-plain, beautiful-ugly and valuable-worthless. Subsequently, the same set of stimuli was used in a multi-dimensional Implicit Association Test (md-IAT) targeting the same three dimensions (Gattol, Sääksjärvi, & Carbon, 2011). As expected, cups (kitschy objects) were explicitly rated more kitschy, more ugly and less valuable than bowls (plain objects). In the md-IAT only the dimension kitschy-plain was selective in terms of cups and bowls. Surprisingly, neither beauty nor value were equally associated with both object categories (kitschy cups or plain bowls). Assuming that impression management accounts for such discrepancies, we speculate that participants were reluctant to admit that they felt susceptible to kitschy objects. Ultimately, this could imply that kitsch is better than its reputation.

[1P1M127] Extracting social information from the visual image of bodies

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A critical aspect of everyday social interactions is understanding who other people are and how we might expect them to behave. To date, neuroimaging studies have focussed on characterising the function of segregated patches of cortex along the ventral visual stream during person perception. It remains largely unknown, however, how such "body patches" functionally couple with other brain regions. Using fMRI and functional connectivity analyses, we investigated the hypothesis that person perception involves a distributed neural circuit, extending beyond the ventral visual stream. Silhouettes of neutral and trait-implying (muscular or overweight) bodies were presented to participants. When observing bodies that give rise to a social inference compared to neutral bodies, univariate analyses showed greater engagement of extrastriate and fusiform body areas (EBA, FBA). Additionally, there was stronger functional coupling between right FBA and right EBA, as well as between bilateral body patches and posterior parietal cortex. The results suggest that when extracting social information from another's body, there is increased connectivity within the person perception network, as well as between person perception network and a dorsal attention network. These findings underscore the importance of considering functional interactions within an extended neural network when investigating functionality of the ventral visual stream.
Economic and Social Research Council

[1P1M129] Unsolvable, yet insightful: The appeal of indeterminate and ambiguous artworks

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Indeterminate, ambiguous, or hidden images defy automatic identification but sometimes offer rewarding insights — such as the emergence of a familiar object within a random pattern in hidden

images, the so-called "Aesthetic Aha" (Muth & Carbon, 2013). Do insights affect the appreciation of artworks as well — even if they never provide a determinate, final interpretation? Here we report a study which aimed at differentiating between effects of ambiguity, solvability of ambiguity, and strength of insights on appreciation. Via multidimensional measurement of appreciation and a subsequent multilevel modelling analysis we revealed that modern and contemporary artworks were preferred with regard to liking, interest, and affect if they featured a high degree of ambiguity and if they provided a potential for strong insights. The estimated solvability of ambiguity, however, did not affect liking but was actually negatively related to interest and powerfulness of affect. We suggest that art perception differs from progressive problem solving in that it is qualified by repeated changes in semantical instability during elaboration — some of these dynamics are marked by rewarding gains of insights. Such dynamics might be crucial for a long-term fascination and appreciation for artworks that are not easy-on-the-mind.

[1P1M131] Three-dimensional Reconstruction of Traditional Chinese Calligraphy Arts for Realistic Perception

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Calligraphy of East Asian Characters is an important and appreciated aspect of East Asian culture, especially in the traditional Chinese culture. However, this art are often neglected nowadays. Since 3D details can be used to realistically present real-world surface structure of an object under various illuminations and viewing angles, we propose a 3D surface texture reconstruction method based on Photometric Stereo to provide users with a more realistic perception of digital art. Calligraphy of characters normally comprise various reflectance properties and rough surface geometry. With the presence of detailed 3D surface geometry of the Calligraphy Arts, Calligraphy fans, students and academic researchers can investigate the style of Calligraphy Arts more easily and effectively. Experiments have been performed on traditional Chinese Calligraphy Arts from the different historical periods and the reconstructed 3D results provide a convenient way and unique perception of art to the community.
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[1P1M133] It is more difficult to judge global properties of shapes described by vertices than by curvature extrema

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Contours are important to perceive solid shape. Along contours extrema of curvatures specify surface curvature. Vertices of polygons are a special case of extrema: when a vertex is perceived as convex (or concave) it is processed as a positive maximum (or negative minimum). A corner enhancement phenomenon would predict faster responses to probes located near vertices. We used polygons and their smoothed versions to compare vertices and extrema in two tasks involving global properties of shape. In Experiment 1 observers discriminated stimuli with bilateral symmetry from random stimuli. The contours were either closed forming a single object, or faced each other forming two separate objects. In Experiment 2 observers indicated whether a pair of stimuli were identical (translation) or different. In both experiments the presence of vertices or curvature extrema was task irrelevant. Because the visual system is tuned to processing smooth curvature, we expected lower performance on RT, accuracy and sensitivity (d prime) for polygons. In both Experiments when stimuli were regular smooth contours led to better performance. Perception of global shape from contours was harder when the convexities and concavities were vertices as opposed to curvature extrema. These findings are discussed in relation to theories of shape representation.
This work was supported by the Economic and Social Research Council (ESRC, Ref. ES/K000187/1)

[1P1M135] Spatial vision research in contemporary art practice: No room for 'perceptual errors'

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An unusual and misleading lack of correspondence between a perceptual object and an object in the external world is often referred to as 'perceptual error', or as 'non-veridical' perception. On a phenomenological level, there is no clear difference between veridical and non-veridical perception – usually, measurements or stimulus manipulations of some kind are necessary to reveal the deceptive nature of a perceptual experience. Here, we present a range of art installations that address the concept of 'perceptual error'. In particular, these installations are characterized by a reduced availability of potentially corresponding external world categories, enabling observers to focus on perceptual experience itself. For example, viewing high intensity, flickering lights with the eyes closed gives rise to rich perception of patterns and objects of varying levels of abstraction. The arrangement of decontextualized light spots in dark spaces triggers the perception of vivid, however, highly mysterious objects. Small spatio-temporal changes of line patterns yield rapid perceptual switching between 2D and 3D objects. By highlighting perceptual experience without corresponding external world categories, these works of art challenge notions of 'perceptual error' and 'veridicality'. We suggest that the installations are useful for experiential and theoretical education, investigating vision and phenomenal reality.
Ministry of Culture of the Republic of Croatia & The City of Zagreb (IF), FWO Pegasus Marie Curie Grant (BS)

[1P1M137] Are visual threats prioritised in the absence of awareness? A meta-analysis involving 2559 observers

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Many behavioral observations suggest that humans can evaluate the threat content of unconsciously presented visual stimuli. For instance, in the masked visual probe paradigm, threatening stimuli rendered invisible by backward masking can nonetheless capture spatial attention. In binocular rivalry and breaking continuous flash suppression paradigms, different stimuli are presented to each eye and compete for awareness. Increased perceptual dominance of threatening, vs. non-threat stimuli has provided evidence of a threat-related bias in these tasks. Here, we provide a meta-analysis of the evidence for a threat-related bias in visual processing from these three experimental paradigms. Across paradigms, the overall effect size was small ($k = 57$, $N = 2559$, $dz = 0.30$, 95% CI [0.17 0.43], $p < .001$) with substantial heterogeneity explained by the experimental paradigm and type of threat stimulus used. Interestingly, when fearful faces were removed from the analysis, the remaining threat-related bias was trivially small and non significant ($dz = 0.07$, $p = 0.35$) and we found no consistent evidence for a threat bias for other stimulus categories (e.g. angry faces, IAPS images, threatening words). Furthermore, our analyses provide quantitative evidence that poor control of awareness, low-level stimulus confounds and response biases undermine the evidence for apparently "unconscious" threat sensitive effects.

[1P1M139] Negative emotional objects cause pupil dilation despite low signal-to-noise conditions

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Semantically-relevant regions attract attention especially in case of emotional images, even in low signal-to-noise conditions. However, if visual noise is high, the semantic meaning of an image is not recognized. The emotional response measured as pupil dilation might precede the recognition of semantic meaning. Semantic regions of interest (ROIs) in neutral, positive, and negative images were selected by observers. Images were transformed by adding pink noise in several proportions to be presented in a sequence in a free-viewing paradigm. Pupil dilation was compared between fixations in the semantic ROIs and fixations in the background. Pupil dilation differed between fixations in semantic ROIs and in background, depending on valence, with larger pupil in case of negative than neutral and positive images. In semantic ROIs the significant difference between negative and other images emerged in lower signal-to-noise condition (80% of noise) than in case of background (70% of noise). At the level of 80% of noise the average accuracy of scene identification was only 13% above chance level, indicating that the content was not fully recognized. The results show that negative images are affecting physiological functioning even when their conscious identification is prevented by obscuring factors such as pink noise.
This work was supported by the Polish National Science Centre (grant number 2012/07/E/HS6/01046).

[1P2M002] Attention! Now That I've Got Your Attention Let Me Sway Your Judgement: Irrelevant, Salient Stimuli and Extreme Outliers Affect Decisions On Value

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We often have to make decisions on the basis of multiple sources of information. Previous work has found that people are able to accurately integrate values presented in Rapid Serial Visual Presentation (RSVP) streams to make an informed judgement of the overall value of the stream (Tsetsos, Chater & Usher, 2012). In this study we investigated whether people's value judgements can be influenced by salience driven attentional processes. Experiments 1 and 2 examined whether the presentation of irrelevant salient red items in a stream influenced accuracy of the perceived value of the stream. The results showed that an irrelevant high or low value red item led people to judge the stream as having a higher or lower overall value, respectively, compared to when the red item was absent. Experiments 3 and 4 showed that extreme outliers presented in the RSVP stream captured attention automatically, leading to less accurate report of subsequent items in the stream. Taken together the results show that people's valuations can be swayed by salient items and that outlier items automatically capture attention, leading to over-weighting of extreme values and less accurate judgements of value.

[1P2M004] Attending redundant information increases the precision of visual working memory for complex stimuli

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Recent evidence suggests visual working memory (VWM) capacity is inversely related to object complexity (Alvarez & Cavanagh, 2004). In this study, we compared memory for objects comprising one or two luminance gratings. Stimuli were circularly vignetted sinusoids comprising high (3.2 CPD), low (0.8 CPD), or both spatial frequencies. Trials contained a test and a probe stimulus with an inter-stimulus-interval of 2000-ms. In Experiment 1, test and probe stimuli were identical except for a change in orientation. In Experiment 2, test stimuli contained two gratings, and probe stimuli could contain one or two gratings at different orientations. Observers matched the orientation of the probe to the remembered test stimulus and a mixture model was used to estimate best fitting Gaussian and uniform components to the errors observed (Bays, Catalao & Husain, 2009). In Experiment 1, estimates of precision for objects containing one or two gratings were equivalent. In Experiment 2, precision was greater for probes containing two compared to a single grating. The results indicate redundant sources of information can increase the precision of VWM for complex objects. Importantly, this benefit was only obtained when observers were required to attend both gratings in the test to complete the task.

[1P2M006] Conversation, a risky business: Naturalistic conversation changes risk behaviour and loss perception

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We often hold conversations whilst performing other everyday activities. However, conversation can interfere with our ability to perform tasks that require our attention (e.g., Strayer, Cooper & Drews, 2004). In the current study we used the Columbia Card Task (Figner, Mackinlay, Wilkening

& Weber, 2009) to assess the effect of conversation on risk taking behaviour and the perception of loss events. The number of cards turned over on each trial was used as a measure of the level of risk taking and we also recorded physiological measures (Electrodermal Activity). Whilst conversing, participants: i) made riskier decisions (turned over more cards), ii) were less likely to use information designed to assist them in their decision making, and iii) were significantly less likely to experience a physiological response to loss events, suggesting that conversation reduced the emotional impact of making a bad decision. The results are considered in terms of the influence of conversation on attention, perception and decision making, and the impact on real-world performance such as driving behaviour.
This work was supported by an ESRC collaborative studentship with Dorset Police, UK.

[1P2M008] An optimum stimulation method in SSVEP-Based researches and BCIs

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Recent researches, especially brain-machine interface (BMI) studies, often used the EEG component caused by flickering visual stimulus, which is called steady state visually evoked potential (SSVEP). Nevertheless, the suitable frequency, duty cycle, and stimulators are still incompletely understood. We investigated the difference of SSVEP caused by different stimulators (the cathode ray tube (CRT), liquid crystal display (LCD), and VIEWpixx monitor). We recorded the SSVEPs presenting a square flickering in the frequencies (7.14 Hz, 10 Hz and 12.5 Hz) and duty cycles (10% and 50%). As a result, the elicited SSVEP by presenting stimuli on CRT and VIEWpixx showed a similar tendency: SSVEP amplitude of harmonics was significantly higher than that of the fundamental frequency in the case of 50% duty cycle except for 12.5 Hz. Only the LCD showed the fundamental frequency power to 10% duty cycle was larger than that to 50%. These differences suggested the importance of selection of stimulators, and duty cycles for SSVEP research.
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[1P2M010] Eye movement strategies are not optimal: people simply employ reasonable but idiosyncratic search strategies

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The ideal searcher framework postulates that during visual search the observer directs attention in order to maximise knowledge on a target's location, taking into account retinal sensitivity. As the human visual field maintains high resolution further horizontally than vertically an implication is that humans are likely to exhibit many short eye-movements in an approximately horizontal direction and then make an occasional jump vertically. This particular behaviour has been observed previously in a visual search task by Najemnik and Geisler (2005, 2008). We tested this hypothesis by repeating their search task, and, as their data was based on two participants, we

increased the number of participants in order to assess whether this behaviour is a general strategy across participants. We took a novel analytical approach by using Hidden Markov Models, allowing for the identification of clusters (i.e., horizontal short saccades and vertical long saccades) in the data, as well as the transitions between clusters. Results however showed the two expected clusters could not be identified from the full dataset. Rather we found that strategies vary across participants. Based on these results we theorise that priming may have influenced the predominance of particular eye-movements. We present some initial results investigating this hypothesis.

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[1P2M012] Overlapping neural codes: Individual frontal voxels are more likely to be re-used if the encoded stimuli are more distinct

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In everyday life we need to select relevant information and ignore distraction. A circuit of frontal and parietal areas, including the anterior cingulate cortex (ACC), are believed to support this process by adjusting their responses to selectively process information that is currently relevant (Duncan, 2001). In different tasks, the same neurons may be "re-used" to code different information. Evidence from non-human primates suggests that the extent to which neurons can be re-used between tasks depends on the similarity of the stimuli (Cromer, Roy & Miller, 2010). To examine this in humans, we developed a variant of multivoxel pattern analysis for functional magnetic resonance imaging data. In two independent data sets, we established the multivoxel codes for different visual stimuli and then assessed the extent to which the same voxels were used in each code. We predicted a counter-intuitive increase in the extent to which voxels were re-used when the encoded stimuli were more different from one another. Indeed, in the ACC, a larger proportion of voxels were re-used to code dissimilar visual objects than were to code different aspects of the same visual objects. This suggests that the flexibility of population coding depends on the demands of the task.

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[1P2M014] Not only excitation but also inhibitory processing is carried over into the subsequent task

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It is known that a prior mental activities crucially affect the performance of subsequent task; carry-over effect (e.g., Hine & Itoh; 2014). There are two accounts of carry-over effects. First, excitation of an appropriate processing in a prior task could lead to greater propensity to use in the subsequent task. Second, inhibition of an inappropriate processing could lead to greater tendency to use in the subsequent task. Most of previous studies focus on the excitation of an appropriate processing. Here, to investigate the possibility that inhibitory processing could be

carried over into the subsequent task, we conducted the experiment in which participants engaged in Global or Local Navon task (Navon, 1977), and then took a Stroop task that was an indicator of inhibitory processing. Global Navon task is reading large letters in Navon figure, which is large letter consist of small letters. On the other hand, Local Navon task is reading small letters in Navon figure, and is required inhibitory processing. Our results showed that the accuracy of Stroop task after Local Navon task was higher than that after Global Navon task. This indicates that inhibition of an inappropriate processing is carried over into the subsequent task.

[1P2M016] Letters in the forest: global precedence effect disappears for letters but not for non-letters under reading-like conditions

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Normally skilled reading involves special processing strategies for letters, which are habitually funneled into an abstract letter code. Previous studies predict an analytic strategy for the processing of letters, while non-letters are preferably processed via a holistic strategy. The global precedence effect (GPE) seems to contradict to this assumption, since, with compound, hierarchical figures, including letter items, faster responses are observed to the global than to the local level of the figure, as well as an asymmetric interference effect from global to local level. We argue that with letters these effects depend on presentation conditions; only when they elicit the processing strategies automatized for reading, an analytic strategy for letters in contrast to non-letters is to be expected. We compared the GPE for letters and non-letters in central viewing, with the global stimulus size close to the functional visual field in whole word reading (6.5° of visual angle) and local stimuli close to the critical size for fluent reading of individual letters (0.5° of visual angle). Under these conditions, the GPE remained robust for non-letters, but disappeared for letters. We interpret these results as according to the view that reading is based on resident analytic visual processing strategies for letters.

[1P2M018] Timed object naming in Russian language

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Picture naming norms were collected in different countries as language specific factors have large effects on the performance in this task (Bates et al., 2003). The aim of this study was to acquire picture naming norms for Russian. For this study, thirty-three native Russian speakers ranging from 18 to 22 years (23 female) named each of 520 black-and-white pictures of objects as quickly as possible. These pictures were taken from the standard IPNP database set (Szekely et al., 2002). Dominant name, name agreement score, percent of valid and invalid answers as well as instances when a subject could not name the object were recorded for each picture. The mean naming times for dominant words and the general mean naming times for each picture were calculated. Comparison of Russian scores to English norms identified pictures where naming rate and other variables differed significantly, as well as pictures that did not differ significantly from English norms. Some of the depicted objects were less familiar to native Russian speakers

compared to other groups. Thus, it is necessary to use norms collected for Russian in studies with native Russian speaking participants.
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[1P2M020] Frontal transcranial random noise stimulation improves the acquisition of verbal knowledge

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Acquisition of verbal knowledge is a crucial skill, and people spend considerable amounts of time and energy to learn new information. Brain areas involved in the working-memory function can be stimulated to improve performance in various cognitive tasks, such as the n-back and attentional tasks. However, it is still unknown whether the stimulation of these areas can improve acquisition of verbal knowledge –encoding information into semantic memory. As the working-memory function is supported by cortical areas in the frontal and parietal lobes, we determined which of these areas is directly involved with verbal knowledge acquisition. Transcranial random noise stimulation, or tRNS, was used to answer this question. Participants carefully read a passage and were then required to write anything they could remember about it. This memory task took place five minutes and seven days after the initial reading of the passage. Participants were stimulated using tRNS over the frontal or parietal lobes; a placebo group was included too. Frontal stimulation, but not the parietal, substantially improved memory performance compared to the placebo condition. This effect was evident both immediately and in the long-term. These results suggest that the frontal cortex contributes to the encoding of verbal information within semantic memory.

[1P2M022] Anatomical dissociations of forward and backwards semantic processing in the cerebellum using theta burst stimulation

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The cerebellum is an area commonly involved in the learning and prediction of motor sequences. Recently, some researchers have begun to study its involvement in other higher order functions, such as visual semantic processing from words. Argyropoulos (2011), for example, stimulated medial areas of the cerebellum, producing a boost in semantic priming. This effect has been explained as a demonstration that the cerebellum does not only model the association between perceptual and motor units but that would also work at higher levels, including semantic associations. In this study we wonder if the cerebellum has a role no only in forward associations normally study in semantic priming (i.e., DOG-BONE), but also in backward ones (BONE-DOG). To do so, we replicated the previous study by Argyropoulos and extended it to the evaluation of backward priming pairs. Results demonstrated a clear anatomical dissociation with an increase in backward priming after stimulating the left cerebellum and an increase in forward

priming in the right cerebellum. These results are discussed with respect to current models of the cerebellum and their role in semantic processing.

[1P2M024] Lesions of the Medial Occipito-Temporal cortex affect spatial binding of sensory and memory data

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Occipito-temporal cortex is parcellated, with medial regions having a greater representation of the visual periphery than regions along the lateral aspect. Imaging studies have suggested disparate functions for medial regions. These proposals do not generally account for the dramatic impairments of attention and memory displayed by patients with strokes in medial Occipito-Temporal cortex. We examined a middle-aged man, who had suffered bilateral posterior circulation strokes involving the medial Occipito-Temporal cortex. The patient showed impaired recognition of compound objects, when constituent parts were rearranged, but not, for example, when their shape was changed. The patient was impaired when recalling the color of an object from visual working memory, only when the object was identified by its location, rather than shape. He showed a specific liability to long recall delays, with an increase in spatial binding errors. The patient had no difficulty discriminating large and small objects, or performing a facial discrimination task, as long as the task did not require the appraisal of fine spatial relations between facial features. We conclude that medial Occipito–Temporal Cortex is crucial for spatial binding of perceptual and memory information, in part because of its role in maintaining stable spatial representations over time.

[1P2M026] Cross-dimensional correspondences in perception enhance short-term memory for congruent but not incongruent shape-elevation and shape-pitch feature pairs

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Recent research exploring perceptual correspondence between and within sensory modalities has demonstrated behavioural advantages when to-be-judged targets are congruent with concurrent distractors (Spence, 2011). This phenomenon holds for a range of perceptual dimensions (e.g. shape- pitch, size-weight, etc). The experiments reported here go beyond current perceptual experience and instead explore the influence these correspondences have on short-term memory. Two experiments tested the idea that congruent dimensions would enhance recognition. In a change detection task participants encoded either six concurrently presented shape-elevation objects (Expt 1: e.g. angular-high, rounded-low), or four sequentially presented pitch-shape pairs (Expt 2: e.g. high-angular, low-rounded). Pairings in both experiments were

equally likely to be congruent or incongruent. A single pair was tested after a 2 s delay. For shape-elevation, performance was influenced by the congruence between the elevation of the object and its shape, with congruent pairings enhancing performance significantly with a large effect size. For pitch-shape, change detection was again significant, with congruent pairs enhancing memory. The results imply that congruent correspondences across the perceptual features of an object or event improve memory. This may be the result of attention prioritising congruent pairings, or object-based binding mechanisms dedicated to the typical feature pairings of an object.

[1P2M028] Slots or resources? It depends on the type of visual memory

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Is short term memory essentially based on slots or resources? The slot model claims that there are a limited number of slots with a fixed precision, while the resource model posits that resources can be distributed gradually, causing a trade-off between capacity and precision. The current research investigated this topic in a change detection task with oriented bars. To evaluate the precision of the memory representation we varied the size of the change (30°, 60°, or 90°). Furthermore we precued a location, to evoke different attentional strategies. We focused on two types of short-term visual memory, Fragile Memory (FM), and Visual Working Memory (WM). FM is the visual memory available before visual interference, and WM is the memory available after visual interference. It is generally found that FM has a much richer capacity than WM.
Interestingly, we found that for FM, precision at the invalidly precued and uncued locations was similar. In contrast, for WM precision at the invalidly precued location was lower than precision at the uncued locations. This suggests that the slots or resources debate may not yield one answer. FM may be based on slots with a fixed precision, while WM may be based on limited resources.

[1P2M030] Internet Based Measurement of Visual Expertise in Radiological Skill

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The correct identification and diagnosis of abnormalities from radiographs is one of the best examples of real-world expertise in visual tasks. Accordingly, understanding and measuring the development of this skill has attracted great interest from visual perception researchers and radiology instructors alike. However, significant challenges remain in collecting behavioural data from trainees and experts who are dispersed geographically and whose availability is limited. We therefore developed a web-based task to measure visual diagnostic skill. Participants viewed a selection of pre-assessed radiographs and were required to identify and localise skeletal abnormalities. 42 final year medical students at the University of Sheffield and 12 consultant paediatric radiologists from across Europe completed the two-stage task. As expected, consultants were significantly more accurate at identifying abnormalities than medical students, and their localisation of abnormalities was significantly more precise. However, in contrast to

previous research, we found that the experts took longer over the task than novices. The results validate the use of a web-based platform for studies of visual cognition expertise in a real-world domain. Future work will add eye-tracking measures to the behavioural task, while the ease of data collection will allow both longitudinal and large-scale behavioural datasets to be collected.
This work was supported by a grant from The Children's Hospital Charity Research Fund

[1P2M032] Variations in implicit social learning in the typically-developed population

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The ability to implicitly or spontaneously learn about others' pro- or antisocial dispositions on the basis of a multitude of social cues is crucial for effective social interaction. The aim of the current study was to investigate variations in implicit social learning abilities in typically-developed individuals with few or many autistic traits, as assessed by Autism Quotient (AQ) questionnaire. In the learning phase, participants repeatedly observed two different identities whose gaze direction and facial expression were manipulated to convey either a pro- or anti-social disposition towards the observer. These dispositions were determined by specific cue contingencies, of which participants were crucially not aware (as confirmed in the debrief). In the test phase, participants showed specific biases in their perceptual report of morphs of the two identities, suggesting that others' dispositions can be learned implicitly, that is, without awareness of the cue contingencies. Importantly, this ability was correlated with AQ scores; participants with higher AQ scores showed significantly less implicit social learning. Future research will examine whether individuals with autism are even more impaired in implicit social learning ability, which may explain their difficulties in adjusting behavior to social demands, and whether it is limited to the social domain.
SM and MK were funded by Hull University studentships.

[1P2M034] Distributed adaptation facilitates long-term face aftereffects

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Adaptation is a neural mechanism supporting the optimisation of visual processing on the basis of previous experiences. Perceptual short-term effects of adaptation have been studied extensively, however recent evidence from the study of long-term aftereffects point also towards a significant role of adaptation in learning about the visual properties of the world in the long run. Here we tested the effects of different adaptation protocols on face distortion aftereffects along multiple time scales. In all experiments adaptation to a distorted image of a famous person biased participants' perception of the original face. These shifts were as large and as stable in a group of participants who followed a distributed adaptation protocol (10×1 min of adaptation within 1 h) as in a group of participants who underwent blocked adaptation (1×10 min within 1 h). However follow-up experiments revealed modulations of this pattern when the degree of visual interference during the interval between different parts of the experiments was varied (low versus

high visual interference). These findings suggest differential neural mechanisms to operate in perceptual short-term aftereffects as opposed to long-term adaptation more closely associated with stable and on-going adjustments of the sensory systems.

[1P2M036] White-matter connectivity for learning of hierarchical structures

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Acquiring new skills (e.g. language, music) and navigating in novel environments involves extracting hierarchical structures from simple repetitive patterns to more complex probabilistic combinations. However, little is known about the brain circuits that support this learning of hierarchical structures. Our previous fMRI work has implicated fronto-parietal regions in learning of simple repetitive structures, whereas subcortical regions in contextual learning. Here we combine behavioural and Diffusion Tensor Imaging (DTI) measurements to test whether white-mater connectivity in these brain circuits changes with learning of hierarchical structures. Observers were trained with sequences that were determined by their frequency of occurrence, followed by sequences determined by their temporal context. We measured performance during training (i.e. learning rate) and fractional anisotropy (FA) – a DTI-derived estimate of white-matter connectivity – before and after training on these two sequence types. Regression analyses showed that for learning of simple repetitive structures learning rate predicted increased FA in inferior parietal cortex. In contrast, for context-based sequences learning rate predicted increased FA in striatum (putamen). Our findings suggest that learning hierarchical structures is implemented by brain connectivity changes in posterior parietal regions for frequency statistics, while subcortical regions for more complex probabilistic combinations.
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[1P2M038] Tracking Perceptual Uncertainty in Rapid Serial Visual Presentations

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Optimal multisensory integration (Ernst & Banks, 2002) and dyadic interaction (Bahrami et al., 2010) rely on computing the uncertainty of visual information. But this is at odds with decision-making models disregarding evidence reliability (Ratcliff & McKoon, 2009) and with data showing

that variance is severely underweighted in confidence judgments (Zylberberg, Roelfsema & Sigman, 2014). Here, we asked whether subjects can track the reliability of serially presented visual information and how it guides choice and confidence. Participants (N = 20) observed a sequence of 30 tilted Gabor patches in rapid serial visual presentation at 4 Hz. The orientation of the patches was drawn from uniform distributions with different variance. Subjects were instructed to report the grand-average tilt of the patches compared to the vertical meridian (clockwise or counter-clockwise) and to state their confidence (from 1 to 6). We observed that objective and subjective performance decreased with increasing variance. We explain these results using a learning model that updates both mean and variance but with different rates. We propose rules for combining these quantities in order to reproduce the observed patterns of choice and confidence. Overall, our results provide novel insights on how uncertainty is tracked by the visual system and communicated as confidence.

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[1P2M040] Under-stimulation at untrained orientation may explain orientation specificity in perceptual learning

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Perceptual learning (PL) can transfer completely to an orthogonal orientation if the latter is exposed through an irrelevant task (Zhang et al., 2010). PL thus is more likely rule-based cognitive learning. Here we used a continuous flashing suppression (CFS) paradigm to investigate why PL is orientation specific in the first place. Foveal orientation training was combined with various conditions of orthogonal orientation exposure that was rendered subconscious with dichoptic flashing white noise. Observers first reported the color of a dot centered on the noise, without knowing the presence of the subconscious orthogonal Gabor. This bottom-up exposure produced partial transfer. In a top-down "exposure" condition, observers guessed whether a Gabor/letter-C was presented while no Gabor was actually shown, which failed to produce transfer. However, when the orthogonal Gabor was actually present, transfer was complete with this combined bottom-up and top-down exposure. These results indicate that bottom-up orientation exposure is required for learning transfer, and that orientation specificity may result from under-stimulation of untrained orientations, either unstimulated or suppressed during training. Although top-down influence has no impact on transfer, it can boost the effect of bottom-up exposure, so that high-level learning can functionally connect to new orientation inputs for complete learning transfer.

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[1P2M042] The perceptual costs and benefits of learning to multitask

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Perceptual learning defines the ability to improve perceptual performance through practice. Most work in this field has focused on the rules governing transfer of learning between different perceptual tasks or the magnitude of learning with different temporal patterns of stimuli. Here we examine the perceptual costs and benefits of learning multiple perceptual tasks at the same

time with stimuli drawn from the same or different visual dimensions. Using the method of single stimuli, one group of observers simultaneously practiced discriminating the mean orientation (45 deg.), spatial frequency (2.5 cycles/deg.) and envelope size (SD 0.66 deg.) of a Gabor over eight daily sessions. Three other groups independently practiced discriminating multiple mean orientations (30, 45, 60 deg.) spatial frequencies (1.5, 2.5, 3.5 cycles/deg.) or envelope sizes (SD 0.33, 0.66, 0.99 deg.) over eight days. A numeric cue indicated the implicit mean to be discriminated on the next trial. When stimuli were drawn from independent visual dimensions, observers learned with the same rate and magnitude on all tasks, but with stimuli drawn from the same visual dimension, there was a cost for learning on multiple tasks. Our results demonstrate there is no cost to multitask perceptual learning with stimuli on independent visual dimensions.
This work was funded by The Leverhulme Trust

[1P2M044] Perceptual training of faces in rehabilitation of acquired prosopagnosia

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Despite the large number of studies on prosopagnosia, there have been few attempts at rehabilitation. Here, we determine whether perceptual learning can be used in the rehabilitation of acquired prosopagnosia. Nine acquired prosopagnosics completed a 12-week face training program and a 12-week control task. Patients were presented with 3 faces and were asked to determine which of the bottom two faces most resembled the top face. A staircase procedure was used to tailor the training to each patient, in which faces became increasingly similar as performance improved. Training began with neutral front-on faces, and varied across expression and viewpoint as the training progressed throughout the weeks. Following training, we observed an improvement on trained faces (23%), as well as for new untrained expressions (28%) and viewpoints (20%), but less on untrained identities (8%). With the exception of untrained identities, improvements were significantly larger following training as compared to the control task. Finally, we found no pattern between lesion location and the benefit of training. In summary, perceptual learning may be a useful tool for improving face recognition in acquired prosopagnosia, allowing generalizability across viewpoints and expressions, but may be limited in its generalizability to new identities.

[1P2M046] Impaired configural processing for other-race faces revealed by a Thatcher illusion paradigm

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Thompson (1980) described the Thatcher illusion, where participants perceive upright faces with inverted eyes and mouths as grotesque but fail to do so when they were inverted, presumably the result of disrupted configural processing in inverted faces. Furthermore, other-race faces are processed less configural (more featural) than own-race faces (e.g., Meissner & Brigham, 2001) and Thatcherisation and inversion lead to stronger impairments in configural processing of own- compared to other-race faces (e.g., Hahn et al., 2011). The present study tried to identify differences in processing own- and other-race faces (thatcherised or not) not only in upright or inverted positions but also for intermediate steps of 30°, following Carbon et al. (2007). Data of 20 participants showed a characteristic sudden increase in reaction times of correct trials for own-race faces once they were rotated by more than 90° (impairing configural processing), whereas there was no such difference for other-race faces. Accuracy was worst for thatcherised other-race faces with a steep decrease starting between 30° and 60° of rotation. Between 150° and 180° performance increased slightly, a minor effect Carbon et al. (2007) already observed in prosopagnosics (non-experts in face processing). Overall, results argue for non-expertise-based, probably featural, processing of other-race faces.

[1P2M048] Effects of configural processing on the perception and the spatial resolution of face features

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The face inversion effect, in which performance is typically better for upright compared to inverted faces, is an established marker of configural face processing. In a series of experiments, we tested whether configural processing influences basic visual abilities such as the perceptual spatial resolution and the perceived distance between features. These abilities were assessed by measuring the just noticeable differences (JNDs) and the perceived differences between different facial features in upright and inverted orientations. The results revealed robust inversion effects for spatial sensitivity to configural-based changes, such as the distance between the mouth and the nose, or the distance between the eyes and the nose. However, JNDs for face features within the eye region (e.g., the distance between the eyes) were not affected by inversion, implicating that this region operates as a separate 'gestalt' unit relatively immune to manipulations that would normally hamper configural processing. Unlike JNDs, the perceived distances between features were affected by inversion across all facial regions including the region of the eyes. Overall, the findings implicate that configural processing modulates different psychophysical abilities in different manners. Furthermore, they indicate that classic psychophysical methods can be used as sensitive measures of different properties of configural face processing.

[1P2M050] What personal factors lead to individual differences in categorizing facial expressions of emotion?

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Individuals vary in perceptual accuracy when categorizing facial expressions, yet it is unclear how these individual differences are related to cognitive processing stages at facial information selection, acquisition and interpretation. By presenting face images displaying six basic facial expressions of emotion with different intensities, we measured expression categorization

performance from 104 healthy adults. The categorization accuracy was then correlated with their information selection (gaze allocation at diagnostic local facial regions) and interpretation abilities (personal traits assessed with Autism Quotient, anxiety inventory, and self-monitoring scale). The observers' gaze allocation had clear impact on categorization accuracy of some expressions displayed at medium/high intensities. Specifically, longer gaze at the eyes or nose region were coupled with more accurate categorization of happy/disgust/surprise or sad expressions, respectively. Regarding personal traits, higher anxiety level was associated with greater categorization accuracy across all expressions, whereas higher autistic score was coupled with better recognition of sad but worse recognition of angry expressions. Furthermore, an individual's anxiety level was positively correlated with the amount of gaze at the nose region for all expressions except for happy. The results suggest that both facial information selection and interpretation capabilities contribute to individual differences in expression categorization within non-clinical populations.

[1P2M052] Dynamic Facial Expression Recognition in Low Emotional Intensity and Shuffled Sequences

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There have been several studies focusing on the dynamic aspects of facial expression recognition. However, the effects of dynamic facial expressions such as low emotional intensity and presentation in shuffled sequences remain unclear. In this study, utilizing actually unfolded dynamic facial expressions by a real expresser, we made one condition with regularly ordered sequences depicting dynamic changes from onset of the expression to the point at which it is most marked, and another with only to low emotional intensity (onset to 40%), and then shuffled these sequences. We asked participants to identify emotions for each sequence, and then measured recognition accuracies and response times. The findings show although recognition accuracy was slightly low for the expression of fear, overall accuracy was significantly higher than chance even when the sequences were composed of shuffled frames. Additionally, the effect of shuffling did not appear in response times, but longer response times were observed for negative facial expressions with low emotional intensity. These results suggest that humans are sensitive to dynamic facial expression with low emotional intensity and subtle changes in facial movements, and also suggest that ordered temporal flow is not required for dynamic facial expression recognition.

[1P2M054] The visual information driving familiarity and identity judgements from faces

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The assessment of another as familiar and the ability to establish their unique identity are the two components that underlie our remarkable face-recognition abilities. A considerable body of work has explored the neural underpinnings of these abilities and debate remains regarding whether they are dissociable, i.e., the separate constituents of a dual process, or rather constitute different

aspects of the same retrieval process. Even less is known about the specific visual information that is used to determine the familiarity of a face and/or to identify it by name. Here we sought to establish the critical information underlying participants' judgments of facial familiarity and identification. To this end we created a new standardised stimulus set comprising 6 personally familiar faces (3 male) and 12 unfamiliar faces from members of the teaching and research staff at Birkbeck College. We then applied the Bubbles reverse-correlation methodology to establish the information driving correct performance in each task. 29 final year Birkbeck students participated in the study. Results indicated that markedly different information underlies familiarity and identity judgements, with familiarity driven by lower spatial frequency broad facial cues (eyes, mouth and face shape), whereas identity decisions rely on fine details in the eyes and mouth.
This work was supported by Leverhulme Trust grant RPG–2013–019.

[1P2M056] Active and passive exploration of faces

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In most face recognition studies, learned faces are shown without a visible body to passive participants. Here, faces were attached to a body and participants were either actively or passively viewing them before their recognition performance was tested. 3D-laser scans of real faces were integrated onto sitting or standing full-bodied avatars placed in a virtual room. In the 'active' learning condition, participants viewed the virtual environment through a head-mounted display. Their head position was tracked to allow them to walk physically from one avatar to the next and to move their heads to look up or down to the standing or sitting avatars. In the 'passive dynamic' condition, participants saw a rendering of the visual explorations of the first group. In the 'passive static' condition, participants saw static screenshots of the upper bodies in the room. Face orientation congruency (up versus down) was manipulated at test. Faces were recognized more accurately when viewed in a familiar orientation for all learning conditions. While active viewing in general improved performance as compared to viewing static faces, passive observers and active observers – who received the same visual information – performed similarly, despite the absence of volitional movements for the passive dynamic observers.

[1P2M058] Adaptation to Perceived and Imagined Facial Gender

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Perceptual adaptation studies show that prolonged exposure to a face (adaptor) typically results in a contrastive face aftereffect (FAE) where a subsequently presented face appears less like the adaptor. As a process recruiting perceptual brain areas, visual imagery is expected to generate similar FAEs. Recent studies of imagery adaptation to facial gender have however yielded inconsistent results. While some experiments report contrastive FAEs, other experiments report no effect or atypical (i.e. non-contrastive) FAEs. In a recent study, D'Ascenzo et al. (2014) observed atypical FAEs, in which androgynous faces appeared more feminine after imagining female faces of recently familiarised strangers than after imagining male faces. Our

study aims to replicate this observation and to investigate the effect of familiarity on adaptation to perceived and imagined facial gender. We found stronger adaptation for celebrities than unfamiliar faces in both perception and imagery tasks, and no evidence of atypical FAEs for imagery. These findings suggest that familiarity may have a modulatory effect on adaptation to perceived and imagined facial gender.

[1P2M060] Influence of viewpoints on facial age perception with eye movement analysis during making a judgment

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The influence of viewpoints on facial age perception is largely unknown. In this study, we focused on the relationship between viewpoint of a face and eye movement during making a judgment of age. 280 Japanese females in their twenties to sixties were recruited as models, and their three dimensional facial shape data were obtained by a stereo camera system. Images of 7 viewpoints of the face including frontal, various horizontal/vertical oblique views were created as stimuli. An ABX paradigm was adopted as a task during gaze recording, where two faces of A and B were presented successively and observer was asked to select face $\times$ from one of A and B as the face looked more aged. A frontal face was always displayed as A/B paired with a face as B/A of another model in one of angled views (including frontal view). The results of ROI analysis of eye movement indicated that observers more intensely viewed around eyes and mouth area of the frontal face, whereas the gaze tended to be dispersed to other areas of same person's face in angled view. In addition, the effects of eye movement and of evaluated age varied in different age groups.

[1P2M062] Influence of facial skin movement and viewpoints on age perception

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In previous studies on facial age perception, static facial images were evaluated on the basis of the static frontal view of neutral, inexpressive face. We conducted an experiment to find out whether motion of faces has any effects on perceived relative age-group by comparing dynamic display to static images. 80 Japanese females in their twenties to sixties were recruited as models, and their regulated facial movements (stretching vertically/horizontally, and puffing out their cheek etc.) were utilized for stimulus movies. In addition, four simultaneous video-recordings as view points were incorporated. In experiment, movies in dynamic condition were presented as continuous changes in their expressions, whereas control movies in static condition were presented as static images selected from each relevant movie of each model at the maximum intensity of facial expression. Participants observed each face in a trial, and made judgement by 2AFC whether the face is in the first half or second half of each age group (meaning an age group as 5-year step). The results indicated that there was a difference in age estimation between

dynamic and static faces; dynamic face is perceived higher age than static one. Moreover, viewpoint dependence was also found in estimated groups of ages.

[1P2M064] On the genesis and processing of facial representations and prototypes

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Face researchers address a huge variety of perceptual and processing issues of faces while hardly addressing how exactly facial representations and prototypes are generated and on which experiences they are established. In the present study we investigated the process of unfamiliar faces become familiar. Accordingly, we let participants position 20 facial presentations of an unfamiliar individual spanning a period of $\sim$60 years on a checker-board with coordinates according to their similarity (in a between-participants-design we employed 4 different unfamiliar persons with one randomly assigned to each participant). Subsequently, participants had seven days to get familiar with these depictions by use of an online face-learning task. In a test-retest fashion, we replicated the initial positioning task, one week later. Analyses by means of cluster analysis and multidimensional scaling revealed clear sub-prototypical clusters of the facial outward appearance of the persons providing first hints that each development period of a person reflects genuine clustered prototypes clearly opposing the idea of a super prototype spanning an entire life of a person.

[1P2M066] Influence of spatial frequencies on early stages of face processing: an event-related potentials study

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Face perception requires coarse configural information and finer featural information transmitted respectively by low spatial frequencies (LSF) and high spatial frequencies (HSF). Results on the early visually evoked components P100 and N170 in response to LSF and HSF filtered images appear contradictory. Particularly, the N170 amplitude was found larger or smaller for HSF compared to LSF face stimuli among studies. Discrepancies might stem from differing methodologies.
The aim of this study was to investigate the time course of SF integration with controlled face stimuli and provide information on how these information form the facial representation. Face images, calibrated in luminance and contrast, were presented in four conditions (LSF ($<$8 cycles/face), middle range SF MSF (8–16 cycles/face), HSF ($>$32 cycles/face), and non-filtered (NF)) during a gender discrimination task through ERP recording. Analysis showed that the P100 amplitude evoked by LSF was larger than HSF stimuli. The N170 amplitude was smaller for HSF than LSF

stimuli. As expected, MSF and NF evoked similar amplitudes. In line with previous studies, LSF supporting configural information are primarily processed (P100) by the visual system while HSF associated with featural information are of later relevance (N170). Results corroborate the coarse-to-fine hypothesis of SF integration.

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[1P2M068] An encoding advantage for own-race faces in Taiwanese participants: A morphing face study

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The "other-race effect" (ORE) is a reliable, cross-cultural observation but little is known as to the exact stage of visual processing at which ORE may come into play. Using a morphing face technique, Walker and Tanaka (2003) reported a small but significant perceptual encoding advantage for own-race faces over other-race faces in Canadian Caucasians. Here we adopted a similar approach to explore the encoding advantage hypotheses in Taiwanese participants. The method of constant stimuli with swathes of morphed images of Caucasian and Asian male and female faces were used. In each trial, the participant viewed an Asian or Caucasian parent face followed by either the "same" face (0%) or a "different" morphed face (i.e., 10%, 20%, 30%, 40%, or 50% contribution from the other race face) with equal probability. The results showed that Taiwanese participants ($N = 20$) had a higher rejection rate for Asian-parent condition than that of Caucasian-parent condition. Furthermore, fitted with a 4-parameter sigmoidal function, the participants' data exhibited a significantly lower discrimination threshold (22.76% for Asian vs. 44.22% for Caucasian) and a steeper slope (0.849 for Asian vs. 0.812 for Caucasian) in the Asian-parent condition. In sum, our results lend a strong support for the encoding advantage hypothesis.

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[1P2M070] Help or hindrance: do facial expressions facilitate identification?

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Behavioural research suggests some degree of interdependence between the processing of facial identity and facial expressions, although this relationship remains unclear. We investigate this using an identity categorisation task that incorporates the extensive within-person variability represented by ambient photographic images. Following Jenkins, White, Van Montfort and Burton (2011), eighty-five participants sorted ambient facial images of 2 unfamiliar actors into piles, one for each separate perceived identity. Participants underwent two conditions (order counterbalanced across participants), one in which the images were expressive and one in

which they were neutral. Expressiveness/neutrality was determined by prior experimentation. We used a measure that combined the number of identities into which images were sorted, along with the internal consistency of those identities. We found no evidence of a performance difference when comparing the neutral-first and expressive-first tasks, however there was a robust increase in performance on the neutral-second task – prior sorting of expressive faces confers a performance benefit. These findings suggest that successful identification of a newly-encountered face is substantially improved by viewing that face with a range of expressions, over and above the recognition rates arising from exposure to more canonical neutral expressions.

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[1P2M072] Facelikeness mediates individual-level discrimination for novel objects: Evidence from extensive training

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Visual expertise leads to fast and automatic individual-level recognition. However, the factors leading to expertise acquisition remain unknown. For instance, adults can learn to quickly and effortlessly name novel objects called Greebles (Gauthier & Tarr, 1997) but this finding may be attributable to the observation that Greebles have, at least at an abstract level, a typical facelike configuration of parts (two eyes above a nose, above a mouth). Here we tested whether the facelikeness of novel objects affects expertise acquisition. Two groups of 11 participants underwent extensive training (20 hours, 2 weeks) with a well-controlled set of novel objects (Willenbockel et al., 2014). The groups differed in whether the picture-plane orientation of the objects led to a facelike or nonfacelike configuration. Both groups reached the same level of performance on naming, verification and visual search tasks. However, the facelike group performed significantly faster in a matrix scanning task (Wong et al., 2009). This task placed a high demand on individual-level discrimination as it required fast and accurate scanning for changing target objects in an array of objects. These findings demonstrate an important role of facelikeness in shaping behavioural responses to novel objects despite the same amount of extensive training.

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[1P2M074] Color induction in the face using eyeshadows of desaturated colors

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Among makeup professionals, two different methods are used to improve skin complexion. It is still an open question how color difference between facial versus makeup colors affects the perceived complexion. The present study examined the effect of eye shadows on the complexion. Eight physically, almost equally, modestly saturated colors were used as eye shadows. Stimuli consisted of two different Japanese female faces, one slightly reddish, the other one slightly yellowish. The lip color was fixed at a natural red. Twenty-three Japanese female students judged the redness of the reddish face and the yellowness of the yellowish face by a paired-comparison method; they also judged the lightness of the faces. The results are as follows: (1) some reddish colors with relatively greater positive a* (CIE L*a*b* redness) made the reddish face more reddish and the yellowish color with relatively greater positive b* made the yellowish face more yellowish. (2) The face without any eye shadows was judged as the face with the highest lightness value (L*). Although the colors used as eye shadows were rather desaturated, assimilation effects of the complexion into the eye shadows were observed. The results are related to the echo illusion (Morikawa, 2012) in hue and chroma.

[1P2M076] Recognising the same face in different contexts: Testing within-person face recognition in typical development and in autism

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Research on unfamiliar face recognition has focused almost exclusively on the ability to tell different people apart, rather than the ability to recognise the same face across varying images. Here, we investigated 'within-person' face recognition across development and in autism. In Experiment 1, 77 typically developing children aged 6–14 years and 15 adults were given 40 different photographs of two distinct male identities and asked to sort them by identity. Children mistook images of the same person as images of different people, subdividing each individual into many perceived identities (median = 15). Younger children divided images into more identities than adults and also made more errors (placing two different identities together in the same group) than older children and adults. In Experiment 2, 32 cognitively able children with autism reported a similar number of identities and made similar numbers of errors to 32 typical children of similar age and ability. Fine-grained analysis using matrices revealed marginal group differences in the ratio of same-identity to different-identity matches. We suggest that the immature performance in typical children and children with autism arises from problems extracting the perceptual commonalities from different images of the same person and building stable representations of facial identity.
This research was funded by a Medical Research Council grant (MR/J013145/1).

[1P2M078] Cues to Gender in Children's Faces

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The human face carries information about the individual's identity, age, gender, race and emotional state; however, it is not always evident which facial properties provide the most information about each of these characteristics. Here we examine the ability of young adults to identify the gender of children aged 7–11 from colour photographs (hair covered), and we compare our psychophysical results to a principal components analysis (PCA) of the geometric properties of the same faces. In a 2 interval forced choice paradigm, participants chose either the male ($N = 40$) or the female ($N = 40$) face where face pairs were matched for age. Findings revealed that this population can identify the gender of children at rates significantly better than chance; in general, performance was in the 75% correct range. A significant ($p < 0.001$) effect of face age was seen in all test conditions (accuracy was worst with 11 yr old face photos). Surprisingly, participants choosing the "female" face performed significantly better than those choosing the "male" face from the same face pairs ($p. < 0.001$). The contribution of individual differences in faces, face geometry (from the PCA), gender of participants, amount of experience with children, and self-report of cues attended to will be considered.
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[1P2M080] The face N170 is mostly sensitive to pixels in the contralateral eye area

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Recently, we quantified the coding function of the N170 single-trial variability in possibly the simplest socially relevant task: face detection (Rousselet et al., 2014). On each experimental trial, observers saw face and noise pictures sparsely sampled with Gaussian apertures ("bubbles"; Gosselin & Schyns, 2001). Using reverse correlation and mutual information, we found that the presence of pixels around the eye contralateral to the recording electrode modulated single-trial ERPs at lateral-occipital electrodes, and most strongly the N170. Here, in three control experiments, each involving 6 subjects, we show that this result holds for faces of different sizes, faces expressing different facial expressions of emotions, and after contrast normalisation. However, the absolute N170 contralateral eye sensitivity differed across face sizes, and was delayed and strongly reduced by contrast reversal. Because contrast reversal preserves local edges, and eye saliency, but affects the distribution of contrasts across the face, the lower brain sensitivity to eye pixels in that condition suggests that it reflects some form of feature processing in a face context, possibly tuned to a particular face size. We conclude that the N170 reflects predominantly, in a face detection task, the encoding of a single feature: the contralateral eye.
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[1P2M082] Unmasking backward masking of emotional faces

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Experimental techniques to render emotional facial expressions subliminal have included brief target presentations, backward masked by emotionally neutral face pictures (Esteves & Öhman, 1993; Whalen et al., 1998). To measure pupillary changes induced by different emotional expressions (whilst keeping luminance pre and post-exposure constant), we presented a target emotional face sandwiched between forward and backward presentation of a neutral face. Twenty participants were presented with a neutral face for 1000 ms, followed by 10 ms exposure of a target face (2 blocks: fear/neutral; happy/neutral), finally masked by a neutral face for 4 seconds. They indicated via button press whether an emotional face was present in the display. Participants were expected to perform at just above chance in identifying masked target emotions. However, under these masking conditions most participants were aware of features (teeth and eyes) and were well above chance at identifying all emotions. Performance was best for neutral faces, and happy faces were more reliably identified than fearful. We conclude that effective backward masking of faces is unmasked by the inclusion of a forward neutral mask, presumably because the contrast between facial features (e.g. teeth) allows participants to more readily detect a change between neutral and emotional faces.

[1P2M084] Further experimental investigations into perception and recognition of two-colour pictures of faces at isoluminance

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First evidence for deactivation of configurational face information processing at isoluminance was shown by Bliem (1993). Further elaboration of fine-tuned experimental conditions to investigate the detailed role of isoluminance in face processing is presented. In the first experiment the subjective isoluminance point for two-colour faces was determined by measuring the threshold where perception of faces was worst. In the second experiment subjects had to recognize faces under positive and negative luminance contrast of +/−80%, +/−8%, +/−4%, each for chromatic and achromatic two-tone conditions and under isoluminant two-color conditions. In the inspection phase faces had been presented as original multi-tone grey-level pictures. Results show a significantly higher error score at isoluminance compared to all positive contrast conditions but there was no significant difference between isoluminance and all negative contrast conditions. Findings reveal a deactivation of global gestalt-like processing at isoluminance and all negative contrast conditions. Further on, findings clearly reveal the exclusive importance of positive contrast conditions to activate face-specific 3D shape from shading underlying successful global face perception and recognition. Interpretations are in accordance with an integrated neural model of global (magno-supported) and local (parvo-supported) face information processing (Bliem, 2010).

[1P2M086] Detection and Recognition of Emotional Facial Expressions in Peripheral Vision

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Successful perception of facial expressions of emotion is a fundamental social skill in humans that facilitates social interaction, by allowing an observer access to information about a signaller's mental states. In order to fully characterize the signalling properties of facial expressions we need to understand the environmental constraints under which they can be recognized (e.g. Schmidt & Cohn, 2001). Signals of danger or threat may be important to recognize in the periphery of the visual field (VF) or at greater viewing distances, due to the evolutionary importance of their correct perception. Here we investigated how perception of the basic facial expression categories (Ekman & Friesen, 1976) changes across different eccentricities in the VF (up to 30 deg). Participants performed both an emotion identification (which emotion?) and an emotion detection (emotion Vs neutral) task. We found that in emotion identification, happy and surprise were the best recognized emotions extending into the periphery, agreeing with our previous work (Smith & Schyns, 2009). Interestingly, in the detection task, happy and surprise but also fearful faces were detected above chance in the periphery. We interpret our results with respect to stimulus salience, evolutionary pressures, and neurobiological theories of fearful face signalling.

[1P2M088] Contributions of feature shape and surface cues to facial expression perception

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Theoretical accounts of facial expression recognition emphasise feature shapes as the dominant visual cue, with surface reflectance and texture cues providing less useful information (Bruce & Young, 2012). Recently, however behavioural adaptation has suggested an important role for surface based cues in expression perception (Benton, 2009).To address this issue, we created stimuli with shape only (normalised reflectance) or surface only (normalised shape) information for expressions of five basic emotions (fear, anger, disgust, sadness and happiness). In experiment one, we found that images containing only shape or only surface cues similarly impacted categorisation of facial expressions. However, we also found that the importance of shape or surface information was different for each expression. Expressions of fear and anger relied more on surface information, while sadness and happiness were strongly dependent on shape information. In the second experiment, we explored the role of feature shape and surface properties on perceptual similarity judgements of facial expression. Using a regression analysis, we again found that feature shape based information provides a strong cue for expression perception, but surface cues can also significantly predict perceptual similarity ratings of expressions. Our findings clarify how shape and surface cues contribute to the perception of facial expressions.
none

[1P2M090] Preconscious processing of facial attractiveness under continuous flash suppression

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Facial attractiveness is an important biological and social signal in social interaction. Although recent research has provided ample evidence regarding spontaneous appraisal of facial attractiveness, it is still unclear whether evaluation of facial attractiveness is restricted to conscious appraisal. To test the possibility that facial attractiveness is processed even at a preconscious level, we used a continuous flash suppression (CFS) paradigm in which monocularly viewed stimuli are erased from visual awareness because of a continuous flash-masking image presented to the other eye. We presented faces to each participant's non-dominant eye while presenting a continuous flash to his or her dominant eye. The faces were attractive, neutral, or unattractive. We measured (i) the time a face needed to overcome CFS and emerge into awareness and (ii) the duration for which a face was being consciously perceived. Results revealed that attractive faces broke CFS faster than unattractive faces, and attractive faces were consciously perceived longer than unattractive faces. These results suggest that evaluation of facial attractiveness occurs even at a preconscious level, and attractive faces shorten suppression. Further, attractive faces captured greater attention and prolonged the duration of awareness of faces at a post-conscious level.

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[1P2M092] Investigating the relationship between human-likeness and eeriness for prosthetic hands

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In 1970, Mori hypothesised the existence of an 'uncanny valley', whereby stimuli falling short of being fully human are found to be creepy or eerie. Previously we demonstrated that more human-like artificial hands are rated as more eerie than clearly mechanical or real hands (Poliakoff et al., 2013). Here, we compared eeriness ratings ($N = 40$ participants) for prosthetic hands pre-selected as more or less human-like, as well as mechanical and real hands. The less realistic prosthetic hands were rated as more eerie (mean = 6.59) than the more realistic prosthetic hands (4.90), the mechanical hands (4.49) and the real hands (1.23). In addition, the orientation of the hands (first person vs. third person) did not significantly affect the ratings. Thus, the notion of an uncanny valley (or peak of eeriness) was supported for the less realistic prosthetic hands, but the more realistic prosthetic hands were not uniformly found to be eerie. Indeed, the ratings of more realistic prosthetic hands varied more between individuals than the other categories, suggesting that individual differences in responses to prosthetic limbs, including familiarity, would be a fruitful avenue to investigate. These findings have implications for the design of more realistic or acceptable prosthetic hands.

[1P2M094] Testing the effects of the familiarity and symmetry in facial attractiveness

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In two experiments we investigated the effects of symmetry (perceptual factor) and familiarity (memory factor) on facial attractiveness. From the photographs of original slightly asymmetric faces symmetric left-left (LL) and right-right (RR) versions were generated. Familiarity was induced in the learning block using repetitive presentation of twelve original (asymmetric) faces. In the test block of Experiment 1 14 participants rated the attractiveness of twelve familiar faces (previously presented in the learning block), twelve novel original faces and both LL and RR versions of all faces (24×3 in total). The same procedure was repeated in Experiment 2. Twenty-eight participants were presented with the same faces, but the faces from learning and test blocks were altered in respect to Experiment 1. Analysis of variance in both experiments revealed the main effects of symmetry and interaction symmetry-familiarity. Post hoc tests indicated that original asymmetric faces were most attractive in both experiments and in both familiarity conditions. These results suggest that facial attractiveness is not positively associated with symmetry, but rather with more „natural "slight asymmetry. Additional analyses have shown that RR symmetrical versions are more attractive in familiar faces, while LL versions are more attractive in unfamiliar faces.

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[1P2M096] Angry faces do not have privileged access to awareness: Evidence from the attentional blink paradigm

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When two targets are placed in a rapid sequence of distractors, identification of first target (T1) disrupts the processing second target (T2) when presented within about 500 ms after T1, a phenomenon known as the attentional blink (AB). Interestingly, with schematic faces, Maratos, Mogg and Bradley(2008) obtained the results that, compared with neutral or happy faces, angry faces presented as T2 were less affected by AB, suggesting angry face priority over neutral or happy faces. In this research, we examined the degree of AB by adopting photos of animal faces as T1 and photos of angry, happy and neutral faces as T2. Distractor stimuli were photos of neutral upside-down faces. Note that we used toothy and non-toothy happy and angry faces: Toothiness of emotional faces was a between-subjects factor. Results showed that, in non-toothy condition, AB was larger when T2 was angry face than when T2 was happy face. In toothy condition, there was no difference in AB between angry and happy faces. Oddly enough, there was little, if any, AB observed for neutral faces in both conditions. Taken together, these findings suggested that, contrary to the results with schematic faces, angry faces did not have privileged access to awareness.

[1P2M098] Staring nervous system stability in the face: reaction time variability predicts attractiveness

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Prior work has shown that lower intraindividual (or within person) variability in reaction time (RT) is a predictor of better long-term mental and physical health outcomes, which suggests that RT variability indexes integrity of the central nervous system. However, it is unknown whether faces signal nervous system stability. We predict that more stable nervous systems would produce more attractive facial signals than less stable nervous systems. Across two experiments, participants chose which of two faces was more attractive. Composite faces were created from a different dataset by averaging images of individuals who completed an RT task. Experiment 1 used composites of the individuals with the highest and lowest standard deviation of reaction time (SDRT). Experiment 2 created new composite images that were based on residual SDRT after the influence general response speed was removed. In both experiments, composite faces that were made based on individuals with low SDRT and low residual SDRT were chosen as more attractive than those that were made from individuals with more variable RTs. These findings provide the first evidence that the more stable an individual's nervous system, the more attractive they appear to others.

[1P2M100] Compressed subjective duration of social interactions mediated by oxytocin

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Communication through body gestures permeates our daily life. Efficient perception of the message therein reflects one's social cognitive competency. Here we report that such competency is manifested temporally as shortened subjective duration of social interactions: motion sequences showing agents acting communicatively are perceived to be significantly shorter in duration as compared with those acting independently. The strength of this effect is negatively correlated with one's autistic-like tendency. Critically, intranasal oxytocin administration fosters the temporal compression effect in socially less proficient individuals whereas the administration of atosiban, a competitive antagonist of oxytocin, abolishes the very effect in socially proficient individuals. These findings clearly demonstrate that perceived time, rather than being a faithful representation of physical time, is highly subjective and imprinted with one's social traits. Moreover, they highlight the role of neuropeptides in mediating time perception, which has rarely been studied thus far.

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[1P2M102] Investigating visual stimuli processing under mortality salience on a microgenetic level

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The impact of processing death-related stimuli under mortality salience (MS) has been highlighted in Terror-Management-Theory (TMT). Thus, when MS is conscious, suppressions of death thoughts have been shown, whereas death thoughts become highly accessible when MS has been removed from consciousness (distal defense). However, only little research has been made taking visual stimuli processing under MS into account. Therefore, we generated a change blindness task on a microgenetic level. Participants had to decide, whether one out of four different pictures had been changed or not with presentation times varying from 33, 67, 134 to 534 msec. Three types of action were implemented: no change, a neutral picture change, or a change from neutral picture to a death-related picture. Before the task, participants were randomly assigned to either a MS-treatment or a controltopic – both followed by a delay task to investigate distal defense reactions. In accordance with TMT we found evidence that MS-treated participants showed higher accessibility for death-related pictures in correlation with longer presentation times, but–most importantly–when presentation times were very short, suppressions of perceiving death-related pictures occurred. This finding is compatible with the idea that general perceptual processes under MS are also susceptible of a microgenetic development.

[1P2M104] Threatening stimuli do not narrow attentional scope

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The present study, using the flanker paradigm, explored whether threatening targets would narrow attentional scope. Flanker compatibility effect was expected solely for non-threatening targets since threat had been found to narrow attentional scope and interfere with flanker processing (Fenske & Eastwood, 2003).Employed were photographs of felines and canines, either threatening or not. The target images were presented as singletons or with flankers, compatible or incompatible with the target, either in valence (threatening, non-threatening) or the animal category. Participants performed two tasks by categorizing whether the target was (1) a 'cat' or a 'dog' and (2) threatening or non-threatening. Significant results in processing speed were found only for the animal classification task. (i) A consistent target valence effect emerged: threatening targets slowed down the performance. (ii) Regardless of the target valence, the flanker facilitating (compatibility) effect was found, but only when the target and the flankers were identical images. This latter finding implies that perceptual features of the stimuli, rather than their emotional content, affect target processing speed (cf. Horstmann, Borgstedt, & Heumann, 2006). Overall, the present findings do not support the hypothesis that attentional scope is narrowed by exposure to threatening targets and indicate that task requirements considerably influence performance.

[1P2M106] What you need is what you like – knowing target and distractor categories is sufficient for distractor devaluation

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Distractors are devalued compared to targets and novel items in search and localization tasks (Raymond, Fenske, & Tavassoli, 2003; Raymond, Fenske, & Westoby, 2005). This does not occur when distractors are expected to become relevant in a subsequent task (Dittrich & Klauer, 2012), suggesting that simply knowing the (ir)relevance of items is enough for devaluation to occur. To test this idea, we conducted a distractor devaluation task, with added evaluations before, and also after, target localization. Halfway through the experiment we switched the roles of targets and distracters, in order to compare item-based evaluations in both roles. Results show that knowing an item's status as target or distractor suffices for distractor devaluation to arise. At the same time, committing errors in the localization task was also associated with task performance, indicating that task performance has effects of its own. The effects of target status and erroneous performance both appeared to be restricted to the second run, which suggests that the role reversal of targets and distractors was required for both types of devaluation. Results showed that distractor devaluation persisted after the localization task ended, suggesting an inflexibility in the termination of devaluation when an item's irrelevance is terminated.

[1P2M108] Attentional control of positive and negative visual emotional distraction

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Emotional information attracts attention. This claim relies on inconsistent findings from studies that mostly use negative stimuli, tasks which target different stages of attentional selection (engagement, disengagement) and evoke different control strategies (information relevant vs. irrelevant). Here, we studied disruption of goal-relevant processing (i.e. capture) by negative and positive stimuli and mechanisms used to control this distraction. In Experiment 1, irrelevant negative, positive and neutral IAPS images, intact or scrambled, appeared peripherally on 50% of trials while participants identified central letters. Emotional images were more distracting than neutral ones but only when intact, supporting the role of content rather than low-level features. In Experiment 2, we manipulated the probability of distractor presentation (25% or 75%) to determine whether people can strategically control emotional distraction. A low distractor probability produced substantial emotional distraction. However, a high probability almost abolished neutral and emotional distraction, consistent with the use of a proactive control mechanism when frequent distractors are expected. Importantly, attenuation of distraction could not be attributed to the repetition of images. Proactive control seems equally effective at inhibiting emotional and neutral distractors, despite the biological relevance of the former. The different control strategies triggered by distractor probability may partly explain previous inconsistencies.
This research is supported by a Marsden grant from the New Zealand Royal Society.

[1P2M110] Do Great Apes also Prefer Curved Visual Objects?

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Several experiments have proven human preference for curved over sharp contours. We think that this kind of preference and similar ones might have partially given rise to the emergence of aesthetics as a phylogenetic trait. However, this does not mean that this preference could be shared with other species. Given that nonhuman primates also exhibit visual preferences, it is conceivable that humans' preference for curved contours is grounded on perceptual and cognitive mechanisms shared with extant nonhuman primate species. The main aim of the present study was to test this possibility by comparing, under similar conditions, humans and great apes' preference for curved and sharp contours. Our results revealed both humans and apes showed a preference for round -as opposed to sharp- objects, albeit under different presentation conditions. In particular, humans preferred round objects under brief presentation conditions but not under free viewing time conditions. In contrast, apes showed the reverse pattern, preferring curved objects under free viewing conditions but not under brief presentation conditions. So, our results cannot refute the possibility that such preferences evolved independently and converged on a common adaptive solution.

[1P2M112] Oculomotor inhibition and the preference rating of abstract visual patterns

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Do different levels of oculomotor inhibition, induced using the minimally delayed oculomotor response (MDOR) task (Wolohan & Knox, 2014), alter the values participants attach to symmetrical and random abstract patterns? Participants competed 240 trials in which after a randomised fixation time (0.5–1.5 s), a pro-saccade target was displayed for either 200 ms or 1000 ms (DT and target 5° left/right randomised). Participants were instructed to saccade to the target position on target offset, prior to which a 3.5° square, random or symmetrical abstract pattern was displayed for 140 ms at fixation. After each trial participants rated the pattern from 1 ("not liked very much") to 9 ("liked very much"). Saccade latency was modulated by DT (200 ms: 449 ± 96 ms, mean $\pm$ SD; high levels of oculomotor inhibition; 1000 ms: 315 ± 62 ms). A repeated measures ANOVA on the pattern ratings (DT vs. pattern type within subjects) showed significant main effects for DT ($F(2,13) = 3.781$, $p = 0.035$, $\eta p2 = 0.21$) and pattern type ($F(2,13) = 16.798$, $p < 0.001$, $\eta p2 = 0.55$) with no interaction between factors ($p = .9$, $\eta p2 = .004$) suggesting that high levels of inhibition depressed pattern ratings. These results are consistent with a linkage between affective responses and (at least) oculomotor inhibition.

[1P2M114] Pupil size is a sensitive indicator of motivation-driven modulation of arousal in the macaque in a visual discrimination task

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Pupil size under constant luminance is thought to reflect arousal in humans. To validate pupil size measurements as an indicator of arousal in the macaque we manipulated motivation (and hence

arousal) by predictably varying reward size when one monkey was performing a visual discrimination task. Simultaneously his pupil size was monitored. The available reward was large after the monkey made correct choices on three consecutive trials and all following correct trials until the next error, when reward size was set back to small. Across 89 daily sessions we confirmed that the available reward size modulated the monkey's motivation: his psychophysical threshold was lower (improved performance) on trials with large available reward ($p < 10-3$). To see if the pupil size was also modulated by motivation, we computed the trial-by-trial mean pupil size during the fixed duration stimulus presentation period. Statistically, the modulation of the pupil size was even stronger than that of performance: pupil size was larger on trials with large available reward than small available reward ($p < 10-12$). This effect was independent of stimulus position and choice. Therefore our results suggest that pupil size is more sensitive to motivation-driven modulation of arousal of the monkey than task performance.
This work was supported by ERC starting funding.

[1P2M116] Developing perceptual scales to measure properties of aesthetic attributes

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The inherently subjective nature and semantic connotations of 'beauty' make aesthetic judgements notoriously difficult to capture experimentally in quantitative and objective measures. We present here the results of a set of experiments that use a simple computer-based procedure to rank the strength of a perceived quality, such as complexity, regularity, or symmetry, in a set of synthetically generated stimuli. These attribute variations were defined by simple mathematical rules, for instance by generating fractal patterns with varying degrees of complexity. In an iterative process the stimulus associated with the smallest (or the largest) percept strength of the particular property is selected by the participant, and eliminated from the set for the next presentation: for a set of 5 stimuli a rank order is established in 4 simple decisions. This ranking is repeated 8 times for newly generated stimulus sets, generating robust data that can be collected quickly and easily in large numbers from naive participants. We use this method to compare how synthetic patterns generated with different algorithms can be used to capture perceptual aesthetic attributes. With complexity, for instance, we find that fractal patterns generate more robust judgements than frequency modulated (1/f) noise patterns.
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[1P2M118] Varying curvature and angularity of architectural façades can influence aesthetic preferences

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Several researches showed that people prefer curved stimuli compared to angular ones (shapes, objects, interior spaces; Bar and Neta, 2006, 2007; Vartanian et al., 2013). Our aim is to extend to architectural façades the role of curves and angles in terms of preference. We produced four different versions of the same building, varying its curvature (high and medium curvature; rectilinear and angular). Twenty-four female participants 1) made a preference-forced choice between pairs of the stimuli; 2) evaluated each stimulus on 5 point likert scales (liking, familiarity, complexity, stability, approach); 3) classified all the stimuli from the most to the least preferred. Asymmetric multidimensional scaling on the forced choices showed that the high curved façade was the most preferred, followed by the medium curved, angular and rectilinear ones. Multidimensional unfolding showed that the majority expressed higher preferences for the curved façades compared to angular and rectilinear ones. A repeated measures ANOVA on liking evaluation showed that the high curvature façade was the most preferred followed by angular, medium curved and rectilinear ones. Our preliminary findings showed that curvature influences preferences also for architectural stimuli. Interestingly the least preferred stimulus was not the angular but the rectilinear one.

[1P2M120] Vita brevis, kitsch longae—When death was salient, kitsch appears less kitschy

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The word "kitsch" is used to dispraise of something as nostalgic, overly simplistic and consoling. This judgmental term suggests that kitsch is liked because it helps people to cope with uncertainty and negative emotions. This assumption was tested in an experiment ($N = 85$) based on the mortality salience (MS) paradigm. Prior to rating 20 images of decorative and devotional objects in terms of liking and kitschiness, participants were randomly assigned to three different conditions: In two conditions participants were instructed to reflect on their own mortality. They were either tested solitarily (MS-solitary) or simultaneously in groups of three participants (MS-group). In the third condition, participants were seated in a wheelchair and asked to imagine how their life would change after a severe car accident (CA). Ratings from these three experimental conditions were compared with ratings of participants ($N = 50$) who rated the same set of images in a neutral setting (NG). Liking did not vary across conditions. Kitsch ratings were lower in both MS conditions, but not in the CA condition. We see evidence that the salience of kitschiness is affected by the previous salience of mortality. One explanation is that existential threat makes kitsch more acceptable.

[1P2M122] Uncomfortable images prevent lateral interactions in the cortex from providing a sparse code

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The visual system is optimised to process natural scenes with few active neurons (a sparse code). Visual discomfort is associated with a hyperneuronal response of the visual cortex. Previous work suggests that certain categories of uncomfortable/unnatural images produce large and less sparse activity in a bank of units with Gabor-like receptive fields (Hibbard & O'Hare, 2015). We develop a model of the visual cortex involving not only Gabor-like receptive fields but also lateral interactions, both excitatory and inhibitory (Penacchio, Otazu & Dempere-Marco, 2013). It is known that lateral interactions are central in producing a sparse code. We measured human ratings of discomfort for a wide range of images and found that the judgments are well predicted by the sparsity of the model network activity. The lateral interactions in the model increase the correlation with discomfort. Our findings suggest that an architecture including lateral interactions fails to produce a sparse representation of uncomfortable images. The greater neural activity is consistent with the hyperBOLD response to uncomfortable images.
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[1P2M124] Computational analysis of visual complexity and aesthetic appraisal reflected in eye-tracking data

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We investigated whether subjective visual complexity (VC) and aesthetic pleasure (AP) of images are reflected in eye movement parameters. Participants ($N = 26$; 13 females) explored greyscale car front images ($N = 50$) while their eye movements were recorded. Following each image exposure (10 sec), image VC and AP were rated on 9-point scales. We found that fixation count positively correlated with VC, while AP correlated with dwelling time. The two eye movement parameters were best-fit by linear functions and correlated negatively ($r = -.507$, $p < .001$). Subjective ratings of AP and VC were related too and followed an inverted U-shape function (cf. Berlyne, 1971) best-fit by a quadratic equation: car fronts with perceived plain design (low complexity) and those with too elaborate design (high complexity) were judged as less aesthetically pleasant. The function peak was more pronounced for females, indicating their greater preference of the medium-complexity images. Also on average, women made more fixations on car images while dwelling shorter than men. The findings suggest that image visual complexity is reflected in fixation count, an objective eye-movement measure. VC affects image aesthetic appraisal, the relationship conjectured to be mediated by perceptual fluency (ease-of-processing) of an image (Orth & Wirtz, 2014).
The authors thank Trym A.E. Lindell for preparation of the stimulus set and data collection.

[1P2M126] The attentional capture by emotional distractor faces differed between adult's and children's facial expression

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The threat related stimuli capture attention efficiently and automatically. Precious studies suggest that threat-related emotional faces captured attention independent of their task-relevancy (Hodsoll, Viding, & Lavie, 2011). Williams and Mattingley (2006) reported angry male faces captured more attention than angry female faces. They discuss that the potential for physical threat is critical for this male advantage. Thus we hypothesize that the lesser threat attribution of the faces like children less capture attention. We use both adults' and children's emotional faces as the task-irrelevant distractor in the visual search task to test this hypothesis. Experiment1, participants asked to detect an adult male face among adult female faces and to decide its orientation. Three facial expressions (neutral, angry, and happy) were used for both target and distractor faces. Experiment2, we used the same task of Experiment1, except the children's faces were used as stimuli. The results showed that angry faces detected significantly faster than other emotional faces (Experiment1). However, there were no significant effects for children's angry faces (Experiment2). These results suggest that the attentional capture for angry face is based on its threat feature; unlike adults' angry face, non-threat children's angry face lesser captured attention.

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[1P2M128] The D-Scope®: Beyond Veridicality

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This paper introduces a new audio-visual medium in the form to the D-Scope®, 'a system of apparent motion using concrete physical objects lit sequentially' (Trope, 2014). Animation occurs in the D-Scope® without an intervening lens or a framing screen so that it occupies the same environment as participants. Apparent motion is simply derived from mapped illumination revealing objects in turn. Attention is mediated, but the objects are real. There is no strobe light or any shuttering device, just objects hung carefully in a void and lit sequentially to produce apparent motion.

This paper considers the implications of what it means if an image is not 'a representation of the external form of a person or thing in art' but is instead constructed both from concentrated and condensed reality (so not an image), and our perception of it is assembled from a continuity of fleeting moments. Here the properties of real/unreal become meaningless and we are dealing with a visual order constructed of abstract purity combined with structural unity. We live in a state of flux and the D-Scope® captures this. It is change made manifest.

[1P2M130] Startling fluency? Testing effects of processing fluency on affect-modulated startle

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Processing fluency is usually associated with increasing affective value (e.g., Reber, Schwarz, & Winkielman, 2004) but can also be interpreted as amplifying the initial affective value of a stimulus, as done in the Fluency Amplification Model (FAM, Albrecht & Carbon, 2014). To

examine an impact of fluency on the stimulus affective value at a psycho-physiological level, we used an affective startle modulation paradigm (for guidelines, see Blumenthal, 2005). Photographic stimuli varying in valence (7 categories from negative to positive), arousal (high vs. low), and processing fluency (original pictures vs. blurred variants of them) were presented while eliciting startle responses by 105 dB white noise bursts (50 ms) at different SOAs. The eye blink component was measured via facial-EMG. Consistent with previous findings, results showed a modulation of startle intensity by the affective stimulus content for late startle SOAs with negative stimuli leading to greater startle responses than the positive ones. Although fluency did not seem to affect startle reflex intensity, we revealed an effect of fluency on the latency of the startle reflex for short SOAs. Implications for the link between fluency and the affective value and subsequent post-processing of stimuli are discussed.

[1P2M132] Predicting perceived visual complexity using objective image properties and eye-movement measurements

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Visual complexity of stimuli is thought to influence many experimental measures like detection rate, reaction time, aesthetic evaluation, etc. The goal of this work is to predict the perceived visual complexity of images by combining objective computational measures (e.g., image compression rate, edge detection) with individual eye-movement statistics (e.g., fixation duration, saccade length). 63 participants were presented abstract paintings and abstract black-and-white patterns in two blocks for a 5 s free-viewing period while recording eye-movements. After viewing each image, they were asked to rate their visual complexity on a 7-point scale. Subsequently, we calculated several objective parameters of image complexity and eye-movement statistics for each trial. A combination of ranking by AICc (Akaike information criterion corrected for finite sample size), VIF (variance inflation factor), and data sub-sampling was used to obtain parsimonious linear mixed-effects models predicting perceived visual complexity. For both groups of stimuli, the best models combined one or more objective computational measures of complexity with some eye-movement statistics. Therefore, we conclude that while objective measures like image compression offer a convenient and often sufficient approximation of visual complexity, eye-movement measures can help to further improve predictions.

[1P2M134] Representational Space of Cave Paintings and Petroglyphs

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Four experiments examined memory for cave paintings and petroglyphs, and the hypothesis of Dobrez (2013) that reports of looming in such rock art was due to representational momentum was tested. Participants briefly viewed a target photograph of a cave painting or petroglyph, and then a probe photograph of the same cave painting or petroglyph was presented. The viewpoint in

the probe could be closer than in the target, the same as in the target, or farther than in the target. Participants judged if the viewpoint probe was (a) the same as or different from the viewpoint in the target or (b) closer, the same distance as, or further than the viewpoint in the target. Experiments 1–2 presented photographs of rock art that depicted various entities, and Experiment 3 presented photographs of rock art that involved hand prints and stencils. In all experiments, memory for the originally viewed target was displaced away from the observer; this is not consistent with representational momentum, but is consistent with boundary extension. It is suggested that looming effects arise only after continued inspection and reflect a mismatch between the remembered initial information (that has been displaced due to boundary extension) and current perceptual information.
none

[1P2M136] The effect of repeated exposure of abstract visual patterns on aesthetic preference in children and adults

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According to the two-step attributional theory the repeated exposure of stimuli enhances the subjective feeling of perceptual fluency, which in turn influences preference for old over new stimuli. However, previous research of mere exposure effect conducted in children compared to adults showed quite inconsistent findings. In the present study we investigated the effect of repeated exposure of abstract visual patterns on aesthetic preference in participants from three age groups (adults, 13 and 9 year olds). In the familiarization phase abstract visual patterns were presented in heterogeneous sequence, on optimal level (100 ms), with frequency of 2, 5 or 10 exposures. In the second phase of study participants rated their aesthetic preference of presented and new visual stimuli on the seven-step bipolar beautiful-ugly scale. The results showed that the positive effect of mere exposure on preference was obtained only in the group of adults. In the group of 13-year-olds, the effect of mere exposure was not significant, while in the youngest age group, the effect of mere exposure was reversed, i.e. respondents preferred new over old stimuli. We conclude that two-step account is not appropriate for interpretation of findings obtained in children and discuss alternative interpretations.

[1P2M138] The influence of teeth-exposure on attentional bias to angry faces in the dot-probe task

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Dot-probe studies consistently show that high trait anxious individuals (in contrast to low trait anxious individuals) have an attentional bias towards threatening faces. However, little is known about the influence of perceptual confounds of specific emotional expressions on this effect. Teeth-exposure was recently recognized as an important factor in a closely related paradigm (the face-in-the-crowd paradigm), leading us to investigate the effect of exposed teeth on attentional bias to

angry faces. Participants (N = 78) were asked to classify probe stimuli that were preceded by two simultaneously presented faces, one angry and the other neutral. The probe either appeared at the location of the angry face (valid condition) or the location of the neutral face (invalid condition). Half of the angry faces exposed their teeth, the remaining ones did not expose them. Afterwards, participants completed the trait anxiety scale of the STAI. Teeth-exposure manipulation moderated the relationship of attentional bias and trait anxiety. For angry faces with non-exposed teeth, we found a positive correlation (r = .44) of trait anxiety with the attentional bias score (i.e., response times invalid minus response times valid). However, we found no influence of trait anxiety on attentional bias to angry faces with exposed teeth.

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Symposium: Beyond Veridicalism: alternatives to conventional vision theory

[1S1A001] Alternatives to veridicalism in vision theory

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Conventional vision theory is based on the assumption that the visual system provides the organism with a representation of the outside world which is as veridical as possible. Examples of this widespread (but sometimes hidden) assumption are found in formulations of vision as inverse optics (e.g., emphasis on the recovery problem) and Bayesian inference (e.g., optimality of cue combination). In addition to suffering from deeply rooted 'physics envy' and misguided philosophical assumptions about realism versus idealism and objectivism versus subjectivism, this line of reasoning denies a crucial problem posed by our phenomenal awareness: Often the world around us does not look like we know it from physics textbooks. Fortunately, phenomenology provides a respectable philosophical alternative, which has also inspired serious contenders to conventional vision theory (e.g., Gestalt psychology, user-interface theory). Many of these alternatives do better justice to how we experience the world, without denying its evolutionary origin (e.g., ecological fitness of behavior, perception-action coupling). This introduction to the symposium provides the necessary theoretical background to understand what is at stake. It also offers a preview to the theoretical alternatives to veridicalism, and how these can inspire new empirical work on a variety of topics (e.g., depth perception, amodal completion).

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[1S1A002] Template structure of visual awareness

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The animal biology of visual awareness has been a major topic of ethology from the early twentieth century on (Nobel Prize 1973 for Konrad Lorenz, Nikolaas Tinbergen and Karl von Frisch, as immediate successors of Jakob von Uexküll). For psychology the work on vertebrates is perhaps of

primary interest. Here we concentrate on the topic of releasers. Animals often react in stereotypical ways that – from an anthropocentric perspective – appear really odd in view of their visual acuities. For instance, a bird may "take a brick for an egg" or "take fishes for its chicks". Such "releasers" apparently act as all powerful templates that fully overrule "inverse optics". Are humans unique among vertebrates in seeing things "as they are"? As we found the answer is perhaps humiliating from an anthropocentric perspective. Human visual awareness is rife of "template" objects that are hugely unlike the "correct" interpretation of the optical data. We show a number of examples that might well be experienced as shocking. Such findings necessarily result from experimental phenomenological methods, as psychophysics proper will not reveal them, probably the reason why the textbooks do not mention them.
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[1S1A003] Where do we see?

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Many theories of visual perception assume there is an external, independent reality full of pre-existing objects. The supposed function of vision is to veridically represent this reality so we are aware, internally, of these objects and their properties. But a perceptually independent reality contains no point of view; it is perspectiveless and lacks perceptual properties. Once subject to an act of perception it ceases to be independent, and so is never truly perceived. This poses an obvious and serious problem for any veridical account of perception. The problem is avoided, however, if we renounce the assumed distinction between internal perception and external reality. The implications for vision science would be profound, and potentially beneficial. Rather than internally perceiving an external object, the object is understood to be located internally and externally at the same time, as is the associated act of perception. The object and its perception become identical and spatiotemporally distributed. The conventional causal chain, in which the object gives rise to the percept, can equally well be inverted: the percept gives rise to the object, thus rendering the inverse problem in optics redundant. Although contrary to current scientific orthodoxy, this approach nevertheless may have explanatory value.

[1S1A004] Perception, Inverse optics, and Probabilistic inference

Manish Singh
Rutgers University, USA

Visual perception is commonly treated as inverse optics—its supposed goal being to "undo" the effects of optical projection/rendering and "recover" the "true" world properties. The standard Bayesian framework for vision (SBFV) models inverse optics by inverting conditional probabilities: if one knows p(Image | Scene), one can estimate p(Scene | Image), assuming some knowledge of p(Scene). SBFV has intuitive appeal; however it makes some strong assumptions. It effectively assumes that the space of perceptual interpretations is identical with (or isomorphic to) the objective world. The posterior mapping can then be assumed to be inverting the rendering map. These assumptions are ultimately unjustifiable, however. First, there are various perceptual phenomena that cannot be understood simply as inverting optics/physics. Second, a consideration

of evolving perceptual systems makes it clear that any general model of perception must allow for different possible relationships between perceptual spaces and the "objective world". Probabilistic inference is still an appropriate and powerful tool for modeling perception, but it now takes place strictly between representational spaces. For biological organisms, perception thus acts as a user interface that allows effective (i.e. fitness enhancing) interaction with a world that remains fundamentally unknown to the organism. [Joint work with: Donald Hoffman; Jacob Feldman]
NIH EY021494; Faggin Foundation

[1S1A005] The reliability of experience and the experience of reliability

Paul Hibbard
University of Essex, UK

Conventional theories of depth perception make a number of assumptions about how cues are encoded, combined and used. Firstly, they assume that estimates are unbiased, and that noise is Gaussian and uncorrelated. Secondly, they assume that the goal of combining cues is to minimise the variance in the resulting estimate. Finally, they assume that all cues provide the same kind of information about 3D shape. While typical psychophysical methods cannot determine whether perception is veridical, other methods have demonstrated significant perceptual biases. Psychophysical and physiological results have also revealed a variety of representations of many aspects of depth. This raises the question of how information from a multitude of qualitatively different representations gives rise to our unitary perceptual experience, and how this information is used in perceptual and behavioural tasks. I will outline how such an array of representations can be combined in the perception of depth, in a way that links perception and action, and places reliability at the heart of phenomenology.
This work is funded by a British Academy Mid-career Fellowship

[1S1A006] The immediate visual quality of visibility: how the visual system communicates confidence

Vebjørn Ekroll
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As has been well appreciated since the early days of Gestalt psychology, visual perception is a highly non-local process in which context plays a pivotal role. In this regard, there is no fundamental difference between the visual perception of occluded and non-occluded object regions. The former (amodal perception) is just a particularly extreme case where the visual system creates representations of objectively invisible object regions based on context information alone. Why then, are unoccluded object regions, but not occluded ones, experienced as visible? I will argue that the seemingly obvious answer – that unoccluded image regions are experienced as visible because they are visible (and vice versa for occluded image regions) is misleading. This conclusion is based on experimental evidence showing that occluded image regions can be experienced as directly visible if the sensory evidence is sufficiently conclusive. Instead, I propose that the immediate visual experience of visibility is better understood as an "icon" in the "user interface" furnished by the perceptual system, which

informs the organism about the trustworthiness of the current sensory evidence available for perceptual inferences. This explains, amongst other things, how "kinesthesis can make an invisible hand visible" (Dieter et al., 2014, Psych. Sci. 25(1), 66–75).
Supported by the Methusalem program by the Flemish Government (METH/08/02), awarded to Johan Wagemans and FWO Pegasus Marie Curie Fellowship (1262014N) to the author.

Symposium: Visual perception research for use in the vision clinic

[1S1B001] Cortical Organization for Binocular Pattern Vision

Andrew Parker, Gaëlle Coullon and Holly Bridge
Oxford University, UK; Oxford University, UK; Oxford University, UK

The 30 or more visual cortical areas form a sophisticated pattern recognition system, able to extract structure flexibly from the retinal inputs. The system is quick and automatic, but demands large resources within the cerebral cortex. It is argued that binocular stereoscopic vision must regard stereo as not just concerned with delivering a sensation of depth but also as an embedded component of cortical pattern vision. Unlike colour or motion, binocular disparity signals are widely distributed throughout many cortical visual areas. There is a formal similarity between the feature pairings that define stereo depth and those that enable detection of symmetry or repeated-element patterns. Proposal of a common cortical circuitry suggests an explanation for the observation that clinical patients with amblyopia often have deficits in pattern vision that accompany the better-known losses of binocularity. High-resolution cortical imaging with 7-Tesla MRI in neurotypical humans reveals locations within early visual cortical areas (V2, V3, V3a) with highly reproducible BOLD responses to binocular disparity. The size and shapes of these regions are comparable with scaled versions of structures that have been identified anatomically and physiologically in the monkey visual system. These findings are relevant to any attempts to restore binocular function.
Supported by the Medical Research Council and the Wellcome Trust.

[1S1B002] ASTEROID: Accurate STEReoacuity measurement in the eye clinic

Jenny Read, Kathleen Vancleef, Ignacio Serrano-Pedraza, Graham Morgan, Craig Sharp and Michael Clarke
Newcastle University, UK; Newcastle University, UK; Universidad Complutense de Madrid, Spain; Newcastle University, UK; Newcastle University, UK; Newcastle University, UK

Stereoacuity measurements are regarded as the gold standard for assessing binocular vision function (Elliott & Shafiq, 2013). Accordingly, children with binocular visual disorders such as strabismus and amblyopia routinely have their stereoacuity measured with one of the clinical stereotests currently available, e.g. the Frisby, Randot or Titmus stereotests. These tests all suffer from severe limitations: They offer only a limited number of discrete test levels; viewing distance has to be controlled by the clinician; they are unengaging so children are typically unwilling to complete very many trials. The ASTEROID project aims to develop a new stereotest on a 3D tablet computer. The tablet uses autostereo (parallax barrier) technology so that no 3D glasses

are required. The test uses a dynamic random-dot stereogram to avoid monocular cues and present the most rigorous test of stereopsis. The computer controls task difficulty via a Bayesian adaptive staircase, while the front camera is used to monitor viewing distance. Most importantly, the stereotest task will be embedded in a fun game which uses colours, sounds and animation to keep children engaged and responsive. In this way, we aim to measure stereoacuity with unprecedented accuracy and precision, providing clinicians with high-quality information about their patients' vision.
Health Innovation Challenge Fund award from the Wellcome Trust / Department of Health

[1S1B003] Short-term monocular deprivation alters early components of Visual Evoked Potentials

Claudia Lunghi, Marika Berchicci, Maria Concetta Morrone, David Charles Burr and Francesco Di Russo
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It has recently been shown that 150 minutes of monocular deprivation alters visual perception in adult humans, causing the deprived eye to dominate the dynamics of binocular rivalry. We investigated the neural mechanisms underlying this homeostatic plasticity by measuring transient visual evoked potentials (VEPs) on the scalp of adult humans during monocular stimulation (visual stimuli: horizontal sinusoidal gratings, size 4°, S.F. 2 cpd, contrast 64%, presentation duration 100 ms, inter-stimulus interval 500–1000 ms) before and after 150 minutes of monocular deprivation. Deprivation strongly affected the amplitude of the earliest component of the VEP (C1), which originates in primary visual cortex (confirmed by source localization analysis). C1 amplitude increased (+66%) for the deprived eye, while it decreased (−45%) for the non-deprived eye. We further report that following monocular deprivation, the amplitude of the peak of the evoked alpha power increased on average by 34% for the deprived eye. These results indicate that short-term monocular deprivation strongly alters ocular balance in the primary visual cortex of adult humans, demonstrating a high level of residual homeostatic plasticity, likely mediated by a change of cortical excitability.
this research was supported by EC project "ECSPLAIN" (FP7 ERC).

[1S1B004] How does inattentiveness affect threshold estimates in children?

Catherine Manning, Peter Jones, Tessa Dekker and Elizabeth Pellicano
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When assessing the visual abilities of children, researchers tend to use psychophysical techniques that have been designed for use with adults. Yet, children's poorer attentiveness might bias the

thresholds obtained by these methods. Here, we quantified inattentiveness in children aged 6- to 7-years-old (n = 31), 8- to 9-years-old (n = 39) and adults (n = 19), and used simulations to assess its effect on speed discrimination thresholds collected using three psychophysical techniques: Method of Constant Stimuli (MCS), QUEST and a 1-up 2-down Levitt staircase. As expected, children had more attentional lapses than adults, across all techniques. Lower speed discrimination thresholds were obtained using QUEST compared to MCS and Levitt staircases, but the difference between techniques did not interact with age group. Next, we used Monte Carlo simulations to model the effect of different levels of inattentiveness on thresholds obtained with each technique. Consistent with our empirical data, MCS and Levitt staircases underestimated sensitivity when lapse rates were increased above 0%. QUEST was more robust to lapses, providing more accurate estimates of sensitivity. These results demonstrate that threshold estimation techniques vary in their robustness to inattentiveness, which has important implications for assessing the visual perception of children and clinical groups.

Catherine Manning was supported by an Economic and Social Research Council (ESRC) PhD studentship and a Scott Family Junior Research Fellowship at University College, Oxford.

[1S1B005] Cerebral visual impairment in children

Renate Walthes, Christiane Freitag and Namita Jacob
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Children born with visual processing problems are usually unable to tell what makes their vision different from that of other people. These children show a broad variety of behaviors in order to master social and educational requirements that can indicate their visual processing difficulties in specific life areas. Therefore, it is crucial to develop approaches which help to observe and assess strategies for everyday life, at home, kindergarten and school.

Pro-VisIoN (Processing visual information in Children) studies visual abilities as well as child strategies in responding to the demands of a task using multiple methods, including conversations with the child and family, observation of child strategies including eye-tracking, standardized tests such as visual acuity and documentation of oculomotor functions.

Findings reveal that difficulties in certain visual abilities are seen most strongly impacting particular life areas. Contrast sensitivity, one of the least attended visual functions, was found to be relevant to Vision for Communication as well as for Sustained Vision Tasks. Visual field problems, especially small scotoma, can cause reading problems as do difficulties in quality of lines and grating acuity. Importantly, most of these visual functions are not typically assessed in Germany either in ophthalmology or in neuropsychology.

[1S1B006] CVIT 3–6, a screening test for cerebral visual impairment in young children

Kathleen Vancleef, Yasmine Petre, Eva Janssens, Silke Bäumer, Els Ortibus and Johan Wagemans
University of Leuven Newcastle University, UK; University of Leuven, Belgium; University of Leuven, Belgium; University of Leuven, Belgium; University of Leuven, Belgium; University of Leuven, Belgium

The lack of tailored neuropsychological tests for Cerebral Visual Impairment (CVI) makes diagnosis and rehabilitation complex. The available instruments often measure only one aspect of visual functioning, results are confounded by comorbid cognitive or motor difficulties, and tests are often too complex for young children. To address these problems, we developed the Cerebral Visual Impairment Test for 3 to 6 year olds (CVIT 3–6). Test development reflected a cross-talk between vision research and clinical relevance. Six pilot studies with 100 children resulted in 14 subtests covering object recognition, degraded object recognition, motion perception and local-global processing. Norm data were collected from 250 children. Based on this sample, age-specific percentile scores can be calculated for each new patient entry. Validity and reliability was evaluated in children with CVI, intellectual disabilities, low acuity or typical development. Test-retest reliability and Cronbach's alpha were determined. Internal validity was evaluated by confirmatory factor analyses. Discriminant validity was assessed by comparing performance between groups and correlating CVIT 3–6 performance with visual acuity, intelligence and autism. Convergent validity was evaluated by correlating CVIT 3–6 performance with the other measures of visual functions.

[1S1B007] Spatial mapping of retinal correspondence in strabismus

Zahra Hussain, Andrew Astle, Ben Webb and Paul McGraw
University of Nottingham, UK; University of Nottingham, UK; University of Nottingham, UK; University of Nottingham, UK

Strabismus (misalignment of the visual axes of the eyes) can lead to visual confusion and diplopia. To avoid these problems, stimuli projecting onto a region of the deviating retina can be actively inhibited (inter-ocular suppression) or realigned with corresponding retinal positions in the fixating eye (anomalous retinal correspondence). Here we describe a dichoptic matching method for mapping the degree of retinal correspondence between the eyes at multiple locations in the visual field in normal and strabismic observers. Two dots, each viewed by a different eye, are positioned at corresponding locations in the visual field with reference to a central fixation cross, seen by both eyes. This positional mapping method provides good quantification of the degree of retinal correspondence in strabismus. We will present evidence for: (1) systematic shifts in positional localization that correspond to the subjective angle of squint; (2) magnified biases in regions of the central visual field that are consistent with classic patterns of suppression; and (3) a left-right hemifield asymmetry in positional correspondence that is well-correlated with the direction of squint. We will discuss these binocular distortions of visual space with reference to the associated cause of early visual deprivation.
The Leverhulme Trust

Symposium: Ecological validity in social eye movement research

[1S1C001] Temporal dynamics of social attention in face-to-face situations

Megan Freeth and Andrius Vablas
University of Sheffield, UK; University of Sheffield, UK

In face to face eye-tracking studies, researchers often use total fixation times on areas of interest to assess social attention. However, other measures can also be used to investigate potentially more subtle differences in social attention strategy. Eye-tracking data from a face to face interaction study will be presented which aimed to assess potential differences in social attention strategy between individuals who were classified as being high or low in autistic traits. No differences in overall fixations in various areas of interest were observed. However, there were clear differences in temporal dynamics of eye-movements. Individuals who were high in autistic traits exhibited reduced visual exploration overall, as demonstrated by shorter and less frequent saccades during the face to face interaction. Differences were not accounted for by social anxiety. Thus it is proposed that multiple eye-tracking measures should be used to understand more of the subtleties of visual attention strategy. Such measures may be less under conscious control and therefore less susceptible to modification in response to observer effects.

[1S1C002] Context dependence of attentional capture

Amelia Hunt, Arash Sahraie and C. Neil Macrae
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A critical issue in attention research is the precise degree to which measures of human orienting behaviour in laboratory tasks scale up to more naturalistic settings. We have been running a series of experiments that attempt to bridge this gap by measuring attentional biases in each participant in two different contexts: 1) speeded responses to stimuli presented repeatedly on a computer screen, and 2) fixation behaviour in an unconstrained and task-free context (for example, while they are sitting in the waiting room, ostensibly before the formal experiment begins). The aim is to evaluate the stability of attentional biases in a group of participants within one context or the other, as well as in the same individual across both contexts. In experiments examining the effect of faces and facial expressions of emotion, statistically robust attentional biases can be measured in both the lab and the waiting room context. However, the stimulus categories that produce stable biases differ across contexts, and a bias in a particular individual does not generalize from one context to another. The results illustrate the context-sensitivity of attention and advise caution in over-generalizing from lab to life.

[1S1C003] The social presence effect of wearing an eye tracker: Now you see it, now you don't

Eleni Nasiopoulos, Evan Risko, Tom Foulsham and Alan Kingstone
University of British Columbia, Canada; University of Waterloo, Canada; University of Essex, UK; University of British Columbia, Canada

People often behave differently when they know they are being watched. It was reported previously that wearing an eye tracker can serve as an implied social presence and cause individuals to avoid looking at particular stimuli. This presents a methodological challenge to researchers who wish to use eye trackers to understand the function of human attention in real world settings. Our recent work reveals that the implied social presence effect of eye trackers can dissipate quickly, in less than 10 min. However, drawing an individual's attention back to the fact that they are wearing an eye tracker can reactivate its social presence effect.

This suggests that eye trackers induce a transient social presence effect, which is rendered dormant when attention is shifted away from the source of implied presence.

[1S1C004] The interpretation of gaze in two-way social interactions

Tom Foulsham
University of Essex, UK

Visual attention allows us to select important stimuli in a complex and social environment. One way to study this in ecologically valid social settings is to present (increasingly-complex) stimuli, such as images and video of people, and record what people look at. Another way is to record attention in real interactions, but these may lack experimental control. I will describe a different approach, where we ask participants to make inferences while they watch the eye and head movements of others. For example, in one study, observers were able to correctly guess which of four items a participant preferred by watching a replay of their eye movements. Moreover, when participants knew that they were being watched and were asked to mislead the observer, they spontaneously changed their behaviour. Thus we can investigate the communicative function of gaze in a two-way, but controlled, situation. Recent extensions of this approach show that participants modulate their eye and head movements differently when hiding their preferences from an observer, presumably because head movements are a more salient cue. Visual behaviour depends on the social context, and studying this across effectors is a rich avenue for future research.

[1S1C005] How attention is shaped by beliefs about other people

Matthias Gobel and Daniel Richardson
UCL, UK; UCL, UK

We are highly tuned to each other's visual attention. Gaze cueing experiments, for example, show that a face looking in one direction will trigger attention in that direction. However, it is not clear whether the effect of such social cues is due to the appearance of a face, or the belief that face represents the attentional focus of another person. We investigated this question by changing participants' beliefs about the social nature of a cue in an inhibition of return paradigm. Participants believed that a red dot reflected either the attentional focus of another person sat behind them, or was randomly placed by the computer. We found that inhibition of return effects were amplified when the cue had a social meaning. Moreover, we found that these inhibition of return effects were modulated top-down by participants' beliefs about their partners' competence level and the task they were engaged in. Despite previous claims that attentional inhibition is 'blind' to such factors, when a cue was imbued with a social context it exerted a stronger influence over low-level visual attention.

[1S1C006] Looking at people in real life: Methods for investigating social attention

Kaitlin Laidlaw and Alan Kingstone
University of British Columbia, Canada; University of British Columbia, Canada

The study of visual attention often relies on eye tracking technologies in order to measure where and when participants look. Using eye trackers poses some challenges, however, not the least of which is that they can make participants aware that their looking behaviour is being monitored and this may change how people behave, especially in social settings. In this talk, we report findings which demonstrate that participants look at another person in real life very differently than when the same person is presented in a pre-recorded video. This suggests that using potentially obtrusive computer-based methodologies to measure attention to images of people may fall short of capturing real-life attentional behaviour. To measure everyday social attention nonintrusively, we recently implemented a simple but powerful paradigm using only a confederate and a hidden video camera. In so doing, we demonstrate that pedestrian will covertly attend to nearby others, and modify their overt reactions based on social norms. These findings open new doors for attention researchers to study how people behave in complex situations and demonstrate the utility of both new technologies and creative, accessible methodologies.
This work was supported by funding from NSERC

Oral Presentations: Attention

[1T2A001] Simulating spatial auditory attention in a gaze contingent display: The virtual cocktail party

Robert Allison and Margarita Vinnikov
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The ability to make sense of cluttered auditory environments is convincingly demonstrated in the so-called cocktail party effect. A speech signal of interest can be better separated from competing speech signals and background noise when listeners have normal binaural cues to the spatial location of the speaker. However, in most media applications, including virtual reality and telepresence, the audio information is impoverished. We hypothesized that a listener's spatial auditory attention could be simulated based on visual attention. Since interlocutors typically look at their conversational partner, we used gaze as an indicator of current conversational interest. We built a gaze-contingent display that modified the volume of the speakers' voices contingent on the current region of overt attention. We found that a rapid increase in amplification of the attended speaker combined with attenuation but not elimination of competing sounds (partial rather than absolute selection) was most natural and improved source recognition. In conclusion, audio gaze-contingent displays offer potential for simulating rich, natural social and other interactions in virtual environments.
Thanks to NSERC Canada for a discovery grant to RA.

[1T2A002] Social orienting in gaze leading: A mechanism for shared attention

Stephen Gareth Edwards, Lisa Stephenson, Mario Dalmaso and Andrew Bayliss
University of East Anglia, UK; University of East Anglia, UK; University of Padova, Italy; University of East Anglia, UK

Here we report a novel social orienting response that occurs after viewing averted gaze. We show that when a person looks from one location to an object, attention then shifts towards the face of an individual who has followed the person's gaze to that same object (Experiments 3–5). That is, contrary to a 'gaze following' effect, attention instead orients in the opposite direction to observed gaze. Thus, those that follow our eye-gaze capture our attention. This 'gaze leading' effect emerges only in active, object-oriented, tasks. The effect is not present when the object is not an image of a real-world artifact, but a mere fixation cross (Experiment 2) and is reversed when the task is passive (Experiment 1; i.e. a standard gaze 'cueing' effect). Thus, the context in which our eye-gaze is followed is crucial to how our attention orients. We propose that the gaze leading effect implies a mechanism in the human social cognitive system for detecting when one's gaze has been followed, in order to establish 'shared attention' and maintain the ongoing interaction.

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[1T2A003] Feed-forward feature-based attention modulates attentional capture and gaze capture by irrelevant onsets in visual search

Stefanie Becker I and Jenna E Axtens
The University of Queensland, Australia; The University of Queensland, Australia

Attention and eye movements are to a large extent controlled by our intentions and goals, so that, for instance, task-irrelevant items will attract attention and the gaze only (or much stronger) when they are similar to task-relevant stimuli. Yet, one type of stimulus has been described as being exempt from goal-driven top-down modulation: Suddenly appearing stimuli or 'onsets' seem to be able to attract attention and the gaze automatically, in virtue of their stimulus attributes and without being necessarily similar to the target. In the present study we examined whether irrelevant onset stimuli can indeed capture attention and the gaze independently of top-down intentions, by asking participants to search for a color target that could be either red or green and announcing the target color prior to each trial with a word cue. The results of separate eye tracking and EEG experiments showed that the attentional capture and gaze capture by the irrelevant onset distractor were strongly modulated by whether it had a color that matched or mismatched the word cue, demonstrating that onset capture is strongly modulated by top-down, goal-driven processes. These results argue against the view that capture by onsets is exempt from top-down, feature-based attention.

This research was funded by an ARC Future Fellowship FT130101282 and a UQ FREA grant to SIB.

[1T2A004] Why don't we see the gorilla? Looking in the wrong place, attending to the wrong objects, or doing the wrong task?

Ruth Rosenholtz, Lavanya Sharan and Emily Park
MIT, USA; MIT, USA; Wellesley College, USA

Observers counting basketball passes often do not notice an unexpected "gorilla" (Simons & Chabris, 1999). They notice it more often when counting black-team passes (83%), than white-team passes (42%). Supposedly, when counting black-team passes, the gorilla's similarity to the attended team leads to its capture by attention, and subsequent conscious perception. However, other attentional factors may play a role. We find that: (1) Fixations differ in important ways when counting black vs. white-team passes. "Black-team fixations" land closer to the gorilla ($m = 6.9$ deg horizontal distance) than "white-team fixations" ($m = 10.0$ deg, $t(57) = 2.31$, $p = 0.02$, display = 40x30 deg). (2) However, observers with a known gorilla discrimination task (150 ms presentation of individual video frames) are equally good with either white-team fixations ($d' = 2.30$) or black-team ($d' = 2.27$). (Umbrella woman $d' > 3.25$) (3) Naïve observers ($n = 11$) with white-team fixations, attending to the black team for a numerosity task (static images, 150 ms), rarely notice anything unusual (54%), whereas with black-team fixations ($n = 10$) they often do (80%). These results suggest that attentional selection of similar items is not the whole story. Rather, an interaction between looking the wrong places, and not knowing the "real" gorilla detection task helps render the gorilla invisible.

[1T2A005] Perceiving Crowd Attention: consensus gaze following in human crowds

Zhongqiang Sun, Wenjun Yu, Jifan Zhou, Meng Zhang and Mowei Shen
Zhejiang University, China; Zhejiang University, China; Zhejiang University, China; Zhejiang University, China; Zhejiang University, China

An effective means to receive information from others in the group is to observe their attention focuses through gaze direction (e.g. gaze cue effect). In many cases, the gazing directions in crowds are not consentaneous. We aimed to figure out how human process the conflicting group attention information, and modified the gaze cueing paradigm into a human crowd version. A group of human avatars was firstly presented, and the situations of gaze cue orientation in crowds were manipulated from Consistency (all gazing at the same orientation) to Inconsistency (1 to 5 out of 10 avatars with opposite gaze orientation). Then the participants had to indicate whether the following probe item on either side (whether was cued by the crowd gaze) contained two or three dots. The results demonstrated that the majority's gaze orientation attracted most of attentional resource, and the attention distribution was in accordance with the proportion of individuals who share the same gaze orientation in this group. As the degree of divergence went up, the difference of attentional resources between two orientations increased. It is the first time to explore the attention distribution mechanism behind the gaze following phenomenon in the crowd attention conflicting situation.

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[1T2A006] Motion direction is processed automatically

Katherine Burnett, Isabel Arend and Avishai Henik
Ben-Gurion University of the Negev, Israel; Ben-Gurion University of the Negev, Israel; Ben-Gurion University of the Negev, Israel

Motion may be prioritised in visual processing since it is highly biologically-relevant. Here we test the idea that motion is processed automatically. In the first study, an arrow pointing to the left or right contained a flowfield of left- or right-moving dots. Participants responded to either arrow direction or motion direction. There was a congruity effect (CE) for both tasks suggesting automaticity. However, reaction time (RT) was faster for the arrow task, and the arrow direction produced a larger CE on the motion task than vice versa. Analyses of the RT distribution by means of a binning procedure showed a significant CE for the motion task across RTs. For the arrow task, a significant CE emerged only for late RTs. In the second study, we presented small translating arrows instead of the large static arrow. Thus arrow direction and motion direction were local properties. We replicated the previous result that arrow direction interfered more and earlier than motion direction, suggesting that the results are not explained by a global over local advantage. Time-course analysis of CEs revealed that motion direction is automatically processed, and interfered at late response times, consistent with the neuro mechanisms supporting shape and motion processing.

Oral Presentations: Surface and texture

[1T2B001] The effect of ambiguity of material perception on the mode of color appearance

Ichiro Kuriki
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The "mode of color appearance (mode)" is a concept suggesting that variations in a medium that emits, transmits, or reflects light can cause differences in color appearance. For example, the same light that appears brown (or gray) when reflected from a given object surface may appear orange (or white) when emitted from a light source. The present study investigates the relationships between material perception and perceived mode, especially in terms of luminosity. In the experiment, a computer-generated image of spheroid was presented with surrounds of various luminance levels. The spheroid was rendered with a surface texture of either matte gray (three simulated reflectance levels) or one of two fabrics. The participants were asked to evaluate the luminosity (mode) and perceived reflectance of the object. The results show that the mode perception was stable to surface mode, when the material identity was disambiguated. The luminosity was fit with a linear function of the CIE L* value of the object surface, unless the material of the surface is identifiable, and the mode perception of the same object can vary with surround luminance when the surface property is ambiguous.
This study was supported by a Grant-in-Aid for Scientific Research on Innovative Areas (KAKENHI, Number 25135702), from MEXT.

[1T2B002] Gloss perception of photographs and real multi-material objects

Sabrina Hansmann-Roth, Sylvia Pont and Pascal Mamassian
École Normale Supérieure, France; Delft University of Technology, Netherlands; École Normale Supérieure, France

Gloss perception experiments mainly investigate unicoloured surfaces. However, there is evidence that the albedo can strongly influence perceived gloss (Pellacini, Ferwerda, & Greenberg 2000). We investigated glossiness judgments within a single surface containing multiple albedos. In addition, we tested real surfaces and photographs of these surfaces. Real surfaces were polystyrene sheets that were then spray-painted in five colours and five gloss levels. Surfaces either had a uniform albedo or were split in two halves painted with two different colours. In a first experiment participants rated the overall gloss of the bicoloured surfaces and we found that overall gloss was close to the mean ratings of corresponding unicoloured surfaces. Similar results were obtained for both, real surfaces and photographs. In a second experiment participants rated only the left or right half of the bicoloured surface. For the photographs displayed on a monitor, perceived gloss of one half of the surface was not significantly influenced by the other half. However, for the real surfaces, there was a simultaneous gloss contrast effect: lighter colors appeared less glossy when presented next to a darker colour. Differences between real surfaces and photographs might come from conflicting 3D cues on the monitor.
EC FP7-PEOPLE PITN-GA-2012-316746 (PRISM)

[1T2B003] Modifying material appearance with bandsifting operators

Edward Adelson, Ivaylo Boyadzhiev, Sylvain Paris and Kavita Bala
MIT, USA; Cornell University, USA; Adobe Inc., USA; Cornell University, USA

To understand the impact of subband statistics on material appearance, we have explored a range of techniques for manipulating images. We split an image up into subbands using an edge-aware variant of the Laplacian pyramid. Each subband is further split into positive vs. negative signs and low vs high amplitudes. We explore the range of effects we can get by "sifting" (i.e. keeping or rejecting) information on the basis of amplitude and sign. This pipeline includes, as special cases, some common manipulations such as sharpening, blurring, and denoising. It is difficult to explore the full space of possible operators, but we have found a useful subset. Consistent with prior work, gloss can be increased or decreased by manipulating the high amplitude positivecoefficients. Depending on the subbands, this can look like sparkly gloss or a more broad burnished gloss. Negative coefficients of low amplitude tend to correspond to pigmentation, dirt, and wear. Other combinations yield apparent changes in lighting, making the light appear directional or broad. As long as one stays within reasonable limits, the manipulations appear natural, i.e., one has the impression of viewing an unaltered picture of a natural object.

[1T2B004] Surface reflectance and motion characteristics affect perceived bumpiness of 3D-rotating objects

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Dynamic visual information projected onto the retina (optic flow) facilitates 3D shape recognition. While optic flow generated by a moving diffusely-reflecting (matte) object is directly linked to its first order shape properties, the flow generated by a specular object is tightly related to its second-order shape characteristics (Koenderink and van Doorn, 1980). Dovencioglu et al.

(2015) demonstrated that reflectance-dependent optic flow yields differences in perceived local curvature of rotating matte and specular objects. Here we investigated these perceptual differences in a global shape task. Stimuli were bumpy spheres with the object boundary masked by a Gaussian aperture. The bumpiness level was varied by adjusting the amplitudes of randomly applied sinusoids. We measured 'percent judged bumpier' in a 2IFC task, where the reference object was always specular and of intermediate bumpiness. Seven observers completed 5(bumpiness) $\times$ 3(material: specular, matte, intermediate) $\times$ 3(rotation axes) $\times$ 30(repetition) trials. Results indicate that matte objects were judged as less bumpy than specular ones. Moreover – unlike for matte objects -the perceived bumpiness of specular objects was not affected by the object's rotation axis, suggesting that specular flow characteristics remain largely robust across different types of object motion.

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[1T2B005] Neural Representation of Spectral Densities in IT Cortex

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The inferotemporal cortex (IT) has been shown to be crucially involved in the processing of complex stimuli such as objects, scenes and faces. Recently, the representation of synthetic fractals was decoded in IT (O'Connel & Chun, 2014), suggesting for the first time that what IT may really process is the complexity of information from energy and phase offset of an image. Here we used multi voxel pattern analysis (MVPA) to decode how neurons in IT decode information about energy and phase spectra obtained from images of faces and environmental scenes. To this aim, we used functional magnetic resonance imaging (fMRI) to record the Blood Oxygen Level Dependent (BOLD) response while participants were exposed to images of faces or environmental scenes where energy was spectrally matched to several distributions, including white, pink (1/f), Brownian noise. Our preliminary findings suggested that the energy of 1/f noise was reliably decoded in the right hemispheres of the scene (PPA) as well as the face (FFA) IT areas. The specific energy distribution of face stimuli could not be decoded either from activation in FFA or PPA regions.

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[1T2B006] Absolute and relative spatial frequency tuning in V1 neurons

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Several psychological studies reported that spatial frequency (SF) tuning of human perception varies depending on stimulus size. The size-dependency of SF tuning may contribute to the perceived object "size constancy". A recent study on neurons in the macaque inferiortemporal cortex (IT) reported that a population of IT neurons decreased their peak SF with increasing stimulus size (Inagaki and Fujita, 2011). They concluded that some IT neurons tuned not to absolute SF (cycles/°) but to relative SF (cycles/image). However, comparatively little is known about whether early visual neurons tuned to relative or absolute SF. In the present study, we investigated the effects of stimulus size on SF tuning of V1 neurons using a drifting sinusoidal grating stimulus. Subpopulation of V1 neurons in the superficial layer (layer 2/3) exhibited nearly perfect relative SF tuning, while most layer 4 neurons exhibited absolute SF tuning. We also found that the neurons with relative SF tuning showed time-varying peak SF from low to high. These results suggest that transformation from absolute to relative SF tuning starts in V1 by converging inputs from absolute SF tuned neurons with different peak SFs.
This work is supported by JSPS KAKENHI #90403188

Oral Presentations: Vision preference and emotion

[1T2C001] Biological foundations of adult colour naming and preference are revealed by infants' response to colour

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Across cultures, there are commonalities in how colour lexicons categorise colour and common patterns of colour preference (e.g., Kay & Regier, 2003; Hurlbert & Ling, 2007). Here, we investigate the origins of commonalities in adult colour naming and preference by investigating colour categorisation and colour preference in 4–6 month old infants. Hues were systematically sampled around the hue circle at maximum chroma in steps that are greater than infants' chromatic discrimination thresholds at 4–6 months. Whether pairs of hues were distinguished in infant memory was measured with a novelty preference method (e.g., Franklin & Davies, 2004). Looking times to individually presented hues were also measured. Infants distinguished blue-green, green-yellow, purple-red and blue-purple colour differences, and did not distinguish hues within blue, green, purple or yellow-red regions even when hue differences were maximised. The distinctions that infants made align with common fault lines in the world's colour lexicons and with cone-contrast mechanisms. Infants also looked longer at colours that adults prefer, and both infant looking and adult preference was greater with more positive S-(L + M) cone-contrast. Overall, the findings suggest that commonalities in adult colour cognition are present in infancy and can be explained by low-level mechanisms of the visual system.
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[1T2C002] Missing it, and missing it badly: negative affect induced by missed changes in change blindness paradigm

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Observers who fail to locate visual search targets despite long gaze dwell times tend to dislike that targets afterwards (Kristjansson & Chetverikov, 2015). We used a novel mouse-contingent change blindness (CB) paradigm to test if this effect contributes to CB via negative feedback. Observers studied a 5x5 matrix of artificial traffic signs repeatedly presented for 250 ms with 83 ms blank intervals. On each repetition, one of the signs changed in color, orientation, or content. The visible area was limited (5 degrees), centered on the mouse position, and began to shrink if the mouse position did not change so observers had to move the mouse to see the stimuli. A trial ended if observers found the changing target or if the mouse stayed on the target (or on a randomly selected item on catch trials) long enough to see both original and changed target. In the latter case, observers were asked to select the traffic sign they liked or disliked (counterbalanced) among the target and the two closest distractors. We found that compared to catch trials, "missed but looked at" targets are disliked, arguing for both implicit change detection in change blindness and the role of affective feedback in perception.
Supported by RFBR grant #15-06-09321

[1T2C003] Low-level Image Properties correlate with Personal Traits in Artificial Face Images

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Recently, low-level image statistics have been associated with several properties of faces like emotions, attractiveness and age. In this study, I investigated these properties according to their association with personality traits of faces. Therefore, I used artificial face images from seven databases created by the Todorov research group (Todorov et al., 2013). Each database included images of 25 maximally distinct face identities that were manipulated on seven different traits (Attractiveness, Competence, Dominance, Extraversion, Likeability, Threat, and Trustworthiness) for shape and reflectance in the positive and the negative direction, respectively. I used established measures for low-level image properties that have previously been associated with aesthetics, like Fourier power and slope, and PHOG self-similarity and complexity, amongst others. Interestingly, there were similar patterns of correlations with low-level image properties for Extraversion, Threat and Dominance, as well as for Attractiveness and Likeability. The results indicate that controlled changes in morphology and colour of lead to specific changes in low-level properties. Therefore, it is conceivable that these low-level image properties might play a role in the subjective perception of personal traits.

[1T2C004] Functional integration of neural signals during person perception

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The role of the ventral visual stream in person perception has been studied extensively. Segregated patches of cortex show selective responses for images of faces and bodies. Less research to date has investigated functional integration between neural signals during person perception. I review recent fMRI studies from my lab that have investigated the hypothesis that functional interplay within the ventral visual stream as well as with extended brain circuits underpins the representation identity. First, I will show that when observing others and overtly inferring social traits (e.g., friendly, kind), body-selective patches are functionally coupled with the theory-of-mind network. Second, I will show how detection of social signals from body cues, such as an overweight or muscular physique, involves functional coupling within body-selective circuits, as well as between body patches and dorsal parietal cortex. These data firmly support the view that the representation of identity engages a distributed neural network, which is not restricted to segregated processing units in the ventral visual stream. Instead, during person perception, category-selective responses show coupling between each other, as well as with attention-orienting and inferential mechanisms. These findings highlight the importance of considering distributed and connected brain circuits when investigating the ventral visual stream.
This work was supported by the Economic and Social Research Council (ES/K001884/1).

[1T2C005] Exogenous cuing of attention increases preference for abstract shapes

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There is growing interest in the role of attention on preference formation. It is known that people attend to rewarding stimuli. We examined the opposite effect: Does orienting attention increase preference? We used an exogenous cuing task followed by an explicit rating of preference. In Experiment 1 an uninformative cue appeared left or right, followed by an abstract pattern. Participants quickly classified patterns regularity, and then rated preference on a 9-point scale. One group overtly attended the patterns whereas the other group maintained fixation trough the whole trial. Patterns at cued (valid) locations were liked more than patterns at invalid locations (validity effect). Interestingly, this effect was observed only with overt shift of attention. In Experiment 2 validly and invalidly cued patterns were tested against a baseline (no-cue condition). There was a 'valid > no-cue > invalid' trend both on performance and preference. By manipulating some parameters in further experiments we observed that preference modulation reflected cueing effect on attention. We conclude that attention and preference are reciprocally related. Moreover, the activation of a sensorimotor response (i.e. overt orienting to/away cued locations) is critical: people move their eyes to preferred stimuli, and in turn, shifting the gaze increases preference.

[1T2C006] The Effectiveness of Augmented Reality in Enhancing the Experience of Visual Impact Assessment for Wind Turbine Development

Larissa Szymanek and David R. Simmons
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A Visual Impact Assessment (VIA) is a formal requirement for proposed building developments likely to significantly affect the landscape. A key component of a VIA is the production of visual materials illustrating the development. But how effective are they? 67 Participants were told about a planned wind turbine development near our University and that the proposed site could be viewed from a location on campus. The illustrations used were: a printed static photograph simulating the proposed development (adhering to current UK guidelines), the same photograph presented on the screen of a laptop and an augmented reality simulation on a tablet computer which included an animated wind turbine superimposed on the scene. Participants were asked to rate various aspects of these simulations (e.g. clarity, trustworthiness) as well as to state their overall preference. The augmented reality simulation was rated as best in all ratings and the most preferred. The reasons given included that the animation gave a better idea of what the wind turbine would look like "in situ" and that it was easier to alternate viewing between the real scene and the simulated scene. These results will inform future government guidelines on materials used in VIAs.

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Oral Presentations: Attention: brain mechanisms

[1T3A001] Perceptual load degrades population orientation tuning in early visual cortex

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It is well established that when attending to a task high in perceptual load, visual cortex responses to unattended stimuli are reduced (for reviews see Lavie, 2005; Lavie et al., 2015). Furthermore, it was shown recently (de Haas et al., 2014) that the coding of location by neuronal populations in early visual cortex is less precise under high (vs. low) load. Here we investigate the coding of orientation in retinotopic cortex under low and high levels of perceptual load using voxel-based orientation tuning functions (VTFs; Serences et al., 2008; Saproo et al., 2010). Perceptual load was manipulated with an RSVP task at fixation demanding either a single-feature search (low load) or conjunction-of-features search (high load), while sinusoidal gratings of varied orientations were presented intermittently in the periphery. Localised cortical responses to these gratings were extracted and used to construct VTFs. In agreement with recent psychophysical work (Stolte, Bahrami, and Lavie, 2014) we report reduced amplitude and increased bandwidth of orientation response profiles in primary visual cortex under high perceptual load. These findings suggest that perceptual load not only lessens visual cortical response to stimuli outside the focus of attention, but also degrades neural population tuning to stimulus orientation.

We would like to acknowledge Jonas Ambeck-Marsden of Toyota Motor Europe for many informative discussions

[1T3A002] Do early sensory P1 event-related potential modulations actually reflect oculomotor inhibition of return?

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A great deal of work has investigated the relationship between modulations of early sensory P1 event-related potentials (ERPs) and inhibition of return (IOR). However, these studies have discouraged eye movements, resulting in an actively suppressed oculomotor system and an input-based form of IOR. In the real world, eye movements are rarely suppressed and the 'true' form of output-based IOR arises (Taylor & Klein, 2000). Recent experiments using combined eye tracking and electroencephalography have investigated oculomotor IOR by incorporating eye movements before targets appear (e.g., Satel, Hilchey, Wang, Story, & Klein, 2013). Although P1 modulations still arise when there is repeated peripheral stimulation, these reductions appear only in retinotopic coordinates (when there is no IOR), not in spatiotopic coordinates (when there is IOR). When there is not repeated peripheral stimulation (as when central arrows are used as stimuli), equivalent IOR is still generated, but there are no P1 reductions. Later modulations of the Nd component do, however, still arise in conjunction with IOR in spatiotopic coordinates and with endogenous stimuli. We propose that modulations of later ERPs, such as Nd and perhaps N2pc, reflect 'true', oculomotor IOR, whereas P1 modulations are simply the result of repeated peripheral stimulation.

[1T3A003] Goal-directed orienting and target-set maintenance in the fronto-parietal attention network

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A network of frontal and parietal regions has been implicated in visual attentional control. However, the respective contributions of different brain regions to sub-processes underlying attentional control remains to be clarified. In the current study, we used a blocked functional magnetic resonance imaging (fMRI) design varying search difficulty and target-set complexity in a visual search task, to distinguish the functional variation in activity for goal-directed orienting and goal maintenance. Increased target-set complexity led to a greater response in the middle and superior frontal gyri as well as in the inferior parietal lobule, whereas increased search difficulty led to a greater response in the precuneus, middle frontal and occipital gyri. Thus, the current study provides evidence that goal-directed orienting and goal maintenance draw on different brain regions, with a potential integrating role for the middle frontal gyrus (Brodmann area 6) previously implicated in planning of complex actions. Distinguishing sub-processes involved in attentional control and their neurofunctional underpinnings is particularly helpful for differentiating attentional disorders and enhancing specificity of treatments.

[1T3A004] Effects of constant and variable target colours in one-, two-, and three-colour search

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Attentional target selection is less efficient in multiple-colour relative to single-colour visual search (Grubert & Eimer, 2013; 2015), demonstrating capacity limitations of top-down search templates. These limitations may be even more pronounced when target colours are not constant, but change across trials, so that new search templates have to be activated on each trial. This prediction was tested in two experiments that compared target selection efficiency during one-, two-, and three-colour search. Target colours were indicated by pre-cues, and either remained constant or varied randomly across trials. RTs increased as a function of the number of possible target colours, and were slower in the variable relative to the constant colour presentation conditions. The N2pc component (an electrophysiological index of attentional target selection) emerged later as the number of target colours increased, confirming the costs of multiple-colour search templates on selection speed. However, the N2pc onset latency delays during multiple-colour search were identical with constant and variable target colours. We conclude that the additional RT costs for multiple-colour search that arise when target colours are variable are not generated during target selection, but during subsequent target identification and response selection stages.
This work was supported by grant ES/K006142/1 from the Economic and Social Research Council (ESRC), UK.

[1T3A005] The role of alpha oscillations in the Attentional Blink

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The Attentional Blink (AB) phenomenon occurs when two targets, embedded within a rapidly-presented sequence of distractors, must be identified. When the second target occurs within around 500 ms of the first, participants frequently miss it. Recently, there has been some focus on the role of alpha (8–14 Hz) oscillations in the brain, their role in temporal attention, and more specifically in the AB. Previous studies show resting-state alpha predicts AB, and that alpha power immediately prior to masked stimulus presentation can predict stimulus perception; however, the role of pre-stimulus alpha in the AB has received relatively little attention. We measured continuous EEG during both resting state and an AB task. There was considerable individual variation in AB magnitude; we failed to replicate MacLean et al.'s (2012) finding that resting-state alpha predicted AB, but found a strong relationship between pre-stimulus alpha power and AB. Comparing AB to no-AB trials, alpha power was higher for trials in which an AB was present. In addition, during stimulus presentation, alpha phase differed markedly for AB compared to no-AB trials. The results support both attentional overinvestment and alpha entrainment accounts of the AB.
NHMRC Grant APP1054726; ANU Research School of Psychology internal grant

[1T3A006] The influence of context on visual selectivity as indexed by the N2pc

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Previous studies showed that attention can not only be top-down tuned to a target's physical feature (e.g., orange), but also to its relative attributes (e.g., "redder"; Becker, 2012). In the present study, participants (n = 24) searched for a target with a pre-defined color among target-context elements (e.g., an orange target in a yellow context, which is "redder"). Spatially unpredictive precues exhibiting various cue and cue-context colors were presented to probe whether attention was tuned to the physical or relative target color. Critically, we measured the N2pc component of the event-related potential to assess whether a cue attracted attention. We found that cues with the same relative color as the target elicited N2pcs, even when they had different physical colors (e.g., a red cue in orange context, which is "redder", but has a different physical color). Conversely, cues with the opposite relative color produced no N2pcs, even when they had the same physical color (e.g., an orange cue in a red context, which is "yellower", but physically matching). Evidently, attention can be top-down tuned to relative target features, so that only cues with the same relative features attract attention. Importantly, these results demonstrate that the N2pc is sensitive to these context-dependent attributes.
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[1T3A007] The focus of spatial attention during encoding determines the capacity and precision of visual face memory

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Visual working memory capacity is widely assumed to be around three or four items. For complex objects such as faces, memory capacity is often restricted to a single item. There is debate about whether such severe capacity limitations arise during memory encoding or during the subsequent memory matching process. I will discuss recent event-related brain potential (ERP) studies designed to ascertain the locus of this capacity limitation. Participants had to encode one or two faces in memory displays and compare them to a subsequent test face. In two experiments, faces had to be encoded either simultaneously or sequentially. Specific ERP components were measured to track the attentional selection of faces (N2pc), the sustained maintenance of these faces in working memory (CDA), and the speed and precision of face identity matching processes (N250r). ERP findings reveal that focal attention is necessary to maintain individual faces in working memory. We suggest that the focus of sustained spatial attention during the initial encoding and maintenance of individual faces causes limitations in the precision and capacity of visual face memory.
This work was supported by a grant (ES/K002457/1) from the Economic and Social Research Council (ESRC), UK.

[1T3A008] Differential brain activity in overt and covert attention shifts: Evidence from co-registered eye-tracking and EEG

Louisa Kulke, Janette Atkinson and Oliver Braddick
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Attention improves visual processing and can be shifted either overtly by making an eye-movement or covertly, without fixating the attended object. Patient groups commonly show impaired ability to disengage from stimuli and shift to peripheral targets, indicating that disengagement requires additional neuronal control. Most previous EEG studies instructed subjects to covertly shift attention, thereby suppressing natural saccades. This study compared covert and overt attention shifts, both with and without a competing central target (requiring disengagement). Participants performed an attention shift task in which they either manually responded to peripheral targets while maintaining fixation (covert) or made a saccade towards them (overt). EEG and eye-tracking were combined to simultaneously measure brain activity and saccades. Event-related potentials differed between overt and covert shifts of attention. An early fronto-central positivity was greater for covert shifts and occipital responses showed significantly longer latencies for shifts requiring disengagement. These results provide insights to the mechanisms of attention shifts in a natural context, and can be used for testing non-verbal populations such as infants and children with communication disorders. The fronto-central component might reflect activation of the frontal eye fields as a crucial difference between covert and overt shifts of attention, reflecting attentional control.
This research was supported by a stipend from the DAAD to Louisa Kulke and an Emeritus Fellowship Award to Prof Jan Atkinson from the Leverhulme Trust, UK.

Oral Presentations: The changing visual system: development and ageing

[1T3B001] Aging and Perception

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The developed world is aging faster than ever before. Even in the absence of neurodegenerative disease, aging affects all kinds of human functions including perception and cognition. In most perceptual studies, one paradigm is tested and it is usually found that older participants perform worse than younger participants. Implicitly, these results are taken as evidence that there is one aging factor for each individual determining his/her overall performance levels. Here, we show that visual and cognitive functions age differently. We tested 131 older participants (mean age 70 years old) and 108 younger participants (mean age 22 years old) in 14 perceptual tests (including motion perception, contrast and orientation sensitivity, biological motion perception) and in 3 cognitive tasks (WCST, verbal fluency and digit span). Young participants performed better than older participants in almost all of the tests. However, within

the older participants group, age did not predict performance, i.e., a participant could have good results in biological motion perception but poor results in orientation discrimination. It seems that there is not a single "aging" factor but many.
Velux Stiftung Foundation

[1T3B002] Tracking developmental shifts in facial expression processing strategies

Louise Ewing, Annette Karmiloff-Smith, Emily Farran and Marie Smith
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Children are widely accepted to process faces and facial expressions of emotion differently to adults, with adult-like processing expertise continuing to develop into early adulthood. Few studies, however, have explored the manner in which children are successful in their face categorizations and in particular the processing strategies they implement. Here we investigated the development of processing strategies for the categorization of emotional expressions with a large developmental sample: 65 young children (aged 5 – 8), 65 middle aged children (aged 9–10), 52 older children (aged 11–13) and 20 adults. Across experimental trials we generated subsampled versions of expressive faces (fear, sadness, happiness, anger) by randomly sampling information from the images (across different spatial frequency bands and different locations in each image) using the Bubbles paradigm (Gosselin & Schyns, 2002). Results reveal clear, age-related shifts in the use of visual information during expression categorizations, which differs across the four emotions. Even the youngest children are adult-like in the way they selectively extract the critical information for happiness judgments, but processing strategies for fear and sadness are refined across development. Children's performance with angry faces was relatively poor, but where participants were successful, they relied on similar information to the adults.
This work was supported by Leverhulme Trust grant RPG–2013–019.

[1T3B003] Development of the other-race effect in school-age Taiwanese children: Using a morphing face paradigm

Sarina Hui-Lin Chien and Chu-Lik Tai
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Previous studies on the other-race effect (ORE) in school-age children mostly focused on recognition memory test. Here we explored the encoding advantage hypotheses (Walker & Tanaka, 2003) in school-aged Taiwanese children using a near-threshold face matching task. A total of 102 5- to 12-year-old children and 22 adults were tested with a sequential face matching task. The method of constant stimuli with swathes of morphed images of Caucasian and Asian female faces were used. In each trial, the participant viewed an Asian or Caucasian parent face followed by either the "same" face (0%) or a "different" morphed face (i.e., 15%, 30%, 45%, or 60% contribution from the other parent face) with equal probability. The psychometric functions on the rejection rates for Asian- and Caucasian-parent conditions were fitted with a sigmoidal function separately. The adults exhibited a smaller discrimination threshold and a sharper slope in the Asian condition, supporting the encoding advantage hypothesis. For

children, the younger groups (aged 5–8) did not exhibit an encoding advantage for own-race yet; it appears to emerge around 9–10 and became apparent around 11–12. In sum, school-age children made steady progress in discriminating own-race faces while their ability to discriminate other-race faces remained relatively unchanged.

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[1T3B004] Neural correlates of face recognition in the first hours of life

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Behavioral studies suggested that newborns can show communicative competences and that they can visually recognize a face previously seen since from the birth. The neurobiological evidence of this ability was demonstrated by four-months of life, and there is a considerable scepticism about the neurobiological maturation necessary for this ability before three-months of life. 23 newborns (11 newborns M = 4.7; DS = 3.3 hours old were included in the analyses) performed the following visual procedure: a presentation of a face for 60s (Target); then 50 trials of Target, 50 trials of Unknown faces and 50 trials of a neutral stimulus, each trial lasted 2 s. Event-related potential (ERP) analysis showed a difference amplitude in response to Target vs. Unknown on left occipito-temporal montage from 300 ms and a shorter latency in response to Target compared to Unknown. Time-frequency analysis showed a higher Beta1-band activity in response to Target compared to Unknown at 500–600 ms on occipital-temporal. Connectivity results showed higher implication in fusiform gyrus with known face. Findings suggest that the newborns have the ability to discriminate a familiar face from a stranger since from the birth; this result has a relevant clinical implication for the possibility to find early neural marker for psychopathology as the autism.

[1T3B005] The effect of age on visual decisions and consequences for models of bi-stable visual perception

Richard van Wezel, Elahe Arani and Raymond van Ee
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We studied the effect of age on visual perceptual decisions of bi-stable stimuli. We used two different stimuli: bi-stable rotating spheres and a binocular rivalry stimulus. At onset, both stimuli can evoke two different percepts: for the sphere clockwise or anti-clockwise rotation and for the binocular rivalry stimulus a percept that switches between the stimuli in the two eyes. The stimuli were presented intermittently for 1 second with a range of inter-stimulus intervals (0.1 – 2

seconds). Subjects ranged between 18 and 73 years old and were instructed to indicate which of the two percepts dominate at each onset of the bi-stable stimulus. Our results show that perceptual choices are more stable for older subjects for the binocular rivalry stimulus and not for the bi-stable rotating spheres. The results will be discussed in the context of current models for bi-stable visual perception.
This work was supported by HealthPAC (FP7-PEOPLE-2013-ITN)

[1T3B006] Aging modifies the direction of the assumed light source

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When judging the 3D shape of a shaded image, observers generally assume that the light source is placed above and to the left of the stimulus. This leftward bias has been attributed to hemispheric lateralization or experiential factors shaped by the observers' handedness, learning and usual scanning direction. As aging is known to be associated with loss of hemispheric lateralization in functional and resting state signals, in the current study, we measured the effect of aging on the assumed light source direction. A group of old adults over the age of 60, and a group of young adults judged the relative depth of the central hexagon surrounded by six shaded hexagons. We found a significant effect of age on the light source bias, with the older participants exhibiting a significantly decreased leftward lighting bias compared to the young participants. This result could be well accounted by the diminished hemispheric lateralization that occurs with ageing.

[1T3B007] Sensitivity to horizontal structure and face identification in developmental prosopagnosia and healthy aging

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Sensitivity to horizontal structure in human faces is related to identification performance in young, healthy observers (Pachai, Sekuler and Bennett, 2013). Here, we explored this relationship in developmental prosopagnosic subjects (DP) and older observers, two populations for which face identification is notably impaired. Specifically, we measured the performance of four groups in a 6-AFC identification task: older observers (mean age = 75), younger controls (mean age = 20), DPs (mean age = 43), and DP-matched controls (mean age = 43). On each trial, the target face was band-pass filtered to retain only horizontal, only vertical, or all orientation components. Additionally, target viewpoint either matched the response screen faces (i.e. front-facing) or was angled slightly to the side. Across all groups, sensitivity to horizontal structure, relative to vertical, was correlated with overall identification accuracy. Further, the older and DP groups performed significantly worse than their corresponding controls, their performance was reduced further when viewpoint variation rendered image matching impossible, and this additional decrement corresponded with decreased horizontal sensitivity, relative to vertical. These results extend the body of evidence relating selective horizontal processing to human face

identification, and may have implications for alleviating the identification deficits experienced by many populations.
NSERC, CIHR, Canada Research Chairs

Oral Presentations: Lightness and brightness

[1T3C001] An Empirical Model for Local Luminance Adaptation in the Fovea

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The visibility and perception of contrast depends strongly on the state of luminance adaptation in early vision mechanisms. Naka and Rushton (1966) modeled luminance adaptation of individual photoreceptors or as pooled across a small retinal region. However, most adaptation models used in computer graphics and vision assume a larger ad-hoc pooling radius. In this work we propose an empirical model for the local luminance adaptation, based on new psychophysical experiments. A custom high-dynamic-range display was build to produce contrasts in excess of 100000:1 and luminance above 5000 cd/m^2. The display was used to measure baseline adaptation due to full-field luminance stimuli, and the adaptation due to various patterns of disks and rings. We discuss the predictive power of several candidate models, ranging from simple Gaussian-weighted luminance averaging to general averaging kernels in the log-luminance domain. We found that the pooling radius is smaller than the ad-hoc radius used in many applications, but larger than the extent of the laterally interconnecting retinal neurons. This suggests that luminance adaptation is also pooled in receptive fields in LGN or the visual cortex. Our predictive model can be used as an adaptation function in existing applications in vision and graphics.
This work was partly supported by High Performance Computing Wales, Wales' national supercomputing service (hpcwales.co.uk).

[1T3C002] Cortical model of object-centered lightness computation explains contrast and assimilation in a luminance gradient illusion

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I have recently proposed an object-centered model of cortical lightness computation (Rudd, 2010, 2013, 2014) in which local directed steps in log luminance are encoded by oriented spatial filters in early visual cortex, then the filter outputs are appropriately integrated along image paths directed towards the target at a subsequent cortical stage. A contrast gain control mechanism adjusts each filter's gain on the basis of the outputs of other nearby filters. Here, I explain how this model accounts for the Phantom Illusion (Galmonte, Soranzo, Rudd, & Agostini, submitted), a new luminance gradient illusion in which either an incremental or decremental target can be made to appear as an increment or decrement, depending on gradient width. For wide gradients, incremental targets appear as increments and decremental targets appear as decrements. For narrow gradients, the reverse is true. I frame my explanation in the context of earlier modeling

results that highly constrain the model parameters. These constraints reinforce the conclusion that the lightness computations must be object-centered and thus 'midlevel.' This conclusion is consistent with the model hypotheses that long-range contrast integration occurs in or beyond cortical area V4, following midlevel cortical computations related to image segmentation (completion, border ownership) in V2.

[1T3C003] Illumination layout of the scene influences visual sampling

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Illumination tends to vary in natural visual scenes, incorporating well-lit areas and darker regions. These darker areas have lower relative contrast and may therefore provide less detailed information. Recent research in the lightness domain, both using eye-tracking methodology and psychophysics, confirmed that there is a tendency to avoid shadowed regions when estimating color. We investigated a similar tendency but instead employed high level visual judgment tasks.
In the two experiments we presented photographs of human faces half covered with a shadow. In the first experiment, we digitally modified photographs in order to obtain well-controlled and equal distributions of lower contrast areas, while in the second experiment we used photographs that already contained natural shadows. We asked our participants to judge beauty, age and profession of the depicted people. Using a state-of the-art eye tracker, we measured the first fixation, the number of fixations and the dwell time, both at the level of the whole image and for pre-defined regions of interest (such as the eyes, the mouth, etc.).
For all measures and for all tasks, a clear preference to fixate the non-shadowed regions was found. This suggests that visual sampling preferences for well-lit areas extend beyond low-level visual tasks.
This research was supported by Ministry of Education and Science, Republic of Serbia (grants No. 179033 and III47020)

[1T3C004] Effects of lateral interactions and adaptation on color and brightness induction

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We introduce a new method for measuring color and brightness induction that separates lateral interactions and adaptation effects, and examines the effect of edge-blur between test and surround. Observers fixated a central annulus (0.66 to 2.0°) on a 12° × 12° surround. Annulus edges were sharp or blurred; surround color was modulated as a 0.5 or 4.0 second half-sinusoid between mid-gray and each of six poles of DKL space (light/dark, red/green, yellow/blue). When annulus color was steady at mid-gray, observers perceived an induced shift toward the opposite pole. Magnitude of the shift was estimated by nulling it with a fraction of the surround modulation added to the annulus, using a double-random 2AFC staircase. Trial blocks alternated surround modulation to opposite poles to maintain adaptation at mid-gray. This method revealed strong induction effects across 6 observers. There were no consistent induction asymmetries along any

axis for fast presentations. For slower presentations, dark-light induction increased to further reduce asymmetry, suggesting asymmetry is not due to adaptation or to lateral interactions. Edge properties didn't change induction magnitude for fast or slow presentations. Lateral interactions underlying induction are thus symmetric for color and brightness, and involve spatially opponent filters of modest widths instead of edge extraction.
EY07556; EY013312

[1T3C005] Luminance and color correlations allow lightness constancy through a veiling luminance without borders

Alan Gilchrist
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Seen through a veiling luminance (additive layer) without borders, lightness constancy is zero for a Mondrian but 100% for a 3D still life (Gilchrist & Jacobsen, 1983). We report nine experiments using a new apparatus that allows a light source to be placed either at the virtual location of the eye (thus eliminating both cast and attached shadows) or 25 degrees away from the eye. Three main findings. (1) Shadows produced significantly better lightness constancy (blacks look blacker; veil perceived), because adding a veil creates a positive correlation between contrast at shadow boundaries and the luminance of the underlying surface. (2) Adding colored patches to the Mondrian had no effect while adding colored objects to the 3D scene produced better constancy, due to a different correlation: Adding a veil creates a positive correlation between the saturation gradient across a curved colored object and the luminance gradient across it. (3) A weakly colored veil (24% purity) produced better constancy than a neutral veil, due to a further correlation: In this case the veil creates a negative correlation between the saturation gradient across a curved achromatic object and the luminance gradient across it. Control conditions showed that these correlations are used.
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[1T3C006] Coming to Terms with Lightness, Brightness, and Brightness Contrast: It's Still a Problem

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Lightness, defined as perceived reflectance, is under-specified because it can refer to three types of judgments. When an illumination boundary is visible observers demonstrate three independent dimensions of achromatic experience: perceived intensity (brightness), perceived intensity ratio (brightness-contrast), and perceived reflectance (lightness). Under homogeneous illumination achromatic experience reduces to two dimensions and lightness judgments are based on either brightness or brightness-contrast. We use the term inferred-lightness to refer to the independent dimension of lightness judgments that exists when there is a visible illumination boundary in order to emphasize that these lightness judgments are inferential and not directly based on appearance. Although the three types of lightness judgments are not comparable they are frequently conflated due to the underspecified definition of lightness as perceived reflectance. This confusion is compounded by inconsistent recognition by both observers and experimenters of when an

independent dimension of inferred-lightness is available for matching. Clearly distinguishing when lightness matches are based on appearance (and do not differ from brightness or brightness-contrast matches) versus when lightness matches are based on the independent dimension of inferred-lightness, resolves confusion in the literature and provides insight into the mechanisms that are employed to tackle the fundamental inverse problem of vision.
NIH P20 GM103505; NSF BCS1430503

[1T3C007] Scotopic lightness perception

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The anchoring theory of lightness proposes that a white percept is linked to a scene's brightest surface. Much evidence for some form of anchoring exists, but mainly from photopic conditions and hardly from scotopic conditions, when only rods respond. We tested whether anchoring occurs when scotopic. We printed 10 chips, equally spaced on the CIELUV L* scale (under D65). 6 naive observers first viewed the maximally and minimally reflecting chips at 277 cd/m^2 and memorized their percepts as 100% white and 0% white. Observers adapted to four light levels ($\sim 1.2 \times 10^{(-4)}$ (scotopic), $\sim$1.8 (mesopic), 28, and 277 cd/m^2) and viewed the chips, one at a time, in two, randomly-ordered blocks for foveal and peripheral fixation. Dark adaptation lasted twenty minutes. Observers reported the perceived amount of white per chip, in 10% steps along their memorized white scale. When photopic, observers assigned an average rating of 92.86% to the maximally reflecting chip. When mesopic, observers assigned an average rating of 54.64% to that chip. When scotopic, they assigned an average rating of 45%. This agrees with our phenomenological observation that the white chip appears gray when scotopic. We propose that "pure" cone activation drives white perception.
Deutsche Forschungsgemeinschaft, grant GE 879/9

Tuesday August 25th

Posters

[2P1M002] Attentional Blink is modulated by Response Selection at T1

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Attentional Blink (AB) is the reduction in accuracy of detecting the second of two targets which appear in close temporal succession in a Rapid Serial Visual Presentation task. Resource limitation accounts explain AB by suggesting that the perceptual features of Target-1 (T1) interferes with the processing and eventually reporting Target-2 (T2) correctly. Hommel, Müsseler, Aschersleben and Prinz (2001) suggested that action and perceptual events are represented as common distal features and activating one will activate the other process. Similarly, Mussler and Wuhr (2002) suggested that action planning interferes with visual encoding. We propose that the response codes associated with T1 perception is critical for AB. That is, perception of T1 automatically

triggers a response selection for it leading to an interference in T2 perception and response selection. Participants completed an AB task in two conditions – experimental condition where the response is contingent on the relationship between both T1 and T2 making it impossible to plan a response when only T1 is seen. The control condition was a standard AB task. Results suggested there is significantly higher T2 accuracy in the contingent response condition as compared to the control condition, providing support for the role of response planning in AB.

[2P1M004] Are some targets tracked more than others? Investigating the role of multifocal attention in Multiple Identity Tracking using frequency-tagging

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Activities such as team sports or driving a car require us to track multiple moving objects. Multifocal attentional enhancement of tracked objects in visual cortex is thought to subserve this ability. Interestingly, objects' positions can be tracked without tracking their identities. This suggests at least partially separate mechanisms for tracking positions and identities. Direct gaze stimuli show a pronounced advantage in identity but not in position tracking. We used this to distinguish both in order to investigate the role of attention in identity tracking. Participants tracked three out of six circular objects having eyespots with different gaze directions and indicated their locations at the end of each trial. Recordings of frequency-tagged steady-state visual evoked potentials (SSVEPs) elicited by the flickering stimuli allowed us to concurrently measure the allocation of attention to each of the six moving objects. We found clear attentional enhancement of SSVEPs elicited by tracked targets and a behavioural advantage for tracking the identity of direct gaze targets. However, this direct gaze advantage was not reflected in the magnitude of attentional enhancement of SSVEPs. Multifocal attention was distributed equally to tracked targets, indicating that the direct gaze bias in identity tracking arises only at later processing stages.

[2P1M006] A neuropsychological dissociation between attentional facilitation and inhibition of objects

Daniel Smith, Robert Swalwell and Thomas Schenk
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Salient peripheral cues produce transient attentional facilitation which is superseded by a sustained inhibitory cueing effect (ICE). In static scenes cueing one part of an object produces an ICE that spreads throughout the entire object. In dynamic scenes the ICE is attached to objects as they move through space. We examined object centred attentional facilitation and inhibition in a patient with visual form agnosia. Consistent with previous studies, the patient showed a deficit of object-centred attentional facilitation. In contrast, object centred inhibitory cueing effects were observed in 3 out of 4 tasks. These effects were weakest in tasks where cues to objecthood were weak and strongest where cues to objecthood were highly salient. These data demonstrate a neuropsychological dissociation between the facilitatory and inhibitory effects of object cueing and are consistent with the view that object-based inhibitory cueing effects are mediated by the

dorsal rather than ventral visual system. From a theoretical perspective we propose that attentional facilitation and inhibition of objects operate at different levels of visual processing, such that inhibitory cueing effects act on visual representations at the level of scene segmentation, whereas object attentional facilitation operates on categorical object representations

[2P1M008] What to consider with subjective measures of conscious awareness

Manuel Rausch and Michael Zehetleitner
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Using subjective measures of conscious awareness raises multiple methodological issues, including what conscious contents participants should be asked to report, what the most apt recording technique is, and what statistical procedures should be applied. Concerning content, reports about the confidence in the accuracy of the preceding task response are associated with lower psychophysical thresholds, greater type-2 sensitivities, and earlier EEG correlates than reports about the visual experience of the stimulus. Concerning recording technique, more precise reports of visual experience can be obtained by visual analogue scales than by discrete labelled scales. Concerning statistics, logistic regression can be a powerful test to detect if there is a correlation between reports and task accuracy at all. However, logistic regression is less convenient to estimate type-2 sensitivity than measures derived from signal detection theory due to bias from subjective criteria. Overall, we suggest the study of consciousness increasingly benefits from subjective reports if methodological choices are tailored to the research questions.

[2P1M010] Priming of visual search reflects facilitated attention shifts: Evidence from object substitution versus metacontrast masking

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Priming of visual search has been shown to strongly affect vision and action, releasing items from crowding and during free-choice primed targets are chosen over unprimed ones. Two accounts of priming have been proposed: attentional facilitation of primed features and postperceptual episodic memory retrieval, involving mapping responses to visual events. Here, well-known masking effects were used to decide between the two. Object substitution masking (OSM) reflects attentional processing: it doesn't occur when a target is precued and is mitigated by distractors. Conversely, metacontrast masking (MCM), has been connected to lower level processing where attention exerts little effect. If priming facilitates attention shifts we expect priming to mitigate OSM, while MCM might not be similarly influenced. If priming allows objects to escape OSM, this would be particularly compelling, given the relation of OSM to attentional processing. Observers searched for an odd-color-out target among distractors. Unpredictably (on 20% of trials) OSMs or MCMs appeared around the target. We assessed whether search repetition affected masking. OSM effects were strongly mitigated for primed target colors, while MCM was mostly unaffected. This casts doubt upon episodic retrieval

accounts of priming, placing the priming locus firmly within the realm of attentional processing of visual input.

Icelandic Centre for Research (Rannís); Research Fund of the University of Iceland; European Research Council (ERC)

[2P1M012] Is the object or location inhibited when IOR is found in faces? Evidence from a dynamic visual orienting task

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A number of studies have examined to what extent social or emotional stimuli generate inhibition of return (IOR) comparable to non-social objects, but results have been inconsistent. One possible explanation for this inconsistency is that previous studies have conflated location IOR and object IOR. The present experiments addressed this by comparing IOR to social and non-social stimuli in dynamic displays. As objects moved between the presentation of the cue and the probe, location and object IOR could be differentiated. Two conditions, one with non-social objects (ovals) and one with social objects (schematic faces), were tested in a within-participants design. When the non-social object condition was completed first, both object and location IOR were observed for ovals whereas object facilitation was observed in the face condition. Additionally, only object IOR significantly differed between the two conditions and not location IOR. When the social object condition was done first, there was no object-IOR effect for either type of object. These results suggest that IOR observed in stimulus arrays containing social objects such as faces is location-based and not object-based. These data are consistent with the view of Perez-Duenas, Acosta and Lupianez (2014) that biologically relevant stimuli override IOR.

[2P1M014] The attentional blink predicts divided attention, selective attention, and alertness

Karina Linnell and Serge Caparos
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An attentional blink occurs when a target presented in an RSVP stream (T2) fails to be detected (only) when it occurs soon after a previous target stimulus (T1). Olivers and Nieuwenhuis (2006) proposed that the blink results from "attentional overinvestment" in the first target (T1) driven by a focused attentional state. Building on this proposal, we show here for the first time that across individuals blink-size is (1) positively related to switch-costs on a divided-attention task; (2) negatively related to interference – deriving from response-competition – on a selective-attention task; (3) positively related to more rightward biases in line bisection. More rightward biases have been linked to decreased alertness (Manly et al., 2005). We conclude that (a) blink-size is a marker of an individual's ability to spread or focus attentional resources and to excel, respectively, at tasks of divided or selective attention; (b) the latter ability may be explained by differences in alertness, with increased alertness favouring divided over selective attention. Taken together, our results are consistent with the idea that there is a trade-off between exploratory and exploitative behaviour (divided and selective attention) and that this trade-off is modulated by alertness (Aston-Jones et al., 1999; Linnell et al., 2014).

[2P1M016] Neural circuits for dynamic tracking of object identity and location

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During real-world vision observers need to attend to and track several moving objects. Sometimes the identities of the objects are task-relevant (when doing multiple identity tracking with distinct objects; MIT), and sometimes task-irrelevant (when doing multiple object tracking with identical objects; MOT). Here we reveal cortical circuits supporting MIT and MOT while tracking moving objects. Twenty-four participants tracked identities and locations (MIT) or locations only (MOT) of 0, 2, or 4 moving targets while their eye movements were recorded and haemodynamic brain activation measured with functional magnetic resonance imaging (fMRI). Participants made more saccades during MIT versus MOT condition. Both the MIT and MOT task engaged similar components of the dorsal attention system, yet MIT resulted in increased activity in frontocortical areas involved in working memory and temporal areas involved in object recognition. Additional activations were observed in intraparietal regions involved in attention shifting. A control experiment with 14 subjects and conditions allowing or not allowing eye movements confirmed that brain activation differences between MIT and MOT were not confounded by gaze shifts. We conclude that the MIT task relies on interactions between the dorsal attention circuit, executive functions, and ventral visual areas.
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[2P1M018] Anisotropic versus isotropic distribution of attention in object tracking: disentangling influences of overt and covert attention

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In recent studies, multiple-object tracking (MOT) tasks combined with probe detection tasks have been used to investigate the distribution of attention around moving objects (e.g., Atsma, Koning & van Lier, 2012). During these tasks, participants were allowed to move their eyes freely around the scene, allowing both overt and covert attention to be deployed. Here we focus on the contributions of these two forms of attention in MOT. An MOT task was used with one overtly and one covertly tracked target and an equal number of distractors. In addition, probes were flashed around all objects and in open space. Preliminary results show an anisotropic distribution of probe detection rates around covertly tracked targets (as in Atsma et al., 2012), but less so around overtly tracked targets. This suggests that attention takes into account movement direction to keep track of object locations, especially when an attended object is not foveated. Remarkably, probe detection rates for the distractors also show anisotropic distribution. We discuss the possibility that these objects were also automatically (covertly) attended because they occasionally interact with the targets by bouncing.

[2P1M020] Pupillometric vs. EEG measures of Attentional State: A Timeseries Comparison

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Attentional state has been linked to both the Locus-Coeruleus-Norepinephrine (LC-NE) system and to prestimulus occipital alpha power. Recent work has also highlighted the relationship between LC-NE activity – measured using pupil diameter – and prestimulus occipital alpha power. Here, we investigated the relationship that attentional state has with pupil diameter and prestimulus occipital alpha power by comparing the temporal dynamics of these relationships. Participants completed an RSVP detection task in which they signalled the presence or absence of a target embedded within a stream of white-noise patterns; in addition, they provided subjective reports of attentional state. Simultaneously, EEG and pupillometric measures were collected. In a second experiment, we used the same paradigm and manipulated the timecourse of participant engagement by altering block length. The temporal dynamics of the relationship between subjective attentional state and 1) pupil diameter and 2) prestimulus alpha power show similarities: both show strong correlations with attentional state at the same frequency of trials. Alongside the similarities between these relationships, our data also show that prestimulus occipital alpha is related to attentional state at a wider range of frequencies of trials than pupillometric measures.

[2P1M022] Temporal attention modulates target selection among distractors: Evidence from a flanker compatibility task

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When participants react to a target stimulus, reaction times (RTs) are shorter when the moment of stimulus occurrence can be predicted. In three experiments, we investigated whether temporal attention based on such predictions boosts the selection of targets among distractors. We employed a flanker task, in which a central target letter required a speeded left- or right-hand reaction. The target was flanked by lateral distractor letters, requiring either a response with the same hand as the target (compatible), no response (neutral), or a response with the other hand (incompatible). Temporal attention was manipulated across blocks of trials by means of a warning signal preceding target onset by a short or long time interval, yielding conditions of high and low temporal attention, respectively. Moreover, target and flankers were presented simultaneously or in short succession (flanker to target interval = 32 ms). As expected, RTs were longer in incompatible trials and shorter in compatible trials as compared to neutral ones, which replicate the usual flanker compatibility effect. Importantly, this compatibility effect was reduced by temporal attention in the simultaneous condition, whereas it was increased in the successive condition. These results demonstrate that temporal attention modulates target processing by boosting targets or strengthening distractors.
This research was supported by Grant RO3034/2-2 of the German Research Foundation (DFG)

[2P1M024] Value Associations Enhance Preparatory Top-Down Attentional Control and Attentional Suppression

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Value-associated distractors slow visual search performance by engaging attention. Here, we ask if value-associated items can boost preparatory cognitive control and aid attentional suppression. In a two-stage experiment, 24 participants first learned to associate a unique combination of colour (purple or orange) and point-value (win or zero) with each of four symbols. They then completed a cued visual search task without point rewards. Each trial consisted of two successive cues (symbols from the learning task) followed by a two-item search task (one orange and one purple letter). The task was to accurately locate one of two pre-specified target letters as quickly as possible. The colour associated with the first cue (present on 80% of trials) always predicted the target colour; the second cue was irrelevant and its associated colour was equally likely to be congruent or incongruent with the target colour. Value-associations were irrelevant. When the first cue was win versus zero-associated, response times were faster, indicating value-based benefits to preparatory control. When the first cue was absent, second cues associated with zero value produced large colour congruency effects, an effect not seen with win-associated items ($p < .05$). This latter finding suggests the presence of a value-based suppression mechanism.
ESRC UK Grant number ES/L000210/1

[2P1M026] Visual marking: Time-based visual selection with illusory stimuli

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Visual search is facilitated if distractors are separated in time, allowing old information to be inhibited and new information to be prioritized (the preview benefit; Watson & Humphreys, 1997). In the present study, we investigated whether stimuli that required spatial grouping can be inhibited effectively. Experiments 1 and 2 showed that with Kanizsa stimuli, or with non-Kanizsa stimuli that required local grouping, a preview benefit was only obtained at small set-sizes. In Experiment 3, we found that local changes to the elements of grouped stimuli totally abolished the preview benefit leading to no search advantage for new stimuli. Overall, the results suggest that: i) the need to group stimuli reduces the capacity to prioritize multiple new items, ii) grouping local elements interferes with the maintenance of inhibitory visual marking irrespective of whether illusory contours can contribute to stimulus formation, iii) changes to locally grouped elements feed back to the inhibitory attentional set to abolish any inhibition at those locations. The findings are discussed in terms of the limits of time-based attentional selection, interference between grouping and inhibitory mechanisms, and the effectiveness of illusory contours in guiding search.

[2P1M028] Effects of probability instruction on attention and maintenance of working memory representations in visual search

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Holding an item in working memory guides attention to the feature-matching item in visual environment. Recent studies have shown that this guidance of attention by memory item can be modulated strategically (e.g., Kiyonaga, Egner, & Soto, 2012). The present study investigated the underlying mechanisms by measuring electrophysiological index of attention to and working memory maintenance of memory item (i.e., colored oriented bars). Participants went through memory task and dual task (memory task and visual search task). In visual search task, we manipulated the probability of memory-match trials (the color of memory item and search target were the same; 0%, 50%, and 100%), which were pre-instructed to participants. Behavioral results showed that target detection became faster in 100% than in 50% condition. P3, which reflects attention allocation, was the largest in 100% condition. In contrast, the contralateral delay activity (CDA), an index of working memory load, was equal across tasks and probability conditions. These results suggest that allocating attention to the feature of memory item, not loading working memory, leads to the improvement of visual search performance.

[2P1M030] Influence of crossing hemifields in Multiple Object Tracking

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Visual perception of attention to multiple moving objects, such as Multiple Object Tracking (MOT) is one of the essential abilities for humans. Some previous studies showed that MOT task performance is influenced by the number of the tracking object, moving speed, and hemifield limit. However, few studies have investigated the attentional state of multiple objects moving across hemifields. Therefore, we examined the attentional state of multiple object crossing hemifields in this study. In the experiment, two pairs of two dots were presented in two positions of each quadrant. In one condition, the two pairs moved up and down, or left and right from the same sides and in the other condition, the pairs moved from the diagonal positions. Participants were instructed to track two moving objects among four. The results showed that the accuracy of tracking objects crossing hemifields (horizontal movement condition) is lower than that of tracking objects moving vertically. The same trend was observed in the diagonal condition. This result showed that attention was suppressed by object crossing hemifields horizontally. Our finding suggests the importance of the object crossing hemifields in MOT.
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[2P1M032] Processing capacity limits in the early stages of visual processing are associated with neglect of unexpected visual stimuli

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Exogenous allocation of attentional resources allows the visual system to encode and maintain representations of stimuli in visual working memory. However, limits in the capacity to allocate resources can prevent unexpected visual stimuli from gaining access to consciousness. Using a novel approach to create unbiased stimuli of increasing saliency, we investigated early visual processing in humans that show a high (Inattentionally Blind, IB) or low propensity (Non-IB) to neglect unexpected stimuli during a visual search task. Electroencephalographic recordings resulted in diminished amplification during the latency of the N1 and poor enhancement of targets in the N2 latency (N2pc), both of which predicted a decrement in the likelihood to detect unexpected visual stimuli; a later modulation in the P3 latency was also found. Our data suggest that a lack of visual attention resources may be responsible for the failure to "ignite" a state of high-level activity necessary for unexpected stimuli to access awareness.

[2P1M034] Expecting higher attentional load affected orienting 'what' and 'where' visual attention: a bimodal brain imaging study with fNIRS and EEG

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Many previous studies reported qualitatively different characteristics of feature and spatial attentions. We investigated the orienting strategy of feature and spatial attentions for visual processing by using bimodal functional brain imaging methods with functional near-infrared spectroscopy and electroencephalogram. By manipulating the feature dimension toward which attention was oriented and the task difficulty in visual search paradigm we examined the mechanism of assigning attentional resource. Two visual search patterns with different colors were displayed in both visual hemifields, which were updated repeatedly at random timing asynchronously. Participants conducted visual search task only for one hemifield and neglected the other. Attended side was indicated by spatial or color cue. Task difficulty level was manipulated by set size, one or eight. OxyHb activation and alpha-band oscillation were recorded mainly on the posterior part of head surface. OxyHb increased as task difficulty in task execution period. In spatial cueing condition, this elevation was observed also in preparation period. Alpha oscillation during preparation period was also affected by the difficulty only in feature cue condition. These results seem suggest that even expecting higher attentional resource consumption would change strategy of orienting spatial attention and that spatial and feature attentions would have qualitatively different anticipatory systems.

[2P1M036] Time for awareness: mask temporal frequency determines continuous flash suppression effectiveness

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Continuous Flash Suppression (CFS) (Tsuchiya & Koch, 2005) has become a popular tool for investigating visual processing outside of conscious awareness. During CFS, masks are flashed to one eye, suppressing awareness of stimuli presented to the other eye. To date, little is known about the precise relationship between masking effectiveness and temporal masking frequency. We investigated the suppression effectiveness of a wide range of masking frequencies (0–32 Hz), using both complex (faces/houses) and simple (closed/open geometric shapes) stimuli in two conditions: different frequencies occurred in random order; trials with the same masking frequency were grouped into blocks.
Break-through contrast differed dramatically between masking frequencies ($F(9,117) = 17.539$, $p < 0.001$), with mask effectiveness following a log-normal curve peaking around 6 Hz. This suggests that the 10 Hz or 20 Hz frequencies used in most CFS studies may not be optimally effective. In terms of type of stimulus, we found no significant difference in peak frequency between the stimulus groups (complex/simple, face/house, closed/open). Condition 1, frequency randomized within blocks, resulted in higher break-through contrast ($F(1, 13) = 6.886$, $p = 0.021$). More generally, these findings support the idea that temporal factors play a critical role in perceptual awareness, perhaps by interacting with the ongoing or stimulus-evoked oscillations involved in conscious perception.
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[2P1M038] Occipital TMS modulates the effect of attention on contrast sensitivity

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Covert endogenous attention, voluntarily allocating attention to a particular location without eye movements, increases accuracy and cortical activity in striate and extrastriate areas. We used attention to modulate cortical excitation and occipital Transcranial Magnetic Stimulation (TMS) to investigate how they jointly modulate early visual processing as a function of cortical excitability. First, observers performed an orientation discrimination task, in which performance is contingent upon contrast sensitivity, across a range of stimulus contrasts under valid and invalid attention cues. A valid cue induced response gain, a higher asymptotic performance for the attended than unattended location. Then, during the TMS sessions, observers performed the same task at their own asymptotic contrast level. On each trial, double-pulses of TMS were applied at various delays, before or after stimulus presentation, to retinotopic early visual areas (V1/V2) to modulate the processing of either the cued or the uncued stimulus. TMS modulated the magnitude of the attentional cueing effect across delays, especially when applied to the retinotopic location corresponding to the unattended stimulus. These findings support the idea that these effects

are activity dependent, and show that occipital TMS modulates the effect of attention on contrast sensitivity.
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[2P1M040] Role of Attention in the Temporal Dynamics of Post-Iconic Visual Memory Stores

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To investigate the role of attention in the time course of post-iconic memory stores in visual short-term memory, a memory scanning experiment was conducted. On each trial, a memory array of 4 items was presented, followed by, after a varying SOA (500 to 4000 ms), the probe stimulus; observers were asked to report whether or not the probe differed from an item in the memory array. In cued conditions, either a neutral or informative spatial cue was presented 300 ms before probe onset. Similar to previous findings (Jacob, Breitmeyer & Treviño, 2013), comparison effects (CEs) in the control condition varied systematically across SOAs, likely to reflect fluctuations in attention to working memory (WM) content. In the location-cued condition the amplitude of these fluctuations was dampened, and the CEs diminished by 4000 ms. This is likely to reflect spatial attention overriding the effects of attention to WM content. In contrast, the CEs in the neutral-cued condition showed fluctuations with higher amplitudes for later SOAs. Thus the neutral cue enhanced the impact of working memory content, especially for the long SOAs. Taken together, our results suggest that attention plays a role in determining stages of information processing in working memory.
Supported by European Research Council Starting Grant 336152 awarded to Dr Juha Silvanto

[2P1M042] Can we select multiple colours simultaneously? Evidence for serial processing from left to right

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Some studies find evidence that multiple features can be simultaneously selected (e.g. Adamo et al., 2008), but Lo and Holcombe (2013) found that multiple-feature selection was achieved only with sufficient exposure duration. Here, participants monitored four simultaneous streams of letters, two to the left of fixation and two to the right, presented at a rate of 5.3 items/second. One stream on each side was a target stream of letters in a pre-cued colour, while the other was a stream of distractors presented in a different colour. At a variable time, circles appeared around the streams, and participants were asked to report the letters of the pre-cued colour for each side. We used mixture modelling to estimate efficacy, the proportion of trials where the participants reported a letter around the time of the circles. When observers monitored the same colour for both targets, efficacy was approximately 60%. When participants monitored different colours for each target, efficacy for the left was approximately 50%, whereas that for the right was as low as 26%. The results suggest that at least for these brief-exposure conditions,

simultaneously selecting multiple colours is difficult and the colour on the left side is usually selected first.

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[2P1M044] The effects of distractor salience on target detection sensitivity

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Whenever people actively ignore stimuli in one half of the visual field, their alpha-band amplitudes measured over the contralateral occipital and parietal cortices increase. Since high alpha-band amplitudes have been associated with low cortical excitability, it is assumed that these stimuli are actively blocked from further processing. Only very salient stimuli might sometimes overcome this active inhibition and attract attention in a bottom-up fashion. This means that increasing distractor salience at an ignored location should impair target detection sensitivity at an attended location. To test this prediction, we asked participants to detect an at-threshold Gabor at one of two possible cued target locations. A neutral cue condition ensured that participants made use of the cues. When the target was accompanied by a distractor of one of three different contrast levels at the uncued location, detection sensitivity was unaffected by distractor contrast. Instead, the participants' response bias was affected by distractor presence. These results suggest that ignored distractors are not completely blocked from early processing stages, but rather contribute to response selection at later stages of visual processing.

[2P1M046] Effects of voluntary attention and priming target and distractor effects on overt and covert orienting

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Inhibition of visual distractors usually follows the presentation of task-irrelevant stimuli. Recent claims suggest that inhibition can also be initiated through purely endogenous processes. We investigated this claim using a central cueing paradigm. The cue indicated the likely location of either a target or a distractor. Targets appeared in only half of the trials. We examined how cue validity and distractors affected manual and saccadic response latencies to targets following the central cue. We found: a) faster responses when the target appeared at the cued location, even when the cue was predictive of the distractor rather than target's location; b) response latencies were delayed in the presence of a distractor, except when the target was invalidly cued; c) orienting was faster, even when the target appeared alone, when one of the previous eight trials contained a target. We conclude: 1) distractor suppression does not underlay the benefits of distractor cueing. 2) Reorienting to invalidly cued is remarkably robust in the face of distractor interference suggesting that during reorienting there is filtering of task–irrelevant stimuli, in keeping with fMRI findings. 3). Orienting to targets is maintained by a tonic, slowly decaying signal, most likely generated by previous target evoked responses.

[2P1M048] Crossmodal modulation of auditory attention by visual emotional cues: The role of attentional engagement and disengagement

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Previous research has demonstrated that emotional pictures, compared to neutral pictures, can bias attention towards non-emotional targets in a different modality (Van Damme, Gallace, Spence, Crombez, & Moseley, 2009). The current experiment used a modified spatial cueing paradigm to test whether affective visual stimuli modulated auditory spatial attention, and which components of attention contributed to the modulation. Participants indicated whether an auditory target appeared either on the left or right, after brief (250 ms) presentation of a spatially non-predictive peripheral visual cue (pleasant, unpleasant, or neutral). Responses to targets were faster when presented in the location of the preceding visual cue compared to in the opposite location (cue validity effect). The cue validity effect was larger for targets following emotional compared to neutral cues, but only for right-sided targets. There were no differences between emotional and neutral conditions on valid trials (targets in the same location as the cue) but on invalid trials (targets in the opposite location), participants showed delayed attentional disengagement when the target was on the right. We conclude that modulation of auditory attention by briefly presented visual emotional cues can be attributed to difficulties in moving attention away from visual affective cues presented in the left hemifield.

[2P1M050] Analysis of pupil response and event-related potential during a fast-paced cognitive and attention task

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Pupil diameter in human eyes plays an important role for clear vision like aperture of a camera. Pupil diameter, however, fluctuates around an optimal value even if a subject fixes one's eyes on a target (Stark, 1968). A part of pupil fluctuations is originated form changes in autonomic nervous activity (Yoshida, et al., 1991). Recently, Hoeks, et al. (1993) showed pupillary dilation can be a measure of attention and Wierda, et al. (2012) also showed that high-temporal-resolution tracking of attention and cognitive processes can be obtained from the slow pupillary response using dilation deconvolution method. EEG analysis is effective for these research but there is no results simultaneously comparing both the pupil dilation and EEG studies. In order to study pupillary dilation during a fast-paced cognitive and attention task, we simultaneously recorded pupil diameter and electroencephalography (EEG) during the AB task as described in the literature (Wierda et al., 2012). Pupil size and EEGs were measured using the HS Eye Tracker (Cambridge Res. Syst.) and EEG-1200 (Nihon Koden Co.), respectively. Event-related potential (ERP) was extracted from the EEGs using averaging method. Finally, we discuss both the results of pupillary dilation and ERP of the response for the AB task.

[2P1M052] Attention deployment in visual contexts of varying homogeneity

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The degree of efficiency with which observers find a target object in a visual scene depends both on the features of the target and on the structure of the background elements. Dissimilarity between target object and surrounding context elements usually increases search efficiency, and so does similarity between the individual context elements. In several experiments, we investigated the role of context element homogeneity in the deployment of visual attention. We hypothesized that context homogeneity modulates attention guidance in addition to other attentional control mechanisms such as the observer's current intention. We used texture stimuli composed of simple line elements that were arranged in such a way as to form homogeneous or heterogeneous contexts. Observers were to search for and report an orientation target. Behavioral search efficiency (accuracy and response times) as well as the neural processes (such as the N2pc component, an attention-related marker in the event-related brain potential) involved in target and background processing were measured. Results showed that (pre-attentive) context grouping preceded target detection and had a strong impact on the way visual attention was deployed in the scene. The relative contribution of top-down and bottom-up processing on attention deployment depended on the homogeneity of the context elements.
SCHU 1330/6-1 and SFB/TRR 135, TP B3

[2P1M054] Salience from multiple feature contrast: Evidence from saccade trajectories

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Feature contrasts, such as differences in luminance, orientation and movement, are salient and capture visual attention. What occurs when an item is salient by virtue of more than one feature, for example if it is both bright and moving? Some evidence suggests that additional salient features are redundant (Nothdurft, 2000), whereas other studies have found that salience in one feature enhances the apparent salience of other features of the same object (Kerzel et al., 2011). We investigated whether these conflicting results might be due to a change in the way salience is processed at different stages in the visual system. 16 participants completed 1080 trials in a visual search task, with distractors of varying luminance, orientation and movement. We measured the latencies of saccades to target and the deviation of these saccades towards distractors. We found interactive effects of these three features on saccadic deviation. Specifically, at short reaction times, salient features combined overadditively, whereas at longer reaction times, they combined underadditively. These two findings suggest that early processing in the visual system is characterised by a sensitive search, in which salience in one feature may trigger increased sensitivity to other features. Later processing then discards redundant sources of salience.
Luke Tudge is supported by the Berlin School of Mind and Brain PhD scholarship

[2P1M056] Biologically plausible colour naming model

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Colour is a construction of our brains which plays an important role in our perception of the world (e.g. we tend to describe objects by their colour, among other attributes). Within the infinite possible combinations of wavelength spectra, an average subject can name about thirty colour categories, eleven of which are believed to be universal across languages (Berlin & Kay, 1969). A recent study (Horwitz & Hass, 2012) suggests many V1 and V2 neurons are isoresponsive to stimuli belonging to the surface of an ellipsoid in LGN-opponent colour space. Coincidently, our psychophysical measurements of colour frontiers resemble such shape. Hence, we have attempted to model human colour vision through a set of 3D ellipsoids in a biologically-plausible colour-opponent space. We dynamically adapt those ellipsoids – i.e. modifying their axes and centres – by considering the image statistics, mimicking what is known about signal normalisation and hue shift. Unlike the majority of the state-of-the-art colour naming algorithms which are pixel-based, our biologically-inspired model considers the surroundings stimulus, addressing many of the challenges that other algorithms cannot overcome. Overall, our new model shows promising results for studying the perception of colour, and in the future we will consider adding colour induction phenomena.

[2P1M058] Red affects reaction times and hit rates in a 2AFC orientation discrimination task

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We measured reaction times and Hit rates in a 2AFC orientation discrimination task of Gabor patches at different spatial frequencies and contrasts surrounded by red, blue, or grey isoluminant surrounds. Preliminary results revealed generally slower reaction times with red in comparison to blue or grey and a stronger effect on low spatial frequencies in comparison to middle or high. A direct within-participant comparison of low vs high spatial frequency and low vs high contrast demonstrated that a red background raises RT and lowers HR in comparison to a gray background only at low spatial frequency and constrast. These findings are relevant to the interpretation of studies that used red backgrounds to selectively isolate the magnocellular pathway, and may have implications for the interpretation of recent results of the effect of red contexts on diverse perceptual and cognitive tasks.

[2P1M060] Color constancy and the vein color illusion

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Color constancy refers to a phenomenon that the color of an object appears to be constant to some extent when the object is viewed through a chromatic transparent filter or when it is illuminated by a colored light. There are two different types of color changes that induce color

constancy: one being the multiplicative color change and the other being the additive one (Kitaoka, 2011). It was pointed out that veins appear to be bluish but are actually of yellow or orange hue (Kitaoka, 2014), though this fact had been reported in the literature on the study of skin color. Here I propose a hypothesis that the vein illusion is not only a color-contrast illusion but reflects an erroneous expression of color constancy based upon the inverse transformation of the additive color change.

[2P1M062] Colour categories are reflected in sensory stages of colour perception when stimulus issues are resolved

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It is commonly argued that colour categories affect colour perception. However, some suggest 'category' effects are due to inequalities in uniform colour spaces or stimulus-specific issues (e.g., Witzel and Gegenfurtner, 2013). Using a visual oddball task, where attention is directed away from colours, we investigate whether colour categories affect colour processing in English speakers, who vary in whether they reliably name a stimulus blue or green. Event-related potentials elicited to this frequently presented 'standard' stimulus were compared to those from two 'deviant' stimuli that were presented infrequently and separated from the standard by 2.5 just noticeable differences. Participants then named each colour 25 times and deviants were classified as same- or different- category to the standard for each participant based on their naming. A category effect was found over occipital sites around 100 ms after stimulus onset: the different-category deviant elicited a significantly lower mean amplitude than the deviant named the same as the standard. Further effects of naming were found over frontal sites around 200 ms. These effects cannot be accounted for by stimulus issues since same- and different-category stimuli varied across participants. The findings support prior claims of colour categories being reflected in early sensory stages of colour processing.
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[2P1M064] Temporal variation of chromatic response during color adaptation

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The purpose of this study is to measure color appearance during color adaptation as a function of time. We conducted an experiment using a 1/6 scale model room in which LED lights and white walls were installed. Five kinds of lighting condition, 2000 K, 2800 K, 4200 K, 5800 K and 10000 K, that combined of six kinds LED chips were prepared. Four participants observed the center of the front wall and evaluated the color appearance with a color scaling method at ten seconds, twenty seconds, thirty seconds, one minute, two minutes, three minutes and four minutes after changing the lighting. They answered the ratio of an achromatic and chromatic color, and the ratio of the selected two colors from four psychological primary colors. Participants were females in their twenties with normal color vision. Participants evaluated each condition three times. As a result, the ratio of chromatic response was large in the case of large differences of CCT between before

and after the lighting conditions. The mean ratio of chromatic response was 0.33 when changing the lighting from 2800 K to 5800 K but was 3.00 from 5800 K to 2800 K. We analyzed these results in terms of XYZ values and LMS cone activities.
This study was supported by JSPS KAKENHI GRANT Number 25282006.

[2P1M066] Separating explicit and implicit biasing mechanisms of global color-based selection in human visual cortex

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Attention to color operates beyond the spatial focus of attention – a property referred to as global color-based selection (GCBS). In a recent EEG/MEG study, we observed a neural correlate of GCBS reflecting the selection of any color that is task-relevant, even when it is absent from the focus of attention (template matching effect, Bartsch et al., 2014), suggesting that this GCBS modulation reflects an explicit bias for target colors. Here we asked whether implicit biasing effects, like color-priming, could contribute to the template-matching-related GCBS modulation. To assess the effect of explicit biasing, we compared GCBS modulations of colors that matched the set of target-defining colors on a given experimental block with task-irrelevant colors that were target-defining on other experimental blocks. The effect of implicit biasing was assessed by comparing GCBS responses of those task-irrelevant colors to that of a color that was never target-defining throughout the entire experiment. We observed that explicit and implicit color biasing both gave rise to GCBS modulations, and that they were dissociable in ventral extrastriate visual cortex. This extends our previous demonstration that GCBS does not refer to a single selection process but instead involves multiple separable selection operations in ventral extrastriate visual cortex.

[2P1M068] Color management system for identical color appearance across different illuminations

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The goal of a color management system (CMS) is to provide consistent colors across different devices or displays. In standard CMSs, equivalent colors are attained using colorimetric values such as CIEXYZ or CIELAB; however, the resulting colors do not always correspond to human perception. In addition, standard CMSs cannot manage color appearance changes due to the observer's adaptation to illumination. To resolve these problems, we have recently developed a new CMS based on color constancy. In our CMS, we derive a matrix to convert the RGB values of a display from one illumination condition to another condition through a color matching experiment. In the present study, we applied our CMS to a smartphone display. In the experiment, a color chip and a smartphone display were placed in separate rooms with

different illumination conditions. Observers moved between the rooms and adjusted the color on the smartphone display until its color appearance was equal to the color appearance of the chip. The result showed that, although the RGB values significantly varied depending on the illumination conditions, the conversion matrices obtained from the experiment could accurately predict the color appearance under different illuminants.

[2P1M070] The most reasonable explanation of the dress: Implicit assumptions about illumination

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Recent buzz in the social media has brought up an example of a photo of a dress in which different observers have surprisingly different judgments about the colour of the dress. The most obvious explanation from colour science should surely be that observers have different implicit assumptions about the illumination in the photo. The reason this particular photo produces so diverse a variety of judgments presumably is that this photo allows a variety of interpretations about the illumination of the dress. To test this hypothesis we measured the perceived colours of the dress, the subjective grey point of the dress, and the estimated colour of the illumination: we did this by using (1) a colour naming and (2) a colour adjustment procedure. The results show that the perceived colour of the dress is negatively correlated with the adjusted subjective grey point and the illumination along the daylight axis. This was also confirmed in the naming data. The phenomenon nicely illustrates the power of prior assumptions in perception. It is exactly what would be predicted from classical colour science, and no additional mechanism need be invoked to account for the surprising diversity in judgments of the dress's colour.
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[2P1M072] Verbal vs. visual coding in the simultaneous color discrimination task

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By showing that verbal interference cancels the categorical perception of color (CPC), previous research essentially suggested that the facilitation of between-category color comparison is based on verbal coding. Those results were mostly obtained on memory demanding tasks, which favors verbal coding. In this study we investigated CPC in a task with no memory load and we combined that task with the simultaneous verbal interference, i.e. the Stroop paradigm. In two experiments with simultaneous color discrimination task (16 participants each) we measured participants' RT. Color stimuli around the blue-green boundary formed 6 within-category and 6 between-category pairs. Stroop (congruent, incongruent or control-fixation crosses) was applied on the top square in Experiment 1, and on the bottom square (test or distractor) in Experiment 2. Despite the interference, CPC was significant both in Experiment 1 ($F(1, 15) = 9.03$; $p < .05$) and Experiment 2 ($F(1,15) = 20.56$; $p < .001$). Participants were slower when Stroop was presented on the bottom test square in relation to the distractor ($F(1, 15) = 4.79$, $p < .05$). The Stroop effect

was not significant – both words and fixation crosses affected RTs. This result suggests that in simultaneous discrimination participants rely more on visual than verbal coding.
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[2P1M074] Comparison of visual evoked cortical potential generated by chromatic gratings and pseudoisochromatic stimuli

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Visual evoked cortical potentials (VECP) are useful for functional investigation of the chromatic visual system and to diagnose color vision deficits. Usually chromatic sinusoidal gratings are used as stimulus to elicit VECP, but it requires a long psychophysical protocol to match the perceptual brightness between their stripes. An alternative is to substitute them by pseudoisochromatic stimulus, which has a luminance noise inserted on its design and the perception of the target is dependent of the chromatic contrast. We compared VECP generated by sinusoidal and pseudoisochromatic gratings. Seven trichromat subjects were stimulated by chromatic sinusoidal gratings and illusory gratings in a pseudoisochromatic design shown at 0.33, 0.66, 1, 1.33, 1.66, and 2 cpd presented in pattern reversal mode (1 Hz) and pattern onset (300 ms) – offset (700 ms). The signals were recorded using surface electrodes, amplified x30000, digitized at 1000 Hz, and filtered between 0.1–100 Hz. Results. Pattern reversal: VECPs elicited by pseudoisochromatic grating had similar amplitude and latency compared to those elicited by sinusoidal gratings. Onset-offset: VECPs elicited by sinusoidal gratings had higher amplitude and earlier latency than those obtained with pseudoisochromatic stimuli. Different visual mechanism possibly underlying the cortical responses for illusory stimuli when presented in different modes.

[2P1M076] "The dress" phenomenon: peculiar to the photograph, or present for the real dress?

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In "the dress" phenomenon of internet fame, striking individual differences in reported dress colours suggest individual variability in colour constancy. We assessed whether the phenomenon is peculiar to the photograph by investigating colour naming for the real dress. Participants viewed the real dress (blue/black) and another version (white/black) displayed singly under five illumination conditions, either two-source (metameric 'blueish' daylight and candle light) or single-source (equal energy white, red or blue). Illuminations were generated with 10-channel LED luminaires. Participants ($n = 12$) viewed the chest area of each item and freely named all colours. Naming variability was highest for the blue/black dress in the two-source condition.

Colour name constancy was poor for both dresses; for the blue/black dress, all observers changed colour names for body, lace or both under at least one light change. Colour name constancy was best for the change from white to blue light for both dresses, but better for the blue/black than white/black dress. The white/black dress showed less constancy under the change from white to red light than from white to blue light. Thus, the phenomenon is likely linked to the "blue" bias for colour constancy (Pearce et al., 2014), but not restricted to the photograph.
EU FP7 HI-LED; The Wellcome Trust

[2P1M078] Differences between alpha, beta and gamma oscillations in the processing of chromatic and achromatic gratings

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The hypothesis that different oscillatory frequencies in Visual Evoked Cortical Potentials (VECP) should have different physiological roles, led us to investigate differences in the power of alpha, beta and gamma bands for achromatic and chromatic stimuli. Eight subjects underwent two four-minute recordings of 1 Hz Pattern onset/offset VECP of the occipital pole for both achromatic and chromatic (red-green equiluminant) 2cpd sine-wave gratings. Separate spectrograms were built with Discrete Fourier Transforms for alpha (8–12 Hz), beta (12 Hz–30 Hz) and gamma (30–60 Hz) bands. For both color and luminance, two amplitude peaks were identified in all frequency bands: an early peak (∼100–150 ms) and a late peak (∼450 ms). The late peak is associated with the stimulus offset and does not differ between color and luminance signals for any of the frequency bands. The early peak differed between luminance and color in both amplitude and latency. Latencies were ∼50 ms earlier for color on average. Amplitude of the early peak was twice as high for color than luminance in the alpha and beta bands, and four times higher for gamma. Results support a different role of different frequency bands in color and luminance processing. Future work must approach the differential role of oscillatory potentials in luminance and color processing.
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[2P1M080] Modeling visibility of periodic and aperiodic flicker

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A unique characteristic of light emitting diodes (LEDs) is that they respond very fast to changes in the driving current, which can be used to e.g. easily control the intensity of the light output. However, improper selection of dimming technology parameters or addition of mains voltage fluctuations can result in flickering of the LEDs' light output. A number of objective measures have been developed in the past to quantify flicker perception (i.e. Flicker Index, Flicker Percent, FVM, Pst), but none of them can accurately predict both periodic and aperiodic flicker for general

lighting conditions. A new measure is proposed, called FVMt. It is based on the human visual system model developed by Frederiksen and Hees (1997) and it consists of two impulse response functions. The parameters of the model were determined so that they fit the flicker sensitivity curve for general lighting conditions, developed in earlier experiments (Perz et al., 2013). A perception experiment was conducted, in which flicker visibility to realistic waveforms was evaluated. The results showed that FVMt predicts flicker visibility significantly better than the conventional measures, FI and MD and correlates well with Pst for aperiodic, and FVM for periodic flicker while predicting the visibility threshold better.

[2P1M082] Neuronal Chronometry of Emotional Attention: Early Interactive Effects of Brightness and Emotion

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The rapid extraction of affective cues from visual environments is fundamental for flexible behavior. However, it is still unclear how the evaluation of emotional information is modulated by basic perceptual features. Recent behavioral studies revealed the existence of a brightness bias, according to which luminance variations of neutral pictures influence their affective evaluations. The present event-related potential (ERP) study investigated the neuronal chronometry of brightness effects in neutral and emotional scenes. Seventeen male participants rated original and bright versions of grayscale neutral and erotic IAPS pictures. Bright scenes were rated more positively compared to their original counterpart when neutral but less positively when erotic. Classical and mass univariate ERP analysis showed, starting at $\sim$200 ms post-stimulus onset, lower N1 amplitude for bright vs. original erotic pictures but no brightness differences for neutral scenes. Complementary spatiotemporal analysis concurrently revealed the selective contribution of a centroparietal positivity following the presentation of original, but not bright, erotic scenes. This topography was also present at later time windows for erotic scenes only, indicating its involvement in emotional processing. These results indicate that neural networks subtending the extraction of emotional information are differentially recruited depending on low-level perceptual features, which ultimately modulate emotion evaluations.

[2P1M084] The effects of depth separation on lightness contrast and lightness assimilation

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An intriguing paradox is created by the phenomena of lightness contrast, in which the difference in lightness between targets and inducers is over-estimated, and assimilation, in which this difference is under-estimated. Inducers' spatial frequency is an important factor: inducers with low-spatial frequency seem to induce contrast whilst inducers with high-spatial frequency seem to induce assimilation. The interaction of this factor with depth is less clear. Wolff (1934) found that contrast disappears when low-spatial frequency inducers are non-coplanar with targets, while Soranzo at al.

(2010) found that contrast persists even with high-spatial frequency inducers when they are non-coplanar with the targets. The difference between these two studies is that Wolff manipulated actual depth, whilst Soranzo et al. manipulated stereoscopic depth. This study manipulated the actual distance between target and inducers, as well as Inducers' Spatial frequency and Intensity. Participants indicated the target lightness by choosing the correspondent chip in a Munsell scale. Results suggest that high spatial-frequency inducers generate assimilation effects only when they are coplanar with the targets, but contrast effects when they are non-coplanar. Low-spatial frequency inducers generate contrast effects both when they are coplanar and at distance. We conclude that assimilation is more affected by distance than contrast.

[2P1M086] The eye physiology: Why don't we have glare from all light sources in our visual field?

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Glare may can be seen in two ways: The quantity of the light entering the eye may be to high or the light contrast of the light spot on the retina may be too high in relation to neighbouring areas. The anatomical and physiological properties of the eye, which are in relation with diminishing of the excess light to access useful vision in difficult light distribution in the eye are discussed. The localisation of retinal area which is the target of the light rays are important. Also the direction of the photoreceptor cells in the retina contributes to avoid glare. The use of the physiological glare avoiding mechanisms in everyday life which end up in a changed visual perception will be discussed.
None

[2P1M088] Peripheral brightness perception is influenced by cone-silent modulations

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The intrinsically photosensitive (melanopsin-containing) retinal ganglion cells are proposed to provide signals to the visual as well as the non-visual pathway, with evidence suggesting melanopic input to both full-field brightness perception (Brown et al., 2012) and peripheral chromatic detection (Horiguchi et al., 2012). Here, in order to separate peripheral from central contributions to brightness perception, we examined brightness matching between stimuli restricted to different retinal locations. Observers performed a dichoptic matching task by adjusting a 1° test field, presented to the fovea of the left eye, to appear equal in brightness to a 3° standard field presented at ∼15° eccentricity in the right eye. Each field's spectrum was controlled independently using 13-primary, tuneable LED luminaires. The standard fields were visual metamers with different amounts of cone-silent spectral modulation targeting the melanopic spectral sensitivity function. Observers controlled the test field's luminance only. Preliminary data from 5 observers demonstrate that test field matches require significantly

higher luminance to match the higher melanopic-activation standard fields. These results suggest that the brightness of peripheral stimuli is influenced by cone-silent modulation most likely driven by a fourth photopigment with melanopic spectral sensitivity.
EU FP7 HI-LED

[2P1M090] Investigation of brightness perception with glare illusion by SSVEP

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A strong light or ophthalmic disorder causes the glare. However, we can perceive the glare except for the environment, for example, the glare illusion makes us perceive the glare. Thus, the neural mechanism of the glare perception has not been clarified. In this study, we used the SSVEPs to observe the neural activity in early visual cortex. We manipulated the luminance of the glare illusion and the dots flickering on its center region at 7.5 Hz. The participants were requested to pay attention to the dots and responded to the random distractor on center of the stimulus. The grandaveraged SSVEPs amplitudes (9 participants) of 7.5 Hz were compared among each gradient and luminance condition. The result of the SSVEP amplitude for the control condition (no glare illusion) showed that it increased in proportion to the contrast ratio. On the other hand, the results for glare showed that the amplitude to high contrast ratio was significantly low compared with the control condition. These results suggested that the perceived contrast was decreased by glare perception whereas the perceived luminance increased in proportion to contrast. Hence, bright enhancement perception with glare has been suggested to be processed in the primary visual cortex.
This work was supported by Grants-in-Aid for Scientific Research from the Japan Society for the Promotion of Science (grant number 25330169, 26240043), and the SCOPE from the Ministry of Internal Affairs and Communications, Japan.

[2P1M092] Dynamic range, light scatter in the eye and perceived image quality

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Light scatter in the eye can substantially reduce the dynamic range (DR) of the retinal signal. We quantify this effect by convolving high DR images with a point spread function that models eye scattering. We find that the resulting retinal DR can be described as the original DR raised to a power p. For images viewed in a dark background the exponent p is 0.68, while for image viewed with a dim background p is 0.45; this implies that a high DR image spanning seven orders of magnitude will span five in dark background conditions, but only three in dim background conditions. We also investigate the perceived quality of high DR images presented on an OLED monitor. We find that the highest quality is perceived when a dark background is used, but also note that the difference is most apparent when low key images are used. We investigate whether this effect can be explained by current image quality models.

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[2P1M094] Power Law of Brightness on Different Edge Filtering

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We measured suprathreshold brightness in different levels of edges hardness. Steven's Power Law for circles modulating in luminance were estimated for 10 subjects (mean age 25 SD 3). Stimuli consisted of two circles of 3 degrees of visual angle, separated by 10 degrees. We tested 7 levels of Michelson contrast: 7, 8, 10, 15, 26, 50, 100. Three edge filtering was tested (0.3, 0.8 and 1.5 degrees of smoothing). The subject task were to judge the brightness of the edge filtered circle compared with the circle of hard edge which was considered the Modulus with an arbitrary level of 50, representing the amount of brightness perception. In each trial, the same contrast level was presented in both circles. Five judgments were performed for each contrast level in each edge filtering. We found an increase in the Power Law exponent as the increase of filtering (for sigma of $0.3 = 0.37$, sigma of $0.8 = 0.55$, and sigma $1.5 = 1.03$). All power function fitting had a correlation coefficient higher than 0.95. We conclude that there is a progressively increase in brightness perception as increase the edge filtering and a full performance in suprathreshold contrast perception is achieved with a half size stimulus smoothing.
FAPESP #2013/0404-9

[2P1M096] Effects of optical appearance on the perception of liquids

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In daily life we readily identify liquids with different viscosities, such as water, honey, or tar. Many such liquids also have distinctive optical properties (e.g., colour, translucency). Optical properties are independent of viscosity but it seems plausible that we may associate specific appearances (e.g. water, caramel) with certain ranges of viscosity. Contrarily, the visual system may discount optical properties, enabling 'viscosity constancy' based primarily on the liquid's mechanical properties. We investigated whether optical characteristics affect viscosity perception. We simulated liquids with viscosities varying over a wide range and rendered them with nine different optical characteristics. Observers performed two tasks: (1) adjusting the viscosity of a match stimulus until it appeared to be the same as a test stimulus at a different time point and with different optical appearance (2) rating six physical properties of the test stimulus. We tested both moving and static stimuli. Observers were good at matching viscosity and optical properties had almost no effect. Some ratings of liquid properties did show substantial interactions between viscosity and optical properties. These results suggest that although optical properties influence the perception of some characteristics of liquids, they have very limited influence on shape- and motion-based viscosity judgements.

[2P1M098] The effect of background and presentation mode on transparent layer constancy

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We investigated the degree of transparent layer constancy when matching filter colors across different illuminations. Previous studies reported varying degrees of constancy and it was suggested that constancy is not influenced by whether or not the subjects have a transparency impression. We systematically examined the role of viewing context and phenomenal impression on constancy performance. We compared normal filter presentation that leads to phenomenal transparency with a flipped filter version that violates geometric transparency cues and appears opaque (X- vs T-junctions). Two different background structures were used and we also varied the presentation mode (static vs motion, monocular vs stereo, simultaneous vs alternating display of test and standard). We found that the geometric cues had the largest effect on transparent layer constancy: It was significantly higher with X-junctions than with T-junctions. Alternating presentation of standard and test enhanced constancy throughout. The effects of motion, stereo and background structure were smaller and more complex: While in the case of X-junctions constancy was enhanced when the objects were moving or presented in a more structured background pattern it was reduced with T-junctions. Together, this suggests that the more vivid the impression of a transparent layer is the higher the degree of constancy.
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[2P1M100] Flexible spatial frequency tuning indicates multiple mechanisms of surround suppression

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Contrast sensitivity can be substantially reduced by the presence of nearby stimuli, a phenomenon referred to as surround suppression. Previous studies have measured contrast sensitivity as a function of surround spatial frequency and revealed surround suppression is band-pass tuned around the target frequency (Petrov, Carandini & McKee, 2005; Serrano-Pedraza, Grady & Read, 2012). This pattern of tuning implies that surround suppression reflects inhibition from cells with similar tuning preferences as the target. To date the spatial frequency tuning of surround suppression has been investigated using a limited range of stimulus parameters. We sought to determine to what extent the band-pass tuning observed in previous research was dependent on the phase of the surround, surround contrast, target size and the spatial configuration of the surround. Manipulation of these parameters changed the selectivity of surround suppression and revealed under different conditions that surround suppression can be low-pass tuned, broadly tuned or show no tuning at all to surround spatial frequency. Our results suggest that the characteristic band-pass tuning previously reported is not a universal property of surround suppression, but may represent the tuning associated with just one of multiple components contributing to the inhibitory influence of surrounding stimuli.
This work is supported by the Wellcome Trust [WT097387]

[2P1M102] Spatial frequency shifts from flicker and from simultaneous contrast

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Apparent spatial frequency of a grating is affected by a surrounding grating (Klein et al., 1974). Also, a fast flickering grating appears finer than it is (e.g. Virsu, Nyman & Lehtiö, 1974). We combined these two effects to locate their responsible processing sites and their relative locations. We used a center-surround configuration to see how various surrounding gratings affect apparent test spatial frequencies. Subjects matched the spatial frequencies of the vertical test grating with horizontal comparison grating presented beside it. The test grating was 2 cpd, and the surrounding vertical grating was either the same (2 cpd) or coarser (1.2 cpd). The surround grating was either flickering (25 Hz, counterphase) or static. All gratings were sinusoidal. The results showed that the test appeared finer when surrounded by the static coarse grating, but not when surrounded by the flickering coarse grating. Additionally, the test appeared coarser when surrounded by a flickering same-frequency grating compared with when surrounded by a static same-frequency grating. Subsequent experiment confirmed that flicker made the surround finer by 14 to 62%. The results suggest that the site of simultaneous contrast of spatial frequency is located after the site of the flicker-induced apparent spatial frequency change.
SK is a Research Fellow of Japan Society for the Promotion of Science.

[2P1M104] Understanding Relationships between Perceptual Texture Features

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Procedural texture models are widely used to generate textures. Previous studies proved that for near-regular textures, twelve perceptual features were sufficient to describe corresponding procedural texture models (Liu & Dong, 2013), i.e. a particular model can be found to generate textures with given perceptual descriptions. However, it is unclear whether these perceptual features are independent or correlated with each other. We analyzed the rating scales of the twelve features obtained from previous psychophysical experiments, and based on these scales, Pearson's correlation coefficients are obtained with a range from 0 to 0.9670, meaning that there existed significant linear correlations between certain features. Meanwhile, 16.5% of the correlation coefficients had magnitudes less than 0.1, indicating that certain features were independent with the others. The most strongly correlated features were "locally oriented" vs "directional", followed by "regular" vs "repetitive". Linear regression models between significantly correlated features were constructed; the results showed that sample perceptual scales fit the regression line well. With these regression models, corresponding features can be predicted with few input perceptual scales. The predicted features can be used to accurately find procedural texture generation models, which were able to produce corresponding textures.
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[2P1M106] Polarity based temporal contrast sensitivity functions in human subjects and tree shrews (Tupaia belangeri)

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Sinusoidally-modulated flickering stimuli are typically used to draw temporal contrast-sensitivity functions (TCSF). However, due to the nature of a sinusoid, these functions don't capture the differences in the perception of flickers with luminance increments or decrements. We generated flickering stimuli using impulses of transient increases or decreases in luminance at different levels of frequency to study distinct influences of contrast polarity on TCSF. Tree shrews were trained and human subjects were instructed to discriminate a flickering stimulus among two other iso-luminant non-flickering stimuli in an automated 3-alternative forced-choice task. We found that both tree shrews and humans exhibited higher sensitivity to contrast decrements compared to contrast increments. We show that the peak sensitivity for human subjects is at 15 Hz. While human subjects showed less difference in the performance, they were faster in perceiving decrements than increments. In tree shrews, we report the largest gap between sensitivity to contrast increments and decrements at higher frequencies. Tree shrews exhibited peak sensitivities to contrast increments and decrements at 24–40 Hz and 60 Hz respectively. Taken together, our results support a higher perceptual acuity for luminance decrements compared to luminance increments and suggest inter-species differences in temporal characteristics of visual perception accounting for their ecological needs.
Swiss national science foundation (SNSF) and University of Fribourg

[2P1M108] Saccadic Suppression of Displacement for Moving Targets

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Detection of target spatial displacement during a saccade is poor, an effect known as Saccadic Suppression of Target Displacement (SSTD). Sensitivity to displacement can be restored, however, if the target is absent for the brief period after a saccade or if there is change of the target's properties during the saccade. According to (Deubel, Schneider, and Bridgeman, 1996), the visual system is biased to assume that the world remains stable during a saccade and the introduction of a blank or property change breaks this assumption resulting in a more accurate comparison of pre and post saccadic location. The goal of this study is to test if task irrelevant, continuous target motion would also break the stability assumption and thus increase the ratio of the correct answers. We modify a classic SSTD experiment design for moving targets. In addition to the distance of the displacement and the presence of temporal gap, in half of the trials the targets are moving orthogonal to the displacement direction smoothly prior to and after the saccade. We

observe the classic SSTD results for both the static and moving conditions, but we find no evidence for the influence of target's motion on the target displacement sensitivity.

[2P1M110] A functional MRI study of the contralateral mapping of activity associated with saccade preparation and execution in the human superior colliculus

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There is strong neurophysiological evidence showing a contralateral mapping of saccade-related activity in the primate superior colliculus (SC). However, functional imaging studies of the human SC have shown an increase in saccade-related activity (BOLD response) in both the contralateral and ipsilateral SC. The present study examined the BOLD response in the human SC using 3 T fMRI during the saccade preparation and saccade execution phases. A univariate analysis (GLM) revealed a significant bilateral increase in BOLD response associated with saccade preparation, but was unable to identify a contralateral bias. A second analysis compared activity in each voxel with a contralaterality index (CI) and provided stronger evidence of a contralateral mapping of saccade preparation. Both the GLM and the CI analysis were sensitive enough to identify the presence of a contralateral bias for the saccade execution phase. The results show that the expected contralateral bias can be measured in the human SC using functional imaging. The bilateral increase in BOLD may reflect the sensitivity to neural activity and local field potentials associated with inhibition.
This work was supported by a grant from the Leverhulme Trust to Robin Walker and Andrew T. Smith.

[2P1M112] How common are "express saccade makers"? Moving beyond Europe and simple East/West comparisons

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A gap between fixation target offset and saccade target onset encourages the production of express saccades (ES; latency 80–130 ms). Express saccade makers (ESMs) persist in producing unexpectedly high proportions (>30%) of ES in overlap trials (fixation target present when the saccade target appears), a pattern of behaviour suggested to be rare in the absence of pathology and/or extensive training. However, we have shown this behaviour is expressed in >20% of Chinese participants compared to 10% or less of Caucasian participants (Knox & Wolohan, 2014). What about other groups? We exposed 70 naive Egyptian/Arab participants to gap (duration 200 ms) and overlap trials (2×200 trials for each condition, in separate blocks, targets 10° left/right randomised, randomised fixation time 1s–2s, order of blocks randomised between runs/participants). The percentage of saccades with latencies of 80 ms to 130 ms (%ES) was calculated for all saccades with latencies between 50 ms and 500 ms. 10/70 (14%) participants were ESMs, a proportion intermediate between Caucasian and Chinese participant groups tested previously. No Egyptian participant reached the very highest%ES in overlap conditions (ie >60%)

occasionally observed with Chinese participants. These results confirm that ESMs may be more frequently encountered than expected based on the (mainly Western) literature.

[2P1M114] Disentangling the effect of eye movements on representational momentum and representational gravity: a Fourier decomposition approach

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The perceived final location of a moving target that is suddenly halted is usually displaced both in the direction of motion (RM) and in the direction of gravity (RG). Moreover, these errors evolve with time in a pattern that mimics an anticipated falling trajectory. The degree to which these errors reflect cognitive analogues of physical invariants or features of eye movements has been a major topic of contend. Separately assessing the role of eye movements for RM and RG is further complicated by the fact that for some target motions both are confounded. The present study addresses this issue by taking advantage of the logic of Fourier decomposition. Targets, moving along 16 possible directions, were shown to participants required to locate their vanishing positions after a variable retention interval from 0 to 1200 ms. Participants completed two tasks differing only on the eye movements instructions (smooth pursuit or fixation). The outcomes revealed that constraining eye movements drastically reduced the spectral signature of RM but not of RG. Moreover, RG increased with time, irrespective of the presence or absence of smooth pursuit eye movements. The results lend credence to the role of an internal model of gravity in spatial localization tasks.
This work was supported by Grant SFRH/BPD/84118/2012; Portuguese Foundation for Science and Technology (FCT).

[2P1M116] Gaze shifting patterns in gymnasts during a jump with full turn

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Gymnasts use visual information during aerial movements, but how they use vision to achieve safe and correct landing in a jump with a turn is still unclear. The purpose of this study was to reveal the gaze shifting patterns in gymnasts during a jump with full turn by measuring horizontal eye-head movements. 10 participants were male skilled gymnasts (age [M $\pm$ SD], 23.90 $\pm$ 3.28years; career length, 15.70 $\pm$ 3.06years). They had to perform a jump with full turn (360°). To measure horizontal eye movement during the jump, electrooculography (EOG) was recorded using a wireless system. Simultaneously, the jump was recorded using two high-speed digital cameras. Gaze direction was determined by adding horizontal angle of eye and head movement. It was found that all participants performed perfect landing. The gaze shifting were classified roughly into two patterns. In the one pattern, gaze stabilization depended before take-off and during landing. This pattern include correcting gaze direction during landing. In the other pattern, additional gaze stabilization developed during flight phase. They might use visual information to optimal landing

and precise rotation by stabilizing gaze during a jump with full turn. Further studies are needed to examine which pattern have an advantage in their best performance.
This research was supported by JSPS KAKENHI Grant-in-Aid for Young Scientists (B), Grant Number 26750280.

[2P1M118] Does visuo-spatial short-term memory load interfere with Inhibition of Saccadic Return?

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Inhibition of Saccadic Return (ISR) is an attentional mechanism which discourages the reorientation to previously inspected locations and thus guides search towards uninspected locations. In the current experiment we investigated how ISR in visual search is affected by the storage of visuo-spatial information in short-term memory (STM). In a dual-task paradigm, participants performed a visual search as primary task while maintaining none, two or four object locations in STM as secondary task. During the search, a visual probe was presented at a location that had either been visited previously (old probe) or not (new probe). The participants were instructed to saccade to this probe immediately and then to resume search. The results showed that saccade latencies to old probes were longer than to new probes. This was independent of the number of stored locations in STM. This suggests that ISR is not affected by this kind of visuo-spatial STM load.

[2P1M120] How does the eye movement system represent visual texture?

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Visual texture is plausibly one of the more important features determining where we look, often being highly diagnostic of the presence of many important objects. Unfortunately even characterising a texture is non trivial: some modern computational models require over one thousand parameters. In contrast multi-dimensional scaling methods based on "perceptual similarity" are well accounted for by only two or three. To find the dimensionality and natural representation of texture underlying eye movements, we measured symmetrised confusion matrices in an eye movement task where performance was based on making eye movements to a pre-cued texture. This measure is a legitimate random partition kernel, but only sensitive over short distances. We therefore analysed the data using the non-linear manifold learning technique tSNE. We present estimates of the dimensionality of eye movement "texture space", and illustrate the nature of the two dimensional solution that captures much of the variance.
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[2P1M122] Eye movement correlates of cognitive strategies in foreign language vocabulary learning

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In the study we modelled a situation of foreign language vocabulary learning: 31 Russian students memorized visually presented word pairs (native language word – pseudoword). Each pair was presented for 6 seconds, recall check was after each trial of 4 pairs. Monocular eye movements and quantitative recall data were recorded. We also analyzed post hoc reports about mnemonic techniques used and kinds of recall mistakes, which allowed us to distinguish 3 main strategies of paired associate vocabulary learning: "graphical" (attention to graphic details), "phonological" (rehearsing the words) and "semantic" (creating associations). These strategies correspond to the levels of processing as proposed by Craik & Lockhart (1972) and Velichkovsky (2006). Recall score was connected with the strategies used $F(3;755) = 11{,}2$ ($p < 0{,}01$), escalating with the increasing "depth" of processing. Eye movement characteristics also reflected types of strategies: "graphical" strategy was associated with more fixations; "phonological" strategy was characterized by more switches between Areas Of Interest (native and pseudo- word) and less fixations on the AOIs; "semantic" strategy was distinguished by fewer switches between AOIs and longer fixation duration. The findings indicate that subjects use different strategies of foreign words memorization, which are reflected in their eye movement characteristics and result in recall efficiency.

[2P1M124] Limits of spatial vision in the presence and absence of fixational eye movements

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The cone photoreceptor mosaic is the cellular entry point for photopic vision in humans. Its discrete packing arrangement and inner retinal connectivity also sets the first limit on spatial sampling. Due to constant eye motion, retinal images are being translated across multiple receptors at all times, yielding spatio-temporal information necessarily to be included in the sampling process. By arresting visual stimuli on a set of targeted photoreceptors, we here explore to what degree this information is employed during high acuity and hyperacuity tasks. We used an adaptive optics scanning laser ophthalmoscope to image the retina and deliver aberration corrected visual stimuli (acuity: 4-AFC tumbling E, hyperacuity: 2-AFC vertical 3 dot) at high levels of retinal contingency. During sustained fixation, subjects were randomly presented with stimuli shown in either retinally stabilized or normal viewing conditions at specific retinal locations for 750 msec, with stimulus feature size below the Nyquist sampling limit. In acuity experiments, all subjects performed significantly worse in the stabilized condition, with a mean performance drop of $\sim$23%. Performance was unchanged during hyperacuity tasks. We conclude

that fixational eye movements can facilitate discrimination in acuity tasks, but do not in tasks where integration processes are operating at maximum already.
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[2P1M126] Effect of mask characteristics on pursuit eye movement during target disappearance

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The gain and speed of smooth pursuit is known to degrade after the disappearance of a tracked target behind a mask (Madelain & Krauzlis, 2003). Here, we measure the effects of mask characteristics on the speed and gain of smooth pursuit after target disappearance. Participants (N = 8) tracked a target moving along horizontal axis (13°/s). After 900 ms, the target disappeared for 700 ms behind a mask consisting either in a uniform, visible or invisible, mask or in a texture of static or flickering (10 Hz) disks. The results show that smooth pursuit gain and speed drop after target disappearance for uniform and textured masks, but are maintained with a flickering mask, indicating that temporally modulated backgrounds facilitate voluntary smooth pursuit maintenance in the absence of a driving target. We suggest that with a flickering mask, the retinal slip elicits reverse-phi motion responses in MT neurons (Krekelberg & Albright, 2005) and interpret this novel effect as reflecting the on-going contribution of motion responses of MT neurons to pursuit. This questions models of pursuit relying on the retinal slip. Instead pursuit generation continuously integrates cortical motion responses, which with the flickering mask used herein provides a positive feedback to the pursuit system.
Supporting by hors-Dim grant from IDF

[2P1M128] Can Eye Movement Features for User Identification Also Be Used for Grouping Cue Classification?

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Schelske & Ghose (VSS, 2015) reported an automatic user-identification system based on eye-movements and how it is affected by different grouping cues. Here we investigate whether the grouping cue present in the stimulus can in turn be predicted from eye-movements. Eye-movements of 8 participants were recorded while inspecting a Gabor-field for 10 s in 120 trials. Their task was to indicate by key-press when a red dot appeared anywhere on the screen (randomly after 10–13 s after stimulus onset). The stimuli contained either no-groups, weak-groups (detection-rate 65%) or strong-groups (detection-rate 82%) induced by either similarity of luminance or orientation of a subset of the Gabor-elements. A support vector machine (SVM) was trained to identify users based on twenty-five fixation, saccade and scanpath features computed from the eye-movement data. The identification accuracy was 71% for no-grouping, 78% for weak-grouping and 73% for strong-grouping (chance-level = 12.5%). Another SVM was trained to classify grouping cues. The accuracy for distinguishing grouping present vs. absent was ~65%, for luminance vs. orientation was 56% and was at chance-level (50%) for weak vs. strong

cue. We conclude that grouping cues per se have strong but inherently different effects on eye-movements that can be utilized to train classifiers.
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[2P1M130] Visual sensitivity during smooth pursuit and saccadic eye movements

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Eye movements, attention and adaptation change and adjust visual sensitivity continuously. In particular, during the execution of saccades, visual sensitivity is reduced by an active process suppressing low-frequency luminance stimuli, but not isoluminant color stimuli (Burr, Morrone & Ross, 1994). During smooth pursuit, we found a small sensitivity decrease for the detection of low-frequency luminance stimuli, but a 16% sensitivity increase for color stimuli (Schütz, Braun, Kerzel & Gegenfurtner, 2008). We investigated whether these sensitivity adjustments interact for saccades to moving targets. As baseline, contrast thresholds were determined for the detection of red isoluminant lines flashed for 8 ms on a gray screen 2 degs above or below a central fixation point. For six observers detection performance for the horizontal line was measured during pursuit with step-ramps and during saccades with steps to stationary and moving targets at two fixed contrasts at different times relative to eye target onset. Contrary to our expectations observers showed for saccades to static and moving targets a marked saccadic suppression for the detection of isoluminant and high spatial frequency stimuli which was not present during pursuit. Whatever sensitivity improvement there is during pursuit, it is suspended during the initial saccade to a moving target.
DFG SFB TRR 135

[2P1M132] Predicting hue scaling for abnormal color vision with perceptual models of color deficient vision

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The aim of this work was to test how perceptual models of color deficiencies predict the performance of dichromats and anomalous trichromats on a hue scaling paradigm. Stimuli presented on a monitor consisted of a square target of variable color displayed at the center of a D65 background. Both target and background had the same luminance of 12 cd/m 2. In order to scale the component sensations of the unique hues observers an arbitrary scoring rule assign a value of 3 when the stimulus is described with a single hue name and if two names were used a value of 2 to the predominant hue and 1 to the other hue. In the normal condition the colors of the target were selected in 24 directions around D65 illuminant with a hue-angle step of 15-deg. The simulation condition corresponds to Brettel's and DeMarco's transformation of the normal

condition. The experiment was carried out by three normal color observers, four dichromats, and four anomalous trichromats. The results suggest that DeMarco transformation predicts anomalous trichromats perception better than Brettel's model predicts dichromats perception.
This work was supported by FEDER through the COMPETE Program and by the Portuguese Foundation for Science and Technology (FCT) in the framework of the project PTDC/MHC- PCN/4731/2012.

[2P1M134] The preferred chromatic composition of unfamiliar paintings is similar to original

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The aim of this work was to compare the preferred chromatic composition for unfamiliar paintings with the original. Stimuli were images of paintings generated by rotating the color volume around the L* axis in CIELAB. The images were presented on a CRT. Four paintings were abstract from Amadeo de Souza-Cardoso, two had figurative elements from the same painter, two were abstract and two were figurative from other painters. In each trial a painting selected at random from the set was presented with its color volume rotated by angle selected at random. The task of the observer was to adjust the angle of the chromatic rotation for best subjective impression. Three groups of observers carried out the experiment: 50 without previous knowledge of the paintings, 8 experts in art but unfamiliar with the paintings tested and 6 experts in the paintings of Amadeo de Souza-Cardoso. It was found that the distribution of angles selected for data pooled across paintings for the non-specialist observers could be described by a Gaussian function centered at −2 deg, i.e. close to the original colors of the paintings, and with a FWHM of 64 deg, just about 1.5 above the threshold to detect a chromatic change.
This work was supported by FEDER through the COMPETE Program and by the Portuguese Foundation for Science and Technology (FCT) in the framework of the project PTDC/MHC- PCN/4731/2012.

[2P2M001] Role of prediction error in selective attention

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According to the predictive coding framework, brain generates a predictive model of statistical regularities in the environment. Attention is conceptualized as a measure of uncertainty in prediction error. (Clark, 2013). We employed a novel paradigm to empirically study selective

attention under predictive coding framework. In two experiments, participants completed a visual search task (display size 8) where they searched through either a spatially fixed configuration (FC) or a configuration in which one of the items were displaced from the fixed configuration (DC), making the displacement a prediction error. In DC, the displaced item was also the target in half of the trials (Exp1) or only 1/8th of the trials (Exp2). If attention is indeed a measure of uncertainty in prediction error then, compared with the fixed configuration, search should be faster when the moved item was the target and slower when it was the distractor. The result showed that the search times were fastest when the shifted element was the target and least when it was distractor, in both the experiments providing empirical support for predictive coding hypothesis. Thus, it seems that attention is indeed the precision weighted on the discrepancy from the predicted model.

[2P2M003] The effect of dual-task and body pitch on visual attention while viewing a video depicting ship navigation

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Oversight is a common cause of ship accidents (Marine Accident Tribunal 2013). We assumed that visual attention played a role in these oversights and examined the effects of a dual-task, body roll, and body pitch on the visual attention of 31 participants viewing a video depicting a scene from the Ship Handling Simulator. The participants were asked to perform a simple-task and a dual-task. The simple-task involved pressing a button as soon as the target presents in the picture was detected. The dual-task involved carrying out the simple-task while performing mental calculations. We used the participants' reaction time as an index of visual attention. Body roll and body pitch were controlled by means of the motion base, which moved sinusoidally with an amplitude of 5 or 10 degrees of arc and a frequency of 0.07, 0.10, or 0.20 Hz. The results showed that the body pitch had an effect on the reaction time only when the motion base was vibrated at a frequency of 0.10 Hz in the dual-task, and that body roll had no effect on the reaction time in either task. These results suggest that body pitch at a medium frequency affects visual attention in the dual-task.

[2P2M005] Competition for attention and spatial frequencies

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We investigated whether different spatial frequencies are equal in competition for attention. Digital face (184) and object (63) photographs were used. Images were equalized in mean luminance and size (7 angle degrees). They were spatially filtered by 5 filters with central frequencies 0.5, 1, 2, 4, 8 cpd and bandwidth 2 octaves. Two differentially filtered images of the same face or object were simultaneously presented on two screens during 1 s (the eccentricity was 7 ang.deg.). Then 4 unfiltered images were shown. The observer was to determine one that

matches to the test stimulus and press the corresponding key. Prior to each trial the observer fixed gaze at the cross-mark located amidst two screens. Then he/she run test stimuli presentation. We determined the image that caused an attentional capture by electrooculogram. It was revealed that the spatial frequencies differ in ability to capture attention and form the significant order. There is a hierarchy of priorities headed by 2 cpd. It was shown that this order does not change when the categories of identifying objects vary. We assume that this phenomenon is based on distinct activation of different spatial-frequency pathways and this mechanism takes part in formation of saliency maps.
This work was financially supported by the Ministry of education and science of Russia (project # 25.2141.2014/K).

[2P2M007] Spatial extrapolation versus temporal entrainment of reflexive attention by apparent motion stimuli are governed by separate mechanisms

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Dynamic stimuli capture attention, even if not in the focus of endogenous attention. Such a stimulus is apparent motion, given that it benefits perception of targets in the motion path. These benefits have been attributed to motion-induced 'entrainment' of attention to expected locations (spatial extrapolation) and/or expected time-points (temporal entrainment). Here, we studied the automatic nature of spatial extrapolation versus temporal entrainment with apparent motion stimuli, when motion was task-irrelevant. Participants performed an endogenously cued target detection task, in which symbolic cues prompted attention shifts to lateralized target positons (75% validity). Simultaneously, apparent motion cues flickered either rhythmically or arhythmically across the screen, such that targets appeared either in or out of motion trajectory. Although the motion cue can be considered a distractor (non-informative as to target location), motion direction influenced target detection, which is in line with automatic extrapolation of spatial positions during apparent motion. An effect that was independent and additive to the endogenous cueing benefit. Importantly, temporal cueing in the motion stream also influenced target detection. However, this effect was independent of reflexive motion-cueing to spatial positions. We conclude that spatial extrapolation and temporal entrainment of attention by apparent motion are governed by partially independent reflexive mechanisms.
This study is funded by my College PhD studentship (College of Science and Engineering, University of Glasgow)

[2P2M009] Attentional modulation of visual acuity has the shape of a Mexican Hat: implications to a bottom-up process

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Classical models of exogenous attention suggest that attentional enhancement at the focus of attention degrades gradually with distance from the attended location. Here we present first

evidence in support of a Mexican Hat shaped modulation in a visual acuity task. In two experiments participants had to decide the location of a small gap in a target circle that was preceded by a non-informative transient attention capturing cue. The distance between cue and target and the latency between their onsets were varied. Enhancement at the focus of attention was accompanied, at short latencies, by suppression at the surrounds, exhibiting a Mexican Hat shaped modulation of performance, whereas at latencies over 200 ms performance decreased gradually with distance. Our results suggest that a rapid Mexican Hat modulation is an inherent property of the mechanism underlying exogenous attention. They further suggest that this modulation is rapid and that a monotonically degrading trend, such as advocated by classical models, develops only at later stages of processing.

[2P2M011] Responding to social and symbolic extrafoveal cues: Cue shape trumps social status

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At visual fixation, gaze cues strongly influence an observer's attention and response preparation. Using an interference paradigm, we have shown that gaze cues presented away from fixation are much less effective. Instead, strongest response cueing is found for pointing hands and rotated heads (Burton, Bindemann, Langton, Schweinberger & Jenkins, 2009; Hermens & Bindemann, 2014). These hand and head cues have a clear shape outline and therefore the results suggest that the strength of extrafoveally presented cues is determined by the shape of the cue. Here, we present data using the same interference paradigm and show that extrafoveally presented arrow cues (symbolic cue; distinct shape) result in stronger response cueing than eye gaze cues and direction words (social and symbolic cue, respectively, no distinct shape). These results further support the notion that cue shape rather than social status determines the strength of extrafoveally presented cues.

[2P2M013] Rapid and Parallel Allocation of Attention to Categories

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In real-world environments, relevant objects can appear rapidly and unpredictably. Research by Eimer and Grubert (2014) used event-related brain potential (ERP) markers to show that attention can be allocated rapidly and in parallel to new target objects defined by colour. The current research aimed to determine whether this phenomenon also exists for targets defined by alphanumeric category (letters versus digits). Two displays were presented in rapid succession, with a stimulus-onset asynchrony (SOA) varying between 10, 20, 50 and 100 ms. Each display contained one item in the current target category and another item in the nontarget category on opposite sides. Participants had to compare the identity of the target-category items in the two displays (e.g., vowels vs. consonants) and to ignore the nontarget items. The speed of category-based attentional selection was measured using the N2pc component. N2pc onset latencies to targets in the first and second display closely matched the objective SOA between the two

displays, demonstrating that attention can be allocated rapidly and in parallel to new category-defined targets. These results show that rapid parallel target selection processes are not confined to simple target-defining features such as colour, but can also be elicited when selection is based on category.

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[2P2M015] The timing, but not the time, of IOR

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Cued locations result in short lived response facilitation and a longer lasting disadvantage – a result termed 'Inhibition of return' (IOR). Krüger et al. (2014) explored the possible contributions of attention and perceptual merging on facilitation with reaction time responses as well as the perceived onset time of the probe using a non-speeded clock judgement task. Cues presented both before and after the target probe influenced results, suggesting that the perceptual merging of cue and target was caused by an attentional account which included re-entrant processing. Here we present data across a range of cue target intervals using both speeded responses and clock judgements to test the timing and transition of IOR, facilitation and re-entrant processing. Although we observe robust IOR at late cue-target onset asynchronies for reaction times, we do not observe an effect of IOR on the perceptual onset times suggesting that IOR is not perceptual. In contrast to Krüger et al. (2004) we do not observe an effect of the cue when it appears immediately before or after the probe neither in RTs nor in perceptual judgements. We conclude that cuing effects are not measured with a spatio-temporal gradient or are susceptible to continuous probability manipulations.

[2P2M017] Priming of visual search and priming of bistable perception: Do they rely on shared mechanisms?

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Attentional selection in visual search and perceptual selection in bistable perception show similar characteristics. Both in visual search and bistable perception observers are biased toward previously selected targets or interpretations. We measured whether these priming effects are related by presenting two interleaved trial types that contained either an ambiguous sphere that could be perceived as rotating in one of two directions around a central axis, or a search display with a target sphere and distractor spheres that resembled the two possible interpretations of the ambiguous stimulus. The two trial types were interleaved to examine whether priming elicited by target selection during visual search could affect the outcome of perceptual conflict during bistable perception and, conversely, whether perceptual priming during bistable perception could affect search response times during visual search. We established that our experiments elicited search

priming and perceptual priming, but found no evidence that search priming affected bistable perception, or that perceptual priming affected search response times. This shows that while each paradigm elicited priming, there was no interaction between the two forms of priming.
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[2P2M019] Attention capture as a function of prediction error

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The predictive coding framework (Friston, 2009) conceptualizes attention as an error in prediction. This theorization implies automatic processing of stimuli that do not fit with the prediction generated by the system. Recently, we showed that action-effect captures attention (Kumar, Manjaly & Sunny, 2015) through intentional binding between action and a feature singleton. Prediction is a critical component in binding. In the present study, we explore how predictions about the space or time and the probability of action-effect occurrence interact with each other to modulate attention capture. In three experiments we showed that a feature singleton does not capture attention when all of these three variables are fully predictable throughout the experiment. That is when there is no error in prediction capture does not occur. However, when there is an unpredictability associated with any one of these variables, the feature singleton captures attention. That is, only in the case of a prediction error do action and effect bind together leading to capture. These results provide conclusive evidence in support that bottom-up attention is an outcome of error in prediction. In case of complete predictability, attention is allocated in a top-down manner as the system requires minimal information from the environment.
Neotia Foundation,

[2P2M021] Visual attention during linguistic-visual conflicts

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Visual attention can be directed by visual and linguistic information. It is not well understood how attention is directed when linguistic information conflicts with the visual scene. Knoeferle and Crocker (2006) established the coordinated interplay account model of sentence comprehension and linguistically mediated visual attention, but it did not address such conflicts. To inform the model, we created a decision making experiment where auditory and visual information provided conflicting information. Participants' eye and hand movements were tracked during a sorting task. Each trial, a square appeared onscreen without a category. The participant selected the square with a mouse and moved it to a 'sensor' to reveal its category, which dictated its sorting location. Once placed on the sensor, the participant would hear a linguistic category utterance and briefly see the visual category. Crucially, on some trials, visual and auditory information mismatched.

Additionally, the conflict was manipulated such that visual information preceded auditory by 200 ms, followed it by 200 ms or they occurred simultaneously. After being presented with this information, participants sorted the block while under a time limit. We present preliminary data examining eye and mouse movements, with a focus on predictive eye movements made following auditory and visual information presentation.
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[2P2M023] A Direct Electrophysiological Demonstration of Object Based Sensory Processing

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Evidence for sensory processing in an object-based frame of reference has previously only been indirect, through object-based attentional deficits in the neglect syndrome. However, no direct physiological evidence exists of sensory processing differentiating, for instance, the left and right parts of an object in a non-retinotopic object-based coordinate system. In the present study we investigate electroencephalographic correlates of different coding schemes in 27 healthy participants. To differentiate cortical responses to the left and right side of faces, independently of retinotopic position, a steady-state paradigm was employed, tagging the two face-halves with distinct frequencies. To separate retinotopic- and object-based frames of reference, we used a general linear model to explain the pattern of induced response. This analysis revealed significant electrode-clusters for both explanatory variables, indicating the co-existence of both types of coding schemes. The object-based processing was further supported by increased within-frequency coherence between lateralized electrodes pairs. In contrast, the integration of the two face halves was supported by between-frequency power envelope correlations between bilateral electrode pairs. Taken together, our results provide direct evidence of object-based coding in healthy humans, which is based on the canonical representation of objects' left and right parts, and relying on intra- and inter-hemispheric communication. *H2020 – H2020-FETPROACT-2014, 641321 (socSMCs)*

[2P2M025] Perceptual identification influences visibility ratings

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How do we estimate visibility of perceptual stimuli? Is this only the effect of perceptual evidence accumulation or do we use other information to judge visibility? We present four studies aiming to investigate those questions by analysing the effects of decision in identification task on subsequent subjective visibility ratings. Perceptual awareness scale was applied in the context of a Gabor patches orientation identification task either before, or after the identification responses. Results of the first two studies show that visibility ratings predict accuracy, but the effect is weaker, when visibility ratings precede identification responses. This could be a result of either

longer time participants required to estimate visibility, or the influence of the identification decision itself. Thus, we run two additional studies to separate the influence of decision time and identification/awareness rating order. First, we manipulated the amount of time participants had to rate visibility, while the identification decision was always made after visibility ratings. Then, we manipulated tasks order but controlled the time participants had to rate visibility. The results show the effects of both manipulations. Thus, we conclude that visibility ratings are based on low-level visual processing, but also influenced by post-decision processing.
The studies were supported with SONATA BIS Program granted to MW by National Science Centre, Poland (Grant 2012/07/E/HS6/01037).

[2P2M027] Stimulus Driven Attentional Capture in Multiple Object Tracking

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Multiple Object Tracking (MOT) is assumed to be handled by bottom-up (e.g. Pylyshsyn & Storm, 1988) or top-down processes of selection (e.g. Yantis, 1992) or both (Oksama & Hyönä, 2008) – depending on the model assumed. As a dynamic task with a certain trial duration it allows strategic control. This notwithstanding strong bottom-up (stimulus-based) influences are shown to play an essential role in tracking (e.g. Erlikhman et al., 2013). The Attentional Capture (AC) paradigm (e.g. Awh et al., 2012) disentangles influences of bottom-up and top-down attentional control. It has up to now not been used to assess stimulus based influences in MOT. Only Bahrami (2003) presented irrelevant unexpected events (mud splashes) during tracking, which however did not affect performance. Alvarez et al. (2005) showed that expectable gaps did also not affect tracking. We investigated whether AC does occur at all in MOT: Is stimulus-driven selection relevant for dynamic attentional tasks? We found that sudden onset singletons were effective in dramatically lowering probe detection thus demonstrating AC. Tracking performance as dependent measure proofed to be insensitive to this effect. We discuss a stable representation of the tracking array in visual working memory to allow managing strong disruptions of attention during tracking.

[2P2M029] Is category a feature? Parallel guidance of attention by object features and categories

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Developing from previous work distinguishing attention to features and objects (Eimer and Grubert, 2014) and work showing early top-down selection for categories, we measured the N2pc component as an electrophysiological marker of attentional object selection. Participants searched for a target that was defined by a conjunction of color and category, using alphanumeric stimuli. Some search displays contained the target or a partially matching non-target that either shared a color or category with the target among three non-matching distractors. In other displays, the target and a partially matching non-target were simultaneously present. N2pc results demonstrated that attention was allocated rapidly and in parallel to target color and target category. This shows that object categories can act as a feature for the guidance of

attention. Following this initial stage of object selection where attention was allocated independently and additively to all objects with target-matching features, global competitive interactions between these objects resulted in the selective processing of target objects. These findings demonstrate that category-based attentional selection can be tracked in real time, Category-based and feature-based selection operate in parallel during the gradual emergence of goal-selective processing biases in ventral visual cortex.
This work was supported by the Economic and Social Research Council, United Kingdom (ES/K006142/1), and the BIAL Foundation (#224/12).

[2P2M031] Attention Does and Does Not Alter Contrast Appearance

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Do exogenous luminance cues increase the apparent contrast of oriented gratings? The primary method used to demonstrate this affect has been to have participants choose the more contrasted of a pair of stimuli in preparation for a secondary judgement, and to infer apparent contrast from their choice probabilities. In a series of experiments I combined a choice probability measure with an explicit matching procedure. When participants were instructed to choose the more contrasted of two stimuli and match the orientation, an increase in apparent contrast was found. However, when participants chose the more tilted of two stimuli and reported the contrast by matching there was no detectable change in apparent contrast, despite a strong correlation between reported contrast and displayed contrast. When the two maniupulations were combined and participants chose the more contrasted of two stimuli, and then reported the contrast for that stimulus with a matching method, the contrast appeared to be increased by the psychometric fits to choice probability, but did not appear increased from the matching reports. In summary, the effect of exogenous cues on contrast appearance does and does not change. The answer depends on the method used to pose the question.
NSERC

[2P2M033] Interference mechanisms revealed by the temporal characteristics: Stroop and Simon effects study

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Visual response tasks are interfered by task irrelevant features in some situations. In this study we chose two popular interfering effects of Stroop and Simon, to investigate temporal characteristics of the interferences. Stimuli were painted with color of red or green: Participants were instructed to respond to the color with their left or right hands. For examining Stroop effect in Experiment 1, the task irrelevant feature was the stimulus shape of color-word of "RED" or "GREEN" (in Japanese). For Simon effect in Experiment 2, the stimulus was a circle, and the irrelevant feature was its location of the left or right of a fixation cross. SOA between the color and the irrelevant feature appearances was set from -300 to $+300$ ms. The irrelevant feature appeared first in negative SOAs, and the color did in positive SOAs. As results, Stroop effect was obtained at 0 ms and negative SOAs, whereas Simon effect was at 0 ms and positive SOAs. This agrees with

that Stroop effect occurs around data processing stages in visual response processing, whereas Simon effect does at response selection stage or later. We further discuss Simon effect with an arrow that is a symbolic figure representing spatial orientation.

[2P2M035] The Role of the Left Dorsolateral Prefrontal Cortex in Attentional Bias; a tDCS Study

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Attentional biases play an important role in guiding visual behaviour. Persistent, long-term attentional biases to arbitrary, non-emotional stimuli (such as a particular colour) can be induced via a single information sheet (Knight et al., 2015). This induced attentional bias causes green objects to capture and hold visual attention even when such items are behaviourally irrelevant distractors and should be ignored. Neurobiologically, the left dorsolateral prefrontal cortex (DLPFC) is thought to be involved in such attentional suppression which we investigated by increasing or decreasing its cortical excitability via transcranial direct current stimulation (tDCS). Anodal tDCS of the left DLPFC reduced distractions caused by irrelevant green items suggesting that increasing the cortical excitability here can improve cognitive control over behaviourally-irrelevant attentional bias-related items. Decreasing the cortical excitability of the left DLPFC via cathodal tDCS on the other hand reduced the overall effect of the induced attentional bias, potentially by preventing the attentional bias fully developing in the first place. These results suggest a causal role of the left DLPFC in the establishment of attentional biases, and the control we have over distractions caused by these biases.

[2P2M037] Detection of brief visual events: an MEG study

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When two visual events happen in very rapid succession, they may not be separable to the visual system and are thus processed as one event. The probability for the events to be temporally segregated increases with longer ISIs. Given suitable timing, identical paired-stimulus presentations may result in different outcomes (segregation or integration) on a trial-by-trial basis. The neuronal correlates of these differences may provide insight into the temporal processing hierarchy of the visual system. We presented two stimuli at different ISIs (33, 66 and 100 ms) while recording MEG. The first stimulus was presented at near threshold intensity, while the second was presented at above-threshold intensity. Stimuli were Gaussian blobs presented on a neutral gray background. Subjects reported the number of stimuli seen (1 or 2). Behavioral performance was most veridical at 100 ms, while at 33 ms most trials were perceived as only one stimulation instead of two. Recorded difference ERFs between trials with one and two reported stimuli show a field strength reduction around and slightly before the time of stimulus presentation. This suggests the probability of detection of the near-threshold stimulus to be modulated by ongoing processes around the time of stimulus presentation, consistent with a theory of perceptual moments.

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[2P2M039] Attentional modulation of steady-state visual evoked potentials (SSVEPs) in human visual cortex (HVC) scales according to the stimulus rank when attending to colors

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Top-down voluntary attention modulates the amplitude of SSVEPs in such a way that cued shifts of feature-selective attention lead to an enhancement of the attended stimulus. It is unclear, if feature-based target selection guided by internal cues, such as a previously learned rank-order rule, leads to a modulation of attentional facilitation in HVC. We hypothesized that SSVEP amplitudes of attended stimuli are positively correlated with stimulus priority. Initially, subjects learned a color rank-rule consisting of three secondary colors of different priority (magenta > cyan > orange), that was changed in a second condition (orange > magenta > cyan). In each experimental trial, two superimposed random dot kinematograms (RDKs) were presented, flickering at different frequencies while we recorded the SSVEP. Subjects had to attend to one of the RDKs based on the learned color rank-rule, while ignoring the competing RDK. We found that SSVEP amplitudes were modulated by stimulus rank: higher amplitudes were found for the attended stimulus of highest priority (magenta) as compared to the identical attended stimulus of medium priority (magenta). Our results indicate that, when a rank rule has to be applied in order to select targets from distractors, activity in HVC scales following the stimulus rank.

[2P2M041] Subjective visual awareness correlates with neural activity around 200 ms

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Does visual awareness correlate with early activity in visual cortex or with later wide-spread neural activation? This question was studied by presenting liminal targets in one of the four quadrants of the screen and asking the participants to make forced-choice localization responses to them and to rate their visual awareness of each target, while electroencephalography was measured. The analyses of event-related potential (ERP) correlates of awareness kept the correctness of the localization response constant so that only awareness varied. Aware-correct trials were associated with enhanced contralateral N200 as compared with unaware-correct trials (=visual awareness negativity, VAN). This effect also correlated with the subjective ability to discriminate between stimulus-present and -absent trials (d'). In addition, aware-correct trials were associated with later enhanced P3 amplitudes, but this effect correlated only with the response criterion (c). ERPs to unaware-correct trials elicited larger contralateral N200 than ERPs to unaware-incorrect trials, and this effect correlated with conservative response bias, suggesting that it reflected weak awareness rather than unconscious

processing. The results suggest that the enhanced N200 correlates with graded awareness. The results support theories of visual awareness in which early activity in the visual cortex gives rise for the first subjective visual experiences.

[2P2M043] The early bird doesn't get the ANT

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According to Posner and Peterson (1990), neural systems of attention can be divided into three networks. These networks execute such functions as alerting, orienting, and executive control. In 2002 The Attentional Network Test (ANT) was developed by Fan et. al. as a tool for testing not only all three systems simultaneously, but interactions between them. Callejas and associates (2004) added an auditory trigger for alerting to further improve the ANT. We present data on the Callejas ANT test while participants gaze was monitored in order to gather information on how eye movements may or may not affect reaction times for each mode of attention. Participants were instructed to remain fixated at centre throughout the experiment, but no feedback was given if they moved their eyes during a trial. Overall RTs were faster in congruent trials versus incongruent and in cued versus uncued. Initial results showed that there was no significant difference in RT between trials with and without alerting sound, which does not replicate previous findings (Callejas et. al., 2004) A significant interaction was found between congruency and cueing with larger spatial cuing in incongruent trials (50 ms) than in congruent trials (13 ms).

[2P2M045] Influence of alpha frequency photic driving on visual detection thresholds

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Recent studies demonstrate that alpha frequency photic driving modulates visual detection thresholds for subsequent target stimuli compared with baseline conditions (Mathewson et al., 2009, 2012: Spaak et al., 2014). However, apparently opposing results regarding the effects of varying the ISI between the onset of the final entrainer and the target have been reported. Mathewson et al. (2012) found peak sensitivity for a target onset in-phase with the entrainer (e.g. occurring when an entrainer would have appeared) and minimum sensitivity at time points that would lie mid-way between entertainers. In contrast, Spaak et al., (2014) report peak sensitivity when the target and entrainer were out-of-phase and minimum sensitivity at in-phase time points. Using a novel variant of Mathewson' paradigm we tested whether this was due to entrainment at mask (Mathewson) rather than target (Spaak) locations. Eleven participants judged whether a black target dot (1 degree) on a grey background appeared before a black annulus mask (80% target present).Prior to the target either the annulus or target area was flickered in white (12 Hz). The results showed peak sensitivity in-phase with both entrainers: the mask in one condition and the target in the second; a pattern that is unreported in previous research.

[2P2M047] Full windscreen Head-up Displays; the effects of dual-task processing and image contrast

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Vehicle Head-Up Displays display information on the windscreen for use whilst driving. In the near future, these displays could cover the entire windscreen. This study asked whether discriminating visual stimuli in the periphery impaired performance on a central continuous tracking task. Participants performed a continuous motion tracking task in central vision whilst also performing a Landolt C detection and orientation discrimination task. The Landolt C targets were presented at four different contrasts in various positions in the periphery, 10° and 20° above, and 60° either side of the participant. In the motion tracking task participants attempted to keep a moving target inside a moveable box (similar to a lane-keeping task in driving). The difficulty of the tracking task was manipulated by varying the size of the box. Participants made more errors in the tracking task when the peripheral task was at low contrast, but eccentricity of the Landolt C did not affect number of errors made. Performance in the Landolt C task was better when the tracking task was harder. Low contrast peripheral targets may reduce attention available to a central task. Allocation of attention to the periphery may depend on the difficultly of a central task.
Jaguar Land Rover and EPSRC

[2P2M049] The effect of attention on the motion aftereffect

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Studies have shown that the motion aftereffect (MAE) is modulated by attention (e.g. Chaudhuri, 1990; Rees, Frith & Lavie, 1997; Taya, Adams, Graf & Lavie, 2009). When a moving stimulus is presented in the periphery the resultant MAE is reduced if, during adaptation, attention is diverted to a centrally presented stimulus. However, recent studies have failed to replicate this effect, attributing previous findings to response bias (Morgan, 2011, 2012, 2013). We explore whether differences in adaptation duration, within or across trials, might account for these apparent inconsistencies.
Observers fixated a stream of letters. A surrounding annulus contained a random dot motion stimulus. Participants detected either speed changes in the adaptation stimulus (attention-focused), or white vowels within the letter stream (attention-diverted). Adaptation duration was manipulated by (i) varying the duration of single adaptation periods, or (ii) allowing adaptation to build up over multiple, short adaptation periods. MAEs were quantified by the reported motion direction of a test stimulus, whose true motion direction was orthogonal to the adapting motion. Observers' MAEs were larger in the attention-focussed than the attention-diverted conditions. However, this effect was more apparent following short adaptation periods. Previous failures to find attentional effects may be due to MAE saturation.

[2P2M051] Unconscious semantic processing under continuous flash suppression

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It remains hotly debated whether semantic information can be processed under continuous flash suppression (CFS), and one factor that affects previous results is the stimuli used. We adopted a priming paradigm and manipulated three types of primes (pictures, Chinese two-character words, and English words). The prime was shown in one eye and made invisible by continuously flashed masks presented in the other eye. Participants were instructed to classify whether a subsequently presented target picture was a living thing or non-living thing. The prime-target relationship was either congruent or incongruent in terms of the living or non-living categories. A visibility test at the end of each trial was conducted to ensure that all the trials included in the analysis contained only invisible primes. Results revealed an interaction of prime types and congruency: only Chinese words showed a robust priming effect (i.e., RTs were shorter for congruent trials than for incongruent ones). The null results for prime pictures may have been caused by the cancellation of positive and negative effects. We conclude that there indeed exists unconscious semantic processing under CFS, and the time course of semantic processing of different stimuli may account for the results we observed here.
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[2P2M053] Local and global limitations in visual search

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There are different opinions about the roles of local interactions and central processing capacity in visual search. This study attempts to clarify the problem using a new version of relevant set cueing. A central pre-cue indicates two symmetrical segments (that may contain a target object) within a circular array of objects presented briefly around the fixation point. The number of objects in the relevant segments, and density of objects in the array were varied independently. Three types of search experiments were run: (1) search for a simple visual feature (color, size, and orientation), (2) conjunctions of simple features, and (3) spatial configuration of simple features (rotated Ts). For spatial configuration stimuli, the results were consistent with a fixed global processing capacity and standard crowding zones. For simple features and their conjunctions, the results were different, dependent on the features involved. While color search exhibits virtually no capacity limits or crowding, search for an orientation target was limited by both. Results for conjunctions of features can be largely explained by the results from the respective features. This study shows that visual search is limited by both local interference and global capacity, and the limitations are different for different visual features.
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[2P2M055] The dead zone of attention has no link to eye movements

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The dead zone of attention (DZA) refers to an exaggerated failure of noticing changes in close proximity to a focus of interest of a visual scene [Utochkin, 2011, Visual Cognition, 19, 1063–1088]. In our study, we tested if the DZA pattern is reproduced in gaze behavior. We ran two change blindness experiments with eye-tracking using DZA-inducing scenes. In Experiment 1, observers looked for one change that could be central, near or far from the focal point, in Experiment 2, they looked for either near, or far changes in the presence of a once noticed central one. Behavioral data replicated the DZA pattern from earlier experiments. However, there was no DZA signature in eye movements. The average fixation hit rate was about the same for all three change types. Moreover, measuring the mean fixation distance to each change, the shortest mean distances were around central changes, the longest were around far changes and intermediate distances around near changes. Eye movements show a gradient pattern around the focus of interest rather than a "Mexican hat" one predicted by DZA. In general, our results suggest that there is some dissociation between eye movements and the distribution of attention around the center of interest.
Programme for Basic Research at National Research University Higher School of Economics

[2P2M057] Testing several hypotheses for dissociate colour perception on #TheDress

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Dissent on perceived colour and colour combinations can often be found in everyday life, particularly with regard to fashion. In the case of the low-quality photograph of an actually blue-black lace dress posted on the internet, this dissent became a viral phenomenon fascinating people around the globe: While some perceived what is now known as #TheDress as being blue-black, others saw it as white-gold, and others again can switch between both impressions. Soon, a huge debate on the underlying reasons developed and various hypotheses were put forth in the media, some of which we tested in a series of experiments. Our results show that about 50% of the people interpret #TheDress as blue-black, the others as white-gold, while both groups show high internal consistencies across different presentation conditions. We further revealed that blue-black perceivers show a slightly higher sensitivity for blue and are stronger affected by visual cues for shades and the source of illumination. This was indicated by strong effects of scrambling the depiction. Changing the background colourisation/light scene was further related to small modulations of the effect, which indicates that anchoring might play its role as well. In sum, #TheDress nicely demonstrates the cognitive nature of (colour) perception.

[2P2M059] A systematic investigation of colour and concept associations

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There has been considerable interest in understanding the capacity of colour to shape our functioning and behaviour (Elliot & Maier, 2014). For example, performance on intelligence tests is found to be poorer after exposure to the colour red, compared to green (Elliot et al., 2007). One possibility is that such effects arise through colour-concept associations (i.e., red – failure). Furthermore, the symbolism of a colour may vary across cultures. However, this has not been systematically investigated. The present investigation explores the range of abstract colour associations that English and Chinese speaking adults have, using hues from the World Colour Survey (WCS: Berlin & Kay, 1969, 1991). In a series of two experiments, we explored: the associations that people have with each of the 11 Basic Colour Terms (black, white, red, yellow, green, blue, brown, purple, pink, orange, grey; Experiment 1); and which specific physical colours are associated with the concepts generated in Experiment 1 (Experiment 2). The findings have implications for better understanding effects of colour on behaviour and enable us to make and systematically test predictions about the direction of colour-behaviour effects across colour space.
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[2P2M061] If That Dress isn't really blue and black, then does it even exist?

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Colour has variously been defined as (a) a real property of objects in the physical world, or a disposition to create certain spectral patterns of light; (b) a subjective experience, or category of experiences, with arbitrary quality; or (c) an emergent property of the interactions between the external world and the body or mind. But (b) and (c) can lead to paradoxes. Berkeley famously argued that 'secondary' qualities (e.g. colour, taste) do not differ metaphysically from 'primary' qualities (e.g. size, shape, hardness). Therefore if colour is not a real, mind-independent property then neither are size, shape, etc. Moreover since colour did not exist before there was consciousness then neither did size – nor rocks, the sun, or any object with primary qualities. Here, primary quality realism is defended by demonstrating Berkeley's reasoning was invalid. For example Berkeley believed only minds have causal powers; therefore external objects cannot cause sensory experiences; therefore belief in external objects (the bearers of primary qualities) is "a contradiction". But Berkeley's argument includes his idealist axiom about the monopoly of mental causation as one of its premises, which we can reject. Thus the metaphysical status of one dimension of experience does not necessarily generalize to others.

[2P2M063] Colour perception and cognition in adults with autism spectrum disorders

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Autism Spectrum Disorders (ASD) are associated with atypical visuo-cognitive processing. Weak central coherence (Happé & Frith, 2006) – the tendency for individuals with autism to employ locally-oriented cognition, with a reduced ability to extract global meaning – may help explain perceptual-cognitive differences in ASD. We present two experiments investigating colour perception and cognition in individuals with and without ASD. In Experiment 1, adults with ASD ($n = 16$) performed just as well as typical adults ($n = 16$) at averaging the colour of a rapidly-presented, colourful ensemble, despite this task requiring distributed attention to the holistic characteristics of the ensemble. However, the ASD group outperformed the typical group when evaluating whether a single colour was part of the ensemble – a task requiring more local attention. In Experiment 2, unexpectedly, there were no group differences in whole-scene colour afterimages ("Spanish Castle Illusion", Sadowski, 2006). For both groups (total $n = 22$), afterimages were stronger for scenes with diagnostic colour (natural scenes) than without diagnostic colour (man-made objects) for both up-right and upside-down images. Together, these findings suggest that the abilities to extract summary statistics from scenes and apply prior knowledge to current percepts is not disrupted in autism, contrary to prominent theoretical accounts.

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[2P2M065] Colour discrimination thresholds for calibrated skin images

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The aim of this study was to estimate discrimination thresholds for calibrated skin images in 3-D colour space. The stimuli were generated by adding test vectors to the original polychromatic image in CIELAB space. Thresholds along 14 directions were estimated using a 4-AFC task and the lengths of the test vectors were controlled by the QUEST adaptive procedure. Ellipsoids were fitted to the estimated thresholds in u'v'Y space. 16 subjects (11 female, 5 male; 15 Caucasian, 1 Oriental; Mean age 24.75) were tested in an anechoic chamber under three illumination conditions – dark, daylight (D65) and cool white fluorescent (TL84). Two skin-patch images were used – Caucasian and Oriental. A subset of these observers was also tested using uniform patches with the same average CIELAB luminance as the images. The stimuli were displayed using the CRS ViSaGe system on a calibrated EIZO ColorEdge CG243W monitor. Our two main findings were: 1. On average, thresholds are lower for Caucasian skin patches as compared to Oriental skin patches. 2. The thresholds in all directions are smaller for uniform patches compared to polychromatic skin patches.

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[2P2M067] Thresholds for colour constancy measured via illumination discrimination depend on adaptation point

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Perfect colour constancy entails no change in surface appearance under changing illumination; therefore the ability to discriminate an illumination change on a fixed scene may provide a probe for measuring constancy. Previously, we found thresholds for global illumination discrimination higher for 'bluer' illuminations compared to 'yellower', 'redder' or 'greener' illuminations, at neutral adaptation (D67), indicating better colour constancy for 'bluer' illuminations (Pearce et al., 2014). Here we examine whether this asymmetry in constancy thresholds depends on the adaptation point. Participants performed the illumination discrimination task in an immersive setting, viewing a 3D Mondrian-papered scene illuminated by spectrally tuneable 10-primary LED lamps. Five adaptation conditions were tested in separate blocks, corresponding to five target lights (neutral, 'red', 'green', and extreme 'blue' and 'yellow' daylights). On each trial, after viewing the target light, participants indicated which of two successive lights (the target and a comparison) matched it; comparison lights ('bluer', 'greener', 'redder', 'yellower') varied systematically away from each adaptation point. Thresholds were determined using a transformed, weighted, 1-up, 3-down staircase procedure. The results reveal an interaction between the direction of illumination change and adaptation point, yet on average, the asymmetry in thresholds prevails across conditions, confirming the blue bias in constancy.
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[2P2M069] Colour discrimination, coloured backgrounds and global and local shape perception

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Background: Associations between global- and local-shape perception and colour discrimination were investigated. The shape tasks were completed on different background colours, although background colour was irrelevant to either task. Little research has been conducted in this area and none has used colours tailored to the cone-opponent pathways early in the visual system. Method: Participants were presented briefly with one of four shapes on different trials: a global square made up of small square (congruent) or diamond (incongruent) local elements, or a global diamond made up of small diamond (congruent) or square (incongruent) local elements. Each display was presented on five coloured backgrounds (tritan/S-cone: purple, neutral, yellow; L(M)-cone: red, neutral, green). Luminance and contrast were equated across conditions. Participants also completed the Farnsworth-Munsell 100-hue test. Results: Participants were more accurate at the global task than local and responded more quickly for congruent than incongruent trials, as expected. There were no significant differences between performance on any of the coloured

backgrounds for either accuracy or reaction times. There were, however, significant correlations between colour discrimination as assessed by Farnsworth-Munsell scores and some of the shape perception tasks. Participants with poorer colour discrimination were less accurate despite colour being irrelevant to the tasks.
None

[2P2M071] Skin colour appearance as a function of ethnicity

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Skin colour measurements were obtained for 539 subjects at four different body locations (forehead, cheek, inner arm, back of hand) in four countries with a view of establishing a new skin colour database for different ethnicities (Caucasians, Chinese, Kurdish, Thai). Skin colour means, variation and skin colour boundaries were calculated. We report three main results. (1) When plotted in a standard colour appearance space (CIE LAB), there is a large overlap between the skin distributions and boundaries for all four ethnicities. (2) The largest variability and gamut in skin tones was found in the Caucasian group, the smallest one in the Chinese group. (3) The largest ethnicity differences were found in yellowness (b*) with the Thai group showing the largest and the caucausian group the smallest b* values. Vice versa, the caucausian group is the group with the largest lightness values and differs significantly from all other groups. The ethnic differences along the redness dimension (a*) are small and less systematic. Consequences for visual processing of skin colour will be discussed.
This project was partially supported by the EPSRC grant EP/K040057/1

[2P2M073] The effect of coloured enviroment on the perception of different objects

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It has been demonstrated that exposure to a particular colour may affect physiological values (heart rate, blood pressure). Results are nevertheless controversial, being related to coloured lights and with a general agreement only on the relaxing effect of blue compared to red. A more ecological approach would consider the interaction between different shapes and colours. We presented 24 participants with three different objects (sphere, cube, mask) suspended inside a rectangular dome and viewed separately in each condition of coloured illumination (blue, red, or white light). If blue has a relaxing effect, it is interesting to evaluate its strength in association with different objects. Participants were asked to rate each object for each condition of illumination using 10 bipolar adjectives on 7 points Semantic Differential (SMD) Likert scales. Heart rate variability (HRV) and Skin Conductance Response (SCR) were recorded for each participant in each condition. SMD data reveal different attitudes towards both different colours and different objects. SCR data reveal an effect of object shape on physiological activation regardless of lighting colour. In sum, the effect of object shape is stronger than that of colour, suggesting at least some caution before generalizing the effect of colour on relaxing/activating states.

[2P2M075] Colour Matching functions in women heterozygous for anomalous trichromacy

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Female carriers of anomalous trichromacy are known to express four, rather than three, types of retinal cone photopigment, but evidence for behavioural tetrachromacy is limited (Jordan et al., 2010). Colour matching functions are the definitive way of specifying a colour vision phenotype. We set out to measure such functions between 550 and 700 nm in candidate tetrachromats and in control participants. Primary lights (550 nm, 610 nm, 690 nm) were chosen by modelling the tetrachromatic dimension in an analogue of the MacLeod-Boynton colour space. In this space the spectrum locus between 550 and 690 nm is convex with 610 nm at the apex, but forms a straight line for trichromats. On each trial, two stimuli, each subtending 2 deg, were presented in succession. One field contained a mixture of two of the primaries and the other contained a mixture of the test wavelength and the remaining primary. For test wavelengths $<$610 nm, the test was combined with 690 nm, and for test wavelengths $>$610 nm, it was combined with 550 nm. Subjects adjusted the luminance ratios of two fields so as to achieve a colour match. In preliminary settings, subjects equated the sensation luminances of all primaries, and of the test, according to a minimum flicker criterion.
Lerverhulme Trust No RPG-428

[2P2M077] Variation of subjective white-points along the daylight axis and the colour of the dress

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We review the evidence, from different data sets collected under different viewing conditions, illumination sources, and measurement protocols, for intra- and inter-observer variability in "generic subjective white-point" settings along the daylight locus. By "generic subjective white-point" we mean the subjective white-point independent of the specific context. We examine the evidence for a "blue" bias in subjective white-points (i.e. increased variability or reduced sensitivity in the "bluish" direction) by comparing the extent of variability along the daylight-locus generally and specifically in the "bluish" direction across all data sets. The variability in subjective white-point may correspond to subjective priors on illumination chromaticity. In turn, individual differences in assumptions about the specific illumination chromaticity on "the dress" (the recent internet phenomenon) is widely thought to explain the individual differences in reported dress colours. We therefore compare the variability in generic white-point settings collated across these datasets with the variability in white-point settings made in the specific context of the dress (Witzel and O'Regan, ECVP 2015). Our preliminary analysis suggests that (1) there is an overall "blue" bias in generic subjective white-point settings and (2) the variability in generic subjective white-point settings is insufficient to explain the variability in reported dress colours.
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[2P2M079] The Dichopter

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A wide range of dichoptic visual phenomena can be displayed and controlled using a smart phone. As part of "Project LITE: Light Inquiry Through Experiments", we developed a suite of about 50 apps (found at http://lite5.bu.edu/v4.1/) that include: binocular rivalry; dichoptic red and green color mixing to produce "cortical yellow"; three dimensional Kanizsa square; controllable texture random dot stereograms; and a variety of stereoscopic images I have now developed a new binocular viewer that can conveniently assist people (who cannot "free view") in seeing and using the displayed image pairs. The "Dichopter" was designed using rapid prototyping software and 3D printing for several of its parts. It consists of a pair of lenses with 10 cm focal length; a newly designed bracket (which obviates the need for a septum) that holds both the lenses and the phone mount; a spring loaded mount that can accommodate a wide range of cell phones or other image display devices; and a screw mount to allow the device to be either handheld or supported by a standard tripod. The Dichopter is intended for the educational display of visual perception phenomena, and for clinical uses, either as a diagnostic or as a training tool.

[2P2M081] Influences of display contrast on contextual cueing

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The contextual cueing effect shows that invariant visual contexts can guide deployment of attention and facilitate visual search (Chun, 2000). Previous studies only focused on normal contrast search displays. However, it is still not clear whether the contextual cueing effect also occurs for low contrast displays. Therefore, the present study used the standard contextual paradigm to investigate this issue. In contrast to the fixed display contrast used in the standard paradigm, here the item-background luminance contrast was set to high level in training and to low level in the transfer session in Experiment 1. Luminance settings were reversed in Experiment 2. All participants attended both experiments with at least two weeks break in between, and the experimental order of their participation was counterbalanced. During the training session, participants were significantly faster in responding to repeated displays than non-repeated displays in Experiment 1 (i.e. contextual cueing effect) but no differences were found between repeated and non-repeated displays in Experiment 2. Interestingly, no contextual facilitation was observed in the transfer session of either experiment, suggesting low display contrast impedes both contextual learning and retrieval. We discuss the findings in relation to the perceptual overload and task difficulty.

[2P2M083] Rhythmic modulation of human visual sensitivity depends on luminance

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After making an action, visual sensitivity modulates rhythmically, within the theta range of frequencies. At low luminances, the frequency of endogenous brain-rhythms increases, reflecting increased alpha power. On the other hand, visual processing slows at low luminances (Pulfrich effect). We measured oscillatory perceptual effects at high and low luminances to test whether their frequency is governed by sensory mechanisms or endogenous brain rhythms. In separate sessions at photopic (38 cd/m2) and mesopic/scotopic (1 cd/m2) luminances, gabor-patches were briefly displayed to subjects after a random delay after a self-initiated button-press: they reported in 2AFC whether the contrast increment was in upper or lower half. In a third control condition, the stimulus was delivered by the computer at random intervals. The results revealed significant theta-oscillations in both button-initiated conditions, but none in the control condition. Importantly, the oscillations at low luminance were significantly higher in frequency, 5.0 Hz compared with 4.5 Hz ($p < 0.05$). However, at low-luminance the phase led by about 15 ms ahead of that at high-luminance. These results show that while low luminance retards visual processing, causing a phase-lead, the frequency of visual oscillations seems to be determined by endogenous brain rhythms, which increase at lower luminance.
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[2P2M085] The perception of shadows and the apparent brightness in the space

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We see shadows everywhere; however, it is not understood how shadows affect our perception of brightness in a space. To investigate this, we used multidimensional scaling to analyze the dissimilarity structure produced by different intensities of illuminance and shadows. Four miniature rooms were set up, each containing a parallelepiped object covered by black felt with an accompanying shadow. Each array was illuminated independently with one of three lighting intensities. Additionally, each shadow was projected by a ceiling digital projector with one of four intensities. Six observers evaluated the apparent brightness of the space in Experiment 1 and the intensity of the shadows in Experiment 2 by ranking. In Experiment 1, the apparent brightness of the space was proportional to the intensity of illuminance and the shades of the shadow. In Experiment 2, the perceived intensity of the shadow was proportional to the intensity of illuminance and the luminance contrast of the shadow and its background, but not to the intensity of the shadow itself. These findings show that shadows affect the perception of brightness in a space.
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[2P2M087] The Effect of Context-dependent Brightness on Contrast Perception

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Contrast is an important feature for visual performance on many tasks such as object identification, speed or motion detection (Kilpeläinen, Nurminen, & Donner, 2011). Perceived contrast of a grating depends on the luminance of its background. On the other hand, context often causes a large difference between luminance and its perceived correspondence, brightness (e.g. simultaneous brightness contrast). Thus, characterizing different effects of luminance- and context-dependent brightness on contrast is critical. In this study we investigate how context-dependent brightness affects contrast judgements using a variant of Adelson's checkerboard illusion stimulus (Adelson, 1995). Two series of behavioral experiments were conducted using different psychophysical procedures. First, brightness of equiluminant target regions on the illusory stimulus was measured. Significant differences were observed in participants' brightness judgements ($N = 8$). Second, we superimposed rectified gratings with incremental and decremental contrast on the target regions, and measured their perceived contrast for various levels of frequency, luminance and contrast. Results show that context-dependent brightness of the target region, not only its luminance, influences the perceived contrast of incremental gratings ($N = 6$). This finding indicates that perceived contrast depends on background brightness, as well as luminance. In addition, results of both experimental series showed that, experimental procedures significantly affected the measurements.

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[2P2M089] Brightness perception for a room with a scenic view through the window

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Although the use of daylight is one strategy for reducing lighting energy, the effect of daylight on space brightness perception is unclear. In the few studies that have examined the effects of daylight, the brightness produced by daylight is not as efficiently enhanced as expected by horizontal illuminance. Moreover, those studies did not consider a scenic view through a window. In the present study, we further investigated the effects of daylight on space brightness by manipulating scenic views outside a window. In the experiment, we used two scale models simulating an office: one was a room with a window (test room) and the other was a room without a window (reference room). There were two types of scenic views (natural or urban landscape) with or without a human-shaped board covered with a full-length photograph of an adult male. In each trial, participants viewed the two models and rated the space brightness of the test room relative to that of the reference room. The results clearly showed that the efficiency of brightness

enhancement provided by daylight was lower with a scenic view than without a scenic view, and the pattern of results did not change with the human-shaped board.

[2P2M091] Degradation of display image due to glare of ambient light evaluated by visibility matching and degradation category rating

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Glare of ambient light degrades the visibility of a display. Optical properties such as reflectance and haze factor are commonly used to evaluate the quality of any anti-glare treatment on the display surface. In practical situations, however, these properties often disagree with actual appearance. In this study, using a visibility matching technique and degradation category rating (DCR), we evaluated the quality of display images on which a glare reflection image was superimposed. In the matching experiment observers adjusted the luminance and contrast in an original display image to replicate the visibility of the degraded image. In DCR experiment observers evaluated the quality of image by seven rating categories. The display image with glare was simulated by superimposing a reflection image on a display image. The results showed that all observers set higher luminance and lower contrast to replicate the visibility of the images degraded by the reflection of images with higher luminance. However, the observers' settings were lower in luminance and contrast than those calculated from superimposed images. This indicates that observers might segregate the appearance of the original display image perceptually from the reflection image. In DCR, the observer's ratings monotonically declined as the image contrast decreased.

[2P2M093] Estimating inter-observer variability in GABA-ergic suppression

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Individual differences in response to visual contrast are typically observed in the amount of (i) saturation of responses at high contrast levels and (ii) suppression by cross-channel masking. A potential mechanism that underlies these processes is GABA-ergic inhibition, as GABA antagonists eliminate both effects in single neurons (e.g. Morrone, Burr & Speed, 1987). However, these two properties of contrast transduction have not been directly compared within the human population. We measured steady-state EEG responses to patches of sine-wave grating s (0.5 c/deg) flickering at 7 Hz in 100 subjects at seven contrast levels (0–64%). In some conditions a high contrast (32%) orthogonal mask flickering at 5 Hz was superimposed on the target stimuli. We calculated a saturation index, defined as the ratio of amplitudes at the two highest target contrast levels. To quantify masking, we took the ratio of amplitudes when the mask was present versus absent, averaged across intermediate contrast levels. We found a highly significant correlation between

masking and saturation across observers ($r = 0.50$, $p < .001$), such that individuals who exhibited substantial masking also displayed strong saturation. This suggests a common underlying mechanism, most likely GABA-ergic inhibition, that varies widely in the population and therefore may have clinical relevance.

[2P2M095] Speed and superimposed chromatic gratings

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On the basis of measurements of the perceived coherence of superposed drifting gratings, Krauskopf and Farell (1990) proposed that motion is analysed independently in different chromatic channels. They found that two gratings appeared to slip if each modulated one of the two 'cardinal' colour mechanisms S/(L + M) and L/(L + M). If the gratings were defined along intermediate colour directions, observers reported a plaid, moving coherently. Since achromatic gratings are less likely to cohere if they differ in speed, we hypothesised that slippage might occur in chromatic gratings if the motion signal from the S/(L + M) channel is weak and equivalent to a lower speed. We asked observers to judge coherence in two conditions. In one, S/(L + M) and L/(L + M) gratings were physically the same speed. In the other, the two gratings had perceptually matched speeds. We found that the relative incoherence of cardinal gratings is the same whether gratings are physically or perceptually matched in speed. Our hypothesis was firmly contradicted. In a control condition, participants judged the 'coherence' of stationary gratings. Surprisingly, the difference in judged coherence between cardinal and intermediate gratings remained as strong as it was when the gratings moved. Krauskopf and Farell's result may not arise from motion processes.

[2P2M097] The role of background distortion for material matches of transparent objects

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It has been proposed that the visual system uses background distortions as a cue to estimate the refractive index of thick transparent objects. We have previously argued that it is theoretically implausible that such estimates can be made and that approximately correct refractive index matches that putatively support this claim can alternatively be explained more parsimoniously by assuming direct matches of image attributes. In the present investigation the subjects had to match the material of two transparent objects, but, in contrast to previous studies, we used different background texture densities for standard and test and manipulated the visibility of the undistorted part of the backgrounds. The results suggest that the subjects simply maximized the similarity of the image patterns inside the object boundaries and thus referred to information that is insufficient to estimate the objects' refractive indices. Subjects can also take the undistorted part of the background into account if this is suggested by experimental layout or instruction, but they do this in a rather simplistic way that also seems inappropriate to estimate refractive indices of transparent objects. These results provide additional evidence against the assumption that the visual system estimates the refractive index of transparent objects from background distortions.

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[2P2M099] Background texture size statistics modulates perceived target size nonlinearly

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We investigated how the mean and variance of the background element size distribution affect the perceived size of a target. The target was a disk (diameter 240 arcmin) on a frontoparallel plane. The background texture consisted of 5000 randomly distributed disks whose diameter was drawn from distributions with various mean (60 to 600 arcmin) and standard deviation (0 to 0.27 fold of the mean). We used a two-interval forced-choice paradigm to measure the perceived target size at various background textures. In each trial, the target with a background was presented in one interval while a reference disk on a blank in the other interval. The observers' task was to determine which interval contained a larger disk. We measured the point of subjective equality (PSE) for the perceived target size with a staircase procedure. Regardless of the variance, the perceived target size decreased with mean background disk size until it reached 360 arcmin. After that the perceived target size changed little with further increase of mean background disk size. Our result shows that only the first order statistics, but not the second order statistics of the background can modulate the perceived target size and this modulation is nonlinear in nature.
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[2P2M101] Interactions in the Perceptions of Light Absorption and Scattering

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Absorption and scattering are the two most fundamental processes through which light is modified by a material, giving rise to all visual surface properties. While each is associated with a perceptual quality (colour and texture, respectively), both have been shown to affect judgements of surface properties in opaque objects. Our objective was to determine whether these fundamental processes produce separable perceptual qualities in translucent liquids, or whether they interact – and if they interact, the nature of this interaction. Perceptual scaling and conjoint measurement techniques (Ho, Landy & Maloney, 2008) were used with physically realistic rendered stimuli, and models of best fit determined. The model that allowed for complex interaction was the best fit for both qualities, showing that our perceptions of light absorption and scattering cannot be easily separated. The between-participant variation for judgements of scatter implied that observers may rely on slightly different cues in the visual scene. We will discuss the relationship between these results and simulated results obtained using low-level image statistics. An additional experiment was carried out using photographs of real stimuli. The models of best fit for real and artificial stimuli differ slightly, suggesting greater separability in the case of physically realisable manipulations.

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[2P2M103] Glossy surfaces enable perceptual separation of gradual changes in lighting and reflectance

Rob Lee and Hannah Smithson
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Changes in the surface reflectance of an object and changes in the spectral content of the illumination both change the spectral composition of light reaching our eyes, but usually we do not have difficulty determining which change occurred. We investigated how specular reflections might allow an observer to distinguish changes in lighting and reflectance in scenes containing only one surface. Specular reflections make a surface look glossy and contain reflected light that has not been spectrally modified by the surface, so could provide information about the illuminant. Additionally, there are spatio-chromatic changes that differ systematically for changes in lighting and reflectance, and we investigate how observers extract information that is not available at any given instant. We presented hyperspectrally raytraced movies showing isolated objects undergoing gradual illuminant and reflectance changes. Observers were able to distinguish the two types of change at very low specularities ($\sim$1%). Performance was reduced, but not extinguished, when we distorted the images to weaken some of the spatial or chromatic relationships. The highlights on low-gloss surfaces are heavily contaminated by surface colour so they do not allow direct estimation of the illuminant. Yet the chromatic transitions under gradual changes in lighting and reflectance are perceptually discriminable.
Welcome Trust Grant WT094595AIA (to Hannah E. Smithson)

[2P2M105] Predicting Fractal Model Parameters in Accordance with Perceptual Descriptions

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The 1/fβ fractal model can be used to generate textures resembling natural surfaces by varying its parameters (high cut-off frequency and β). However, it is difficult to choose proper parameter values so that the model can produce textures described using perceptual features, e.g. roughness and directionality. This work focuses on automatically finding such parameter values. We generated 16000 textures by sampling in the parameter space at a linear scale. Twelve perceptual features for each texture were predicted by using the PCANet classification model, which were initially trained based on samples with subjective ratings (Liu & Dong, 2013). The sparse autoencoder was then used to construct a mapping between the twelve scales and the two parameters. It consisted of one input layer with 12 neurons, one hidden layer with 200 neurons and one output layer with 2 neurons. The autoencoder was learned by optimizing a cost function defined as the mean square error between the predicted and real parameters. We randomly chose 14000 textures for training and the remaining 2000 for testing. The result showed that our

method can accurately predict parameter values, and with these values the model can produce texture in accordance with perceptual description.
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[2P2M107] Looking through the camoufleur's eye: what makes a camouflage pattern Woodland?

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Of the hundreds of camouflage uniform patterns only a handful were given official names (e.g. the US Army's M81 Woodland), therefore camouflage collectors have introduced their own terms of classification. Based on visual similarity, patterns are grouped into 'families', such as 'Lizard' or 'Splinter'. While there is considerable consensus on the group identity of most patterns, classificatory features of groups are often loosely defined and with circular arguments arising from prior historical knowledge. While previous attempts to classify features of human textiles were based on manual selection of reoccurring shapes and structures by researchers (e.g. Tehrani & Collard, 2009), camouflage patterns are composed of abstract, hardly interpretable elements. Here we present a computational method describing the most exclusive features of groups and simulating the assortment process of camouflage experts. The method is composed of applying a log-Gabor filter bank to each colour segment of a pattern, followed by nonlinear dimensionality reduction (Tenenbaum et al., 2000) of the sum of filter responses. After applying a Gaussian mixture model to the low-dimension data, similar segments are grouped together and posterior probabilities of each cluster can be interpreted as the prevalence of a particular feature in the pattern.

[2P2M109] Fixation-Aligned Pupillary Response Averaging: How many Targets can you "C"?

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Fixation-aligned pupillary response averaging uses gaze data to identify events of interest which occur at unpredictable times during a task, such as the detection of a target during visual search. Proof of principle for this technique was given by Klingner (2010) though its validity remains questionable due to the lack of statistical comparisons between subjects, the use of a remote eye tracker and the lack of consideration for the gaze-dependent measurement error (GDME) in video-based eye trackers. Using a tower-mounted eye tracker and a routine described by Brisson et al. (2010) to correct the GDME, we tested the ability of fixation-aligned pupillometry to resolve the transient pupil dilations that are known to accompany target detection during visual search. Participants searched for target "C"s among heterogeneously oriented distractors and reported

the number of targets present at the end of each search (0, 1, 2 or 3). Interest areas assisted the identification and matching of target and control fixations and the extraction of the subsequent 3000 ms pupil time course. Preliminary analysis has revealed that target fixations consistently elicit a pupil dilation that peaks around 800 ms after fixation onset and withstands correction for the gaze-dependent measurement error.

[2P2M111] Impulsivity and the Generation of Express Saccades

Felicity Wolohan and Paul Knox
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Express saccade makers (ESMs) produce high proportions (>30%) of low latency (80–130 ms) express saccades (ES) in prosaccade overlap tasks; a behaviour that is stable over time (Knox & Wolohan, in press). ESMs also produce higher proportions of errors on the antisaccade task, compared to non-ESMs (Knox et al., 2012); although this is not due to a deficit in oculomotor inhibitory control (Wolohan & Knox, 2014). The relationship between this saccade behaviour in ESMs and personality traits is unknown. We investigated self-reported impulsivity and the occurrence of ES. Healthy participants ($N = 138$) classified as ESMs ($n = 43$) or non-ESMs ($n = 95$) based upon their performance on prosaccade overlap tasks, completed the UPPS questionnaire (Whiteside & Lynam, 2001) which distinguishes five independent dimensions of impulsivity. These dimensions as predictors of ES% were explored using a linear regression analysis. This model indicated no relationship between ES% and any of the dimensions ($R2 = 0.03, F(5,137) = 0.79, p = 0.56$; all dimensions $p > 0.05$). Thus while associations between other aspects of oculomotor behaviour and impulsivity have been observed (Cirilli et al., 2011), and relationships between inhibitory control and impulsivity have been suggested (Roberts et al., 2012), we find no evidence to link impulsivity with the high levels of ES production in ESMs.
The Leverhulme Trust

[2P2M113] The role of ocular proprioception in prism adaptation

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Reaching toward a visual target displaced by laterally refracting prisms results in adaptation of limb and ocular proprioception, which individually and additively lead to prism adaptation (PA). The recalibration of oculomotor corollary discharge signals, from which orbito-ocular straight-ahead is derived, displaces perception of visual straight-ahead. The contribution of ocular proprioception to PA has not yet been directly measured. This research will be the first to utilise eye-tracking technology to measure eye position before, during, and after PA, and to compare those measures with a condition where eye muscle potentiation occurs in the absence of visual error feedback. Additionally, it will be the first study to correlate ocular proprioceptive changes with traditional PA after-effect measures of straight-ahead pointing (limb proprioception), open-loop pointing, and dual-limb passive proprioceptive pointing in both conditions. We found that visual adaptation does not occur in patients with lesions of intraparietal cortex. We therefore hypothesise that calibration of ocular proprioception with oculomotor corollary discharge in this brain region is

used in computing visual straight ahead. With this novel work, we aim to better understand the role of ocular proprioception in the rehabilitative application of PA.

[2P2M115] Inflight Correction of Saccadic Eye Movements – no time for cortex

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Inflight correction of saccades remains a topic of debate, as saccades are too short for peri-saccadic visual signals to be processed and to subsequently manipulate saccade path. To test this, we measured saccades to targets randomly stepping or not after saccade onset, and compared the trajectories. 10 subjects' eye movements were recorded (Eyelink2000, 1000 Hz). After central fixation (1.5 sec), a saccade target (135 deg, distance 8.9 deg from fixation) appeared. Saccade onset triggered target displacement (0.7 deg leftwards). Sample-by-sample Step/NoStep-trajectory distances were calculated by randomly pairing trials (bootstrapped) within each session (min. 150 trials). Using t-tests we estimated when trial types started to differ. Saccade trajectories significantly differed between step and no step trials, with step-saccades landing closer to stepped targets. Trajectory differences arose shortly after the velocity peak at ∼20 msec after saccade onset, with average velocities of ∼400 deg/sec. Step information was not available before saccade onset. As visual signals reach cortex with a latency of ∼50 msec (Schmolesky et al., 1998), our results indicate that subcortical pathways may modulate saccading performance at least to apply small deviations from an initial path, or to switch between two alternate, trained paths. We discuss possible substrates for this effect.

[2P2M117] Motion induced position shift in perception and eye movements

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Kosovicheva et al. (2014) investigated the 'two-stream-hypothesis' with perceptual shifts and saccades made to carrier-drifting, stationary Gabor stimuli. The perceptual test used three, the eye movement test one stimulus. Therefore, magnitudes of the effects cannot be compared directly. We used single stimuli in each case. Each trial started by fixating a central fixation-cross (700 ms), followed by a vertical grating with vertical blurred edges, azimuths of 64°, 57°, 45° or 41°, and eccentricities of 2.95°, 3.71° 5.17° or 5.92°. 500 ms later, fixation-offset triggered saccades to the grating center. After saccade landing, either one dot (MSS) or two dots (2AFC) were shown superimposed on the grating. In the single-dot-task participants reported by key press whether the point had been to the right or left of the perceived center. In the two-dot-task participants reported which of the dots was closer to the perceived center. Both the asymmetry of the dot pair and their separation varied over trials so that a perceptual bias would not be confused with a response or decisional bias. Results showed that both perceived position and saccades were

influenced by direction of motion, but the 2AFC-position shift was smaller than with MSS, indicating that MSS-results contain decisional bias.

[2P2M119] Voluntary saccades in the presence of task-irrelevant eye-gaze conveyed by White and Black individuals

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Humans tend to orient attention in response to gaze direction of conspecifics, a phenomenon which can be shaped by several social variables. Here, two experiments are reported aimed to investigate whether voluntary saccadic eye movements are modulated by centrally-placed task-irrelevant White and Black faces with averted gaze. A symbolic central cue informed White participants to perform a saccade rightwards or leftwards. Saccade direction could be either spatially congruent or incongruent with gaze direction of the facial stimulus. In the first experiment, more directional errors emerged in response to White vs. Black faces, but only when the averted-gaze face and cue onsets were synchronous (i.e., 0 ms) rather than separated by a 900-ms asynchrony. In the second experiment, two temporal intervals (50 ms vs. 1000 ms) occurred between the direct-gaze face and the averted-gaze face onsets, whereas the averted-gaze face and cue onset were synchronous (i.e., 0 ms). Also in this case, a greater interference emerged for White vs. Black faces, and irrespective of the temporal interval. Overall, these findings suggest that saccadic generation system seems to be sensitive to features of facial stimuli conveying eye gaze.
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[2P2M121] The interaction between stimulus properties and saccadic parameters

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For maximum visual acuity we have to fixate an object of interest and keep it on the fovea because visual acuity declines very fast outside the fovea. Eye movements are therefore vital for accurate visual perception since they allow us to maintain gaze on the object of interest. Latency, peak velocity, duration and accuracy are the most studied parameters of eye movements and their characteristics are rather well known. Less is known about how stimulus properties, such as size and saliency, might influence these parameters. We tested saccades to targets of varied size (ranging from 0.2° to 1.4° in seven steps), and saliency (brightness varied from almost white on a white background, to black, also in seven steps). The targets appeared either left or right of central fixation (at 8° eccentricity). Our results show that latencies were shorter towards larger than smaller stimuli, but size did not affect peak velocity. Similarly, latencies became shorter with increased salience, but peak velocities were again unaffected. Our results emphasize the importance of stimulus properties for investigations of saccadic parameters.

[2P2M123] Brain responses to the perception of dyadic gaze interactions: the role of adult attachment

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Eyes and gaze direction play an important role in social and non-verbal communication. This study investigated the time course of brain processes involved in the visual perception of different gaze interactions in woman–child dyads and the association between attachment dimensions and brain activation during the presentation of gaze interactions by using ERP and sLORETA methodology. Electroencephalogram (EEG) data about 44 female subjects (24 ± 2 years old) were recorded using a 256-channel HydroCel Geodesic Sensor Net.
The findings showed a main role of limbic and primary somatosensory brain areas in response to the gaze interaction. Moreover the woman who avoids the infant while the infant looks at her produces an spontaneous and early alert response probably due to the un-responsiveness of the caregiver toward the infant. In response to the convergence gaze, was found a negative association between the confidence attachment dimension and the intensities of the temporal and limbic areas, which seems to be an early spontaneous and emotional response to the intimacy; moreover was found a positive association between the relationships as secondary attachment dimension and the intensities of the frontal and parietal areas, which seems to be a more controlled and defensive response to the intimacy.

[2P2M125] Model of eye movements that predicts errors in routine tasks

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Most of the routine tasks that people perform on a daily basis are processed automatically. For example, a person can detect obvious grammatical errors in the text in her native language without much effort.
Knowing that automated eye movements can serve as predictors for decision making process, we developed a computational model that can identify the stimulus material containing errors based on the subject's fixations. In our experiment, the subjects were asked to check if the presented text contained errors. They provided correct answers in more than 92% of cases, and their average fixation duration was not statistically different in cases with errors and without them. To design the model that predicts the presence of errors in the stimulus material, we relied on the duration and the average value of the fixation and used only the correct answers of the subjects for training the model. After comparing several algorithms, we chose the DecisionTree with learning outcome equal to 79.7% (kappa 0.533) (ZeroR 60.51%). We then tested it on the new dataset and got accurate predictions for errors in the text in 68.6% of the cases.

[2P2M127] The effect of different types of eye movements on optic flow information during walking

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Eye movements play multiple roles – small stabilizing movements keep the scene steady during locomotion, whist relevant parts of the scene attract large directed movements. We investigated the effect of these movements on motion information available. Observers navigated through an office and a woodland environment, wearing a head mounted device that recorded the scene ahead and tracked eye movements, allowing us to determine the gaze direction in the scene. A target was present in the scene for observers to fixate or walked towards naturally. Local motion direction and magnitude was calculated for each frame of the sequences using a biologically plausible motion detection model. By realigning the frames relative to eye fixation location, we could reconstruct the input in retinal coordinates and compare this to the uncorrected input received by the camera. We used a method for calculating the error in heading direction estimation to evaluate the effect of eye movements on the available motion information as a function of time. We assessed whether the eyes were pointing in the direction of heading or scanning the scene. We found eye movements allowed heading information to be extracted accurately, even when large saccades away from the heading direction were made.

[2P2M129] A simulation study of the effects of fixation eye movements on retinal responses

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Micromotions of the eyes while fixating a target are called fixation eye movements. Little is known about effects of fixation eye movements on visual perception. In this study, we performed a simulation experiments using a mathematical model of a wide-scale retinal network considering the receptive fields' properties in parafovea. Vertical sinusoidal grating patterns and random dot patterns, which consist of particular spacial frequencies, were given as input patterns. We computed the retinal ganglion cells responses which were composed of either a high or a low spacial frequency. Simulation results of grating pattern input suggest that microsaccades enhance the membrane potential of ganglion cells for the low-frequency pattern, and as for the high-frequency patten, it is influenced by drifts and tremor, particularly on the responses of M-type cells under both conditions. On the other hand, they do not influence the activity of M- or P-type cells when any random dot pattern inputs was given. These results suggest that the strength of the effects derived by fixation eye movements on the retinal responses depend on the nature of the input patterns.

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[2P2M131] Distinct Scan Modes in Monkey's Free Viewing of Natural Images and Related Neuronal Activities

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Jülich Research Centre and JARA, Germany; Osaka University, Japan; Osaka University, Japan; Osaka University, Japan; Jülich Research Centre and JARA, Germany

Humans employ two distinct visual exploration modes, i.e., local scan and global scan, while they freely view natural scene images. Here we show that these modes are also observed in macaques and affect neuronal activities in the primary visual cortex (V1). We trained a macaque monkey to freely view a set of images constructed by embedding 5 object images (2 deg in diameter) at random positions in natural scene images (40×30 deg2). Eye movements and V1 neuronal activities were concurrently recorded with a scleral search coil and extracellular electrodes, respectively. We found that 70% of the fixations were on the embedded objects. Saccades into an object followed by a saccade to another object (i.e. across-object saccades, representing global scan), or saccades made successively within an object (i.e. within-object saccades, representing local scan) occurred at significantly higher rates than expected by chance (chi-square test, $p < 0.001$). V1 neuronal activities showed stronger responses following fixations after across-object saccades than after within-object saccades, even when both saccades brought the gaze to the same embedded images. These results suggest the existence of distinct scan modes and a top-down modulation of V1 activity affecting the response magnitude depending on the current mode.
Partial funding by German-Japanese Joint Computational Neuroscience Program of BMBF (grant 01GQ1114), Strategic International Research Cooperative Program (Japan-Germany) of JST, Helmholtz Portfolio Supercomputing and Modeling for the Human Brain (SMHB), BrainScaleS (EU Grant 269912), The Naito Foundation Subsidy for Female Researchers after Maternity Leave, JSPS KAKENHI Grant Number 25870405 Grant-in-Aid for Young Scientists (B), Takeda Science Foundation and Osaka University.

Symposium: The ageing visual system in health and disease

[2S1A001] Measurements and Simulations of Aging Visual System

Katsunori Okajima
Yokohama National University, Japan

First, I introduce a smart and mobile system that achieves the measurements of the human spectral sensitivity function in a short period of time, and show the age-related changes. Second, we introduce an experiment where young and aged subjects responded to the appearance of color patches using an elemental color scaling method so as to compare and relate the color appearance as seen by elderly and young people, and a color vision simulator which enables young observers to perceive color appearance as seen by the elderly in real time by using our color conversion method and dynamic image processing techniques. Third, I introduce a contrast discrimination experiment using achromatic Gabor patches (3.24×3.24 degrees, average luminance: 47.5 cd/m2) with several kinds of spatial frequency (1, 2, 4, 8, 16 cpd) and contrast intensity C (0, 5, 10, 15, 20, 40, 60, 80%) in young (23–27 yrs) and elderly (65–75 yrs) participants and expressions for contrast

sensitivity and contrast response as functions of age, spatial frequency and contrast intensity. Finally, I introduce age-related changes of visibility of characters.

[2S1A002] Learning for flexible decisions across the lifespan

Zoe Kourtzi
Univ of Cambridge, UK

Learning is known to facilitate performance in a wide range of perceptual skills and promote flexible behaviour. However, the brain mechanisms that support our ability for flexible perceptual decisions in older age remain largely unknown. Here we review perceptual and statistical learning studies suggesting that different brain plasticity mechanisms mediate behavioural improvements in young and older adults. First, we test for brain mechanisms that support learning to discriminate targets in cluttered scenes. Our behavioural studies demonstrate that visual selection rather than global feature processing provides a fundamental limit for learning-dependent plasticity in the ageing brain. Complementary fMRI studies suggest that visual shape learning in older adults engages primarily parietal regions, suggesting a key role for attentionally-guided learning in older age. Second, we test whether learning facilitates our ability to predict upcoming events based on implicit knowledge about the past. Our fMRI studies show that while predictive learning engages both implicit (striatum) and explicit (medial fronto-parietal) learning circuits in young adults, it recruits mostly implicit (striatum) learning circuits in older adults. Thus, our findings suggest that flexible behaviour is maintained across the lifespan by brain plasticity mechanisms that may compensate for decline in attentional and explicit memory circuits.
BBSRC, Marie Curie

[2S1A003] Neural plasticity in the visual cortex of patients with macular degeneration following perceptual learning

Mark Greenlee, Katharina Rosengarth and Tina Plank
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Patients with juvenile (JMD) and age-related macular degeneration (AMD) develop central scotomata in both eyes. We trained JMD/AMD patients to perform a texture-discrimination task (TDT) at their PRL. Six training sessions of approximately one hour duration were conducted over a period of approximately three weeks. Before, during and after training twelve patients and twelve age-matched controls took part in three fMRI sessions. Training led to a significant decrease in the stimulus onset asynchrony (SOA) between target and mask. We found a training-induced increase in the BOLD response in the early visual cortex and this increase was more pronounced for the PRL (trained) location compared to the opposite-PRL, untrained location. Our results suggest that perceptual learning can enhance eccentric vision and increase cortical activation in patients with central vision loss.
DFG (FOR 1075)

[2S1A004] Stability and plasticity of the visual system following age-related vision loss

Frans W Cornelissen
University Medical Center Groningen, Netherlands

Age-related eye diseases such as glaucoma and age-related macular degeneration (AMD) are associated with retinal defects and vision loss. Because of the retinotopic organization of the connections of the visual pathways this may affect specific parts of the visual pathways and cortex. For this reason, over the past several years, structural and functional MRI studies have examined patients with age-related eye diseases and found structural changes –most often degeneration– in the visual pathways and brain, while most studies find that functional maps in visual cortex are remarkably stable. The most parsimonious explanation is that brain changes are caused by deprivation of the visual pathways and brain regions, rather than by transsynaptic degeneration. Of clinical relevance, for some of the diseases – in particular glaucoma and AMD – present results are compatible with the view that the eye disease is part of a more general neurological or neurodegenerative disorder that also affects the brain. Finally, establishing the degree of structural and functional stability and plasticity of the visual pathways has been relevant in the context of new therapeutic strategies to restore retinal function: the presence of degeneration implies that restoring retinal function may not suffice to also effectively restore vision.

European Union H2020 Marie Skłodowska- Curie Innovative Training Networks (NextGenVis – grant #641805)

[2S1A005] Age Changes In The Aqueous Humour Outflow System Of The Eye And Their Relevance To Primary Open Angle Glaucoma (Poag)

Ian Grierson
university of liverpool, UK

High IOP is a major POAG risk factor for most forms of glaucoma contributing to retinal ganglion cell loss, cupping of the optic nerve head and loss of visual field which are the characteristic features of the condition.

As we age resistance increases due to age changes but IOP does not rise because aqueous production and flow rate also decreases. In POAG the changes in the trabecular meshwork (TM) are so marked that IOP is often elevated to pathologically high levels that compromise retinal function. There is a marked loss of TM cells such that we have about 800,000 at birth which falls to around 400,000 in 80 year olds. In POAG the cell population falls to about half of that of age-matched normals. Understanding of drainage through the outflow system in ageing and glaucoma is essential as IOP lowering is the only means of halting glaucomatous progress. POAG patients are not aware of either their elevated IOP or their loss of visual field so early diagnosis remains a challenge and repeated population prevalence studies show that almost half of glaucoma patients are undetected.

Fight For Sight:; International Glaucoma Association.

[2S1A006] Eye Movements and Reading Speed in Macular Disease: Influence of Fixation Clusters

Éric Castet, Aurélie Calabrèse, Jean-Baptiste Bernard, Géraldine Faure and Louis Hoffart
Cognitive Psychology Laboratory – CNRS – Aix-Marseille University, France; Laboratory for Low-Vision Research, University of Minnesota, Minneapolis, USA; Cognitive Psychology Laboratory – CNRS – Aix-Marseille University, France; Low Vision Clinic, University Hospital of La Timone, Marseille, France; Department of Ophthalmology, University Hospital of La Timone, Marseille, France

Age-related Macular Degeneration (AMD) patients with central field loss make saccadic eye movements whose average horizontal component (in the forward direction) correlates with their reading speed. This is usually interpreted as evidence that patients' perceptual span is the major determinant of their reading speed (Calabrèse et al., 2014). Despite this consensus, very little is known about the characteristics of other oculomotor factors and their influence on reading speed in AMD. In this study, we describe and quantify an important oculomotor pattern which seems specific to AMD and which, to our knowledge, has never been investigated: the presence in many sentences of regions with very high densities of fixations (fixation clusters). We measured eye movements (with a video eye-tracker – 500 Hz) of 39 low vision patients who monocularly read aloud 14 single-line French sentences (print size: 3X acuity threshold). All patients had a dense scotoma covering the fovea, as assessed with MP1 microperimetry, and therefore used eccentric viewing. Only correctly read sentences were kept in the analysis. Our main result is that fixation clusters are strong determinants of reading speed independently of other oculomotor factors. This finding should help constrain the design of low vision reading models.
French Ministry of Research and CNRS

Symposium: The concept of fluency: Current streams, active models, new challenges, general limitations

[2S1B001] The concept of fluency: Current streams, active models, new challenges, general limitations

Claus-Christian Carbon
University of Bamberg, Germany

Processing fluency has been proven to be an important driver in forming judgments, especially in the domain of empirical aesthetics. For instance, Hedonic Fluency Model assumes that we like objects more when we can perceive and process them more fluently. The model has repetitively been verified but still faces clear limitations and also conceptual problems. One issue was addressed only recently: whether objective or subjective fluency is mainly causing the documented effects (Forster and colleagues)—actually, it was shown that perceptual fluency is not only implicitly processed, but can also be explicitly reported and is as such a subjective variable still an important determinant of liking. Another limitation is that most research used neutral or positive stimuli with low complexity, thus fluency effects on valence could not be effectively tested. However, when integrating negatively affected stimuli into a stimulus set, typical increases of liking could not be demonstrated but instead amplified evaluations. As a result, extended models have been established quite recently, for instance the Fluency Amplification Model (FAM) which

assumes that fluency does not increase affective value, but amplifies the initial affective value of an object (Albrecht & Carbon).

[2S1B002] Flipping Fluency: On the fascinating flexibility of fluency phenomena

Piotr Winkielman
UCSD, USA

Much evidence shows that perceptual and conceptual fluency influences diverse cognitive judgments and affective reactions. This evidence usually comes from studies which manipulate fluency by (i) objective features of the current target stimulus (e.g., averageness), or (ii) contextual stimuli that change fluency of the current target (e.g., identity priming). This evidence seems to suggest a straightforward recipe for increasing fluency and predicting its impact on judgments (e.g., enhance averageness, or use stronger priming). However, fluency is very much a subjective property – it is in the processing experience, not in the stimulus. As such, any stimulus could be potentially made "fluent" or "disfluent", depending on the current task context. My talk will show how easy it is to "flip" fluency of a stimulus with contextual and task manipulations, and, as a consequence, reverse cognitive judgments and hedonic reactions to the same target stimulus. I will illustrate this theoretical perspective with several empirical phenomena, including the "over-priming effect", "cross-modal fluency" effect, "ugliness-in-averageness" effect, and "distrust-in-smiles" effect.

[2S1B003] Necker's Smile: Immediate Affective Consequences of Early Perceptual Processes

Thorsten Michael Erle, Rolf Reber and Sascha Topolinski
University of Würzburg, Germany; University of Oslo, Norway; University of Cologne, Germany

Current theories assume that perception and affect are separate realms of the mind. In contrast, we argue that affect is a genuine online-component of perception instantaneously mirroring the success of different perceptual stages. Consequently, we predicted that the success (failure) of even very early and cognitively encapsulated basic visual processing steps triggers immediate positive (negative) affective responses. To test this assumption, simple visual stimuli that either allowed or obstructed early visual processing stages without participants being aware of this were presented briefly. Across three series of experiments, we found more positive affective responses to stimuli allowing than obstructing Gestalt completion at very early visual stages, contour interpolation in illusory contours of Kanizsa stimuli, and visual disambiguation in possible versus impossible Necker cubes. This effect was observed on both verbal preference ratings as well as subtle facial muscle responses occurring within 2–4 seconds after stimulus-onset. For instance, we found affective discrimination between possible and impossible Necker cubes although a conscious discrimination between the stimuli was rendered impossible by very brief presentation timings. These effects demonstrate that early perceptual processes work remarkably fast and accurate and that there are distinct intrinsic affective signatures of success and failure of these processes.

[2S1B004] The Fluency Amplification Model (FAM)

Sabine Albrecht and Claus-Christian Carbon
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Department of General Psychology and Methodology, University of Bamberg, Germany

Processing fluency provides a gratifying explanation for elevations of judgment in regard of various constructs, including truth, confidence, familiarity, fame, typicality, and especially liking. It is assumed that fluency is linked to a positive affect (e.g., Reber, Schwarz, & Winkielman, 2004). However, there are several findings which do not seem to fit into the theory (e.g., Albrecht & Carbon, 2014, Brinol, Petty, & Tormala, 2006, Olds & Westerman, 2012). Drawing on recent outcomes, we suggest a re-interpretation of processing fluency as an amplifying factor on affective reactions: The Fluency Amplification Model (FAM, Albrecht & Carbon, 2014) assumes an intensified affective judgment depending on the initial stimulus valence. FAM can serve as a framework for integrating seemingly contradictory findings. We attempt to compile several factors (including stimulus, person and context variables) under which fluency can affect behaviour and how these influences can be interpreted. Moreover, we address the risk of attributing findings to fluency effects whilst there might be shared variance of other origin, e.g. effects due to reward.

[2S1B005] Factors of experience of beauty and aesthetic fascination: pleasure, interestingness, harmony and clarity

Slobodan Markovic
University of Belgrade, Serbia

Different approaches in psychological aesthetics stress the importance of different factors of aesthetic preference: Affective approaches stress Pleasure (preference for stimuli with positive valence), Motivational approaches stress Interestingness (preference for arousing or supernormal stimuli), Perceptual approaches stress Harmony (preference for the good Gestalt), and Cognitive approaches stress Clarity (preference for fluently processed stimuli). In the present study we investigated the relationship between these factors and two main forms of aesthetic preference, one based on experience of Beauty and the other based on aesthetic Fascination (i.e. aesthetic experience, Markovic, 2012). Fourty-six participants judged seventy-two photographs of artificial objects and scenes (buildings, interiors, tools) on six scales: Beautiful, Fascinating, Pleasant, Harmonious, Interesting and Clear. Analyses indicated that all scales were significantly positively inter-correlated except Harmony (not correlated with Fascination) and Clarity (not correlated with Beauty and negatively correlated with Fascination). Multiple regression showed that Beauty was most strongly positively correlated with Pleasure, while Fascination was most strongly negatively correlated with Clarity. These results are in line with predictions of affective approaches, whereas predictions of cognitive approaches (e.g. processing fluency theory) failed: both clear and vague stimuli can be equally beautiful, while clear stimuli are less fascinating than vague stimuli.

This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia, grant number 179033

[2S1B006] The Measurement of Visual Antecedents of Processing Fluency and Aesthetic Liking

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Goethe University Frankfurt, Germany; Goethe University Frankfurt, Germany

A key prediction of processing fluency theory is that the ease of processing a stimulus determines the aesthetic response towards the stimulus. In particular, visual symmetry, simplicity, prototypicality, and contrast/clarity have been proposed to facilitate processing and hence to increase aesthetic liking. The existing literature provides a rich set of empirical studies in support of this basic notion. The majority of these studies either manipulates visual aspects of the stimulus according to one of the four mentioned dimensions or they measure subjective perceptions of these dimensions to predict aesthetic liking judgments. However, algorithmic and hence objective measures of these visual stimulus properties have not been established thus far. The key aim of the present research is to propose such objective measures and to validate their predictive strength with respect to a subjective fluency experience and aesthetic liking. The major advantage of these measures is that they can be applied in research that examines fluency effects based on large stimulus databases. Furthermore, several stimulus properties and their interactive effects can be considered simultaneously. We provide successful applications of the proposed measures across a range of stimulus categories (e.g., visual art, car designs) and discuss theoretical implications of our findings.

Symposium: Frequency tagging neural dynamics of visual perception in the human brain

[2S1C001] EEG frequency-tagging of natural face images

Bruno Rossion
University of Louvain, Belgium

The EEG frequency-tagging approach has been recently expanded to high-level vision by periodically modulating diagnostic information (e.g., a periodic change of identity in a rapid train of identical face stimuli, Liu-Shuang et al., 2014). Here we designed a paradigm to identify an objective signature of visual discrimination (from nonface objects) and generalization (across widely variable face exemplars) with natural images. Scalp EEG is recorded while observers view natural images of objects at a rate of 5.88 images per second for 60 seconds. Natural images of faces are interleaved every 5 stimuli, i.e., at 1.18 Hz (5.88 Hz / 5). Face categorization is indexed by a high signal-to-noise ratio response specifically at the 1.18 Hz face stimulation frequency and its harmonics, localized over the right occipito-temporal cortex. Despite the use of natural images, this face-selective periodic EEG response is free of low-level visual confounds and is highly significant for single participants, even for one stimulation sequence. This approach reveals face-selective responses in the right hemisphere of 4–6 month old infants, and reveal a sequence of novel differential face-selective EEG components between 120 and 450 ms after natural face image onset, progressing from right lateral occipital to occipito-temporal and anterior temporal regions.

[2S1C002] Temporal neural dynamics of early visual cortex activity in feature based shifts of attention

Matthias Mueller, Christian Keitel and Susann Szukalski
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We investigated neural temporal dynamics in early visual cortex in feature-based attention when subjects shifted attention either within a feature dimension (i.e. color to color) or between feature dimensions (i.e. color to orientation) by means of frequency tagged random dot kinematograms (RDKs) that elicited steady state visual evoked potentials. Based on the Dimensional Weighting Account (DWA) that predicts a time consuming shift of weights between but not within feature dimensions, we expected longer shifting latencies from color to orientation compared to shifts from color to color. Neither Biased Competition nor the Feature Similarity Gain model would predict such latency differences. In line with DWA we found longer shifting times between compared to within feature dimensions. Interestingly, shifts to color were always faster compared to orientation, indicating top-down modulation in reversed hierarchy as previously found in animal and human studies. The following experiment manipulated shifts in color and/or location. To this end subjects either attended to the same location but shifted attention to another color, shifted location but remained at the same color or shifted color and location. We were interested in the temporal dynamics of such isolated or combined shifts. During the time of abstract submision, data is still analyzed.

[2S1C003] Using EEG-frequency tagging to understand visual scene perception

Greg Appelbaum
Duke University, USA

The ability to parse scenes into objects and their surrounding backgrounds is a fundamental aspect of visual function that provides the building blocks for perception and higher-level cognition. In the current talk, I will discuss our research using frequency-tagged EEG, combined with an fMRI-based source imaging approach, to investigate the cortical networks responsible for figure-ground processing. In this approach, different spatial texture cues modulate at periodic frequencies causing the displays to alternate between uniform and segmented states. In different conditions and tasks these scenes create surrounded figure-ground arrangements or ambiguous figure-ground arrangements that are either the focus of attention or are task-irrelevant. Through these studies we identified separate brain networks responsible for figure and background processing that are invariant with respect to low-level stimulus texture attributes. We demonstrate that the Gestalt property of "surroundedness" is necessary to selectively activate the figure network, while processing of the border regions between figures and backgrounds elicits additional activity in frontal and occipital areas. In addition, we find that attention to the scene selectively enhances figure and border, but not background, responses. Collectively, these studies illustrate how frequency-tagged EEG can be used to investigate the mechanisms supporting the early stages of visual scene processing.

[2S1C004] Audio-visual synchrony and selective attention co-amplify early visual processing

Christian Keitel and Matthias M Müller
University of Glasgow, UK; Universität Leipzig, Germany

Frequency-tagging of stimuli in different sensory modalities at the same time can be a versatile means to study the dynamics of multisensory processing. Nevertheless, studies employing respective approaches have remained sparse. Here, we briefly review findings from previous multisensory frequency-tagging experiments and summarize data of two recent studies on the interplay of selective attention and audio-visual (AV) synchrony. Using frequency-tagged visual and auditory stimulation, we investigated influences of AV synchrony on spatial- (study 1) and color-selective gain effects on early visual processing (study 2). Steady-state responses (SSRs) driven by frequency-tagged stimuli allowed examining individual stimulus processing under conditions of synchronous vs. asynchronous tone presentation and when respective stimuli were attended vs. unattended. A prominent assumption holds that single AV-synchronous stimuli stand out and act as strong attractors for attention in unisensory contexts. In line with this prediction we found that, both, attending to the spatial location or color of a visual stimulus and its synchrony with a simultaneously presented tone, enhanced its processing. Interestingly, both gain effects combined additively, indicating that they relied on independent pools of neural resources.
Research funded by Deutsche Forschungsgemeinschaft (DFG). Conference visit funded by Wellcome trust.

[2S1C005] Threat versus Safety in Human Visual Cortex: How Affective Experience Impacts Perception

Andreas Keil
University of Florida, USA

A plethora of studies suggest that the biological relevance of visual stimuli is associated with facilitated sensory processing. Beyond the phenomenological demonstration of this effect however little is known about the neurophysiological mechanisms that mediate selective facilitation of biologically relevant cues. In this presentation, we discuss conceptual and methodological issues regarding the characterization and induction of threat and safety in the laboratory. We then turn to experimental explorations of behavioral and neurophysiological dynamics as observers learn that a novel, initially unengaging, stimulus is behaviorally relevant. Combining the steady-state visual evoked potential and other electrophysiological signals with hemodynamic neuroimaging techniques, we find that activity in lower-tier visual cortex changes as a function of motivational relevance acquired through Pavlovian fear conditioning. The temporal rate of these changes, their extent, and the brain regions involved reflect the specific behavioral and environmental contingencies to which observers adapt. Findings will be discussed in a theoretical framework that views emotions as action dispositions.
Research was supported by the National Institutes of Health (R01MH097320)

Oral Presentations: Motion

[2T2A001] Optic flow induces crossmodal aftereffects in self-motion perception

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For the first time we report that adaptation to optic flow induces robust crossmodal self-motion aftereffects in the vestibular domain. We assessed the dependence of these aftereffects on adaptor duration and their relationship with visual motion aftereffects. A motion nulling procedure was employed to measure the inertial (i.e. vestibular) stimulus needed to cancel the aftereffect induced by a visual-only optic flow. Experiments were conducted using a motion platform, equipped with a 3D monitor. On each trial, subjects experienced a visual-only adaptor consisting of expanding or contracting optic flow, followed by a 2-seconds physical movement on the fore-aft axis. Then they indicated the perceived direction of the physical movement. Exposure to optic flow stimulation lasting 15-seconds induces a shift of the point of perceived zero-motion (i.e. an aftereffect) whereas shorter adaptor durations were ineffective, suggesting that sustained perception of self-motion is required to elicit these aftereffects. Magnitudes of crossmodal and visual aftereffects were not correlated, suggesting separate underlying mechanisms. These crossmodal aftereffects likely result from adaptation of multimodal neural mechanisms specialized for self-motion processing. Transfer of adaptation across modalities provides behavioral evidence for neural systems that constantly function to calibrate sensory modalities with each other as well as with the environment.

[2T2A002] No integration of optic flow and stereoscopic depth in the perception of ego-acceleration

Hanspeter Mallot, Florian Ott, Ladina Pohl, Marc Halfmann and Gregor Hardiess
University of Tübingen, Germany; University of Tübingen, Germany; University of Tübingen, Germany; University of Tübingen, Germany; University of Tübingen, Germany

Purpose. Optic flow does not allow to distinguish ego-motion from object depth and thus leads to erroneous ego-motion estimates in tunnels with varying diameters (Festl, Recktenwald, Yuan, Mallot 2012). Mathematical optic flow theories predict that additional feature- or object-based stereo cues might support veridical ego-motion perception. We tested this prediction with human subjects. Methods. Three experiments are reported: (i) yes-no judgments for the presence of ego-acceleration in straight, narrowing, and widening corridors defined by limited lifetime random dots; (ii) maintenance of constant speed in tubular tunnels with varying diameter (adjustment task); and (iii) yes-no judgments for the presence of ego-acceleration in straight, narrowing, or widening alleys passing through rows of 3D blocks. Results. In all experiments, ego-acceleration judgments were affected by the change of corridor diameter, even though depth could be assessed independently by stereoscopic cues. Results are in quantitative agreement with the assumption that ego-motion is judged from overall radial flow, i.e. from matching retinal flow to a radial template. Conclusion. Independent depth information that would be useful in technical optic-flow algorithms is not used in human ego-acceleration judgments. We suggest that vectional ego-acceleration and environmental depth structure are independent perceptions.

[2T2A003] Influence of shading on biological motion perception: illusion and model

Leonid Fedorov and Martin Giese
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Research on biological motion perception has focused on 2D motion and form cues, while shading cues were largely neglected. Using point-light stimuli with volumetric elements, we discovered a new visual illusion, where the change of the light source direction flips the perceived walking direction. We extended a neural model for biological motion perception (Giese, 2003) to account for this illusion. METHOD: Walker stimuli consisted of 3D conic shapes that were centered on the limbs and illuminated from different light-source positions. We studied the dependence of the perceived walking direction on the position of the light source. We extended the model by a new pathway, which processes shading cues by analysis of inner brightness gradients. RESULTS: The light source position has a strong influence on the perceived walking directions ($F(16,176) > 178$, $p < 0.01$), where illumination from below results in a flip of the perceived walking direction by 180 deg compared to the veridical direction. The model reproduces this illusion. A control experiment reveals the critical shading features that cause the illusion, consistent with predictions from the model. CONCLUSION: Biological motion perception is influenced by a lighting-from-above prior, similar to the perception of static shapes (Brewster, 1874; Ramachandran, 1988).
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[2T2A004] Effect of motion discontinuities on discrimination of periodic trajectories

Hugh R. Wilson and Jeffrey Fung
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Many biologically important motions are described by periodic trajectories. Previously we introduced radial frequency (RF) trajectories in which the motion of a difference of Gaussians (DOG) stimulus differed from a circular trajectory by having the radius vary sinusoidally as a function of polar coordinate angle. Here we explore the hypothesis that discrimination of these trajectories involves global spatio-temporal processes that depend on motion continuity. To test this hypothesis RF3 and RF4 trajectories were presented such that there was smooth motion during each single cycle, but the moving DOG jumped discontinuously to a different position at the end of each cycle. For example, if the cycles in an RF3 trajectory were traversed in the sequence 1-2-3 for continuous motion, discontinuous motion would be defined by the temporal sequence 1-3-2. Significantly, both continuous and discontinuous stimuli traverse the same spatial points in the same period of time. Thresholds for discrimination of discontinuous RF motion from discontinuous circular motion were compared to thresholds for continuous motion. The discontinuous trajectory motion increased thresholds by a factor of approximately 2.0 across conditions. These results provide evidence for global processing of periodic RF motion trajectories.
NSERC (Canada) grant to HRW

[2T2A005] Prolonged microgravity alters the perceptual and neural responses to visual gravitational motion cues

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Would escaping from the Earth's gravity alter human visual perception? On the Earth, people are less sensitive to upside-down biological motions (BM) whose motion violates the effect of gravity compared with the upright ones whose motion carries natural gravitational acceleration. Such inversion effect has been taken as evidence for the visual system's exquisite sensitivity to gravitational motion cues. Here we reported that the inversion effect of BM perception declined after prolonged exposure to space microgravity environment (2-week spaceflight) or simulated microgravity condition (45-day -6° head-down bed rest, HDBR). Moreover, HDBR resulted in a substantial reduction in neural response to upright versus inverted BM in the STS, a brain region dedicated to BM processing, as well as a perception-related increase in the functional connectivity between the STS and the key vestibular cortex that is involved in multisensory gravitational computation. Together, these results show that altered vestibular input due to microgravity leads to a re-adaptation of the brain's response to visual gravitational motion cues. The Earth's gravitational environment that we undergo may serve to maintain our brain's selective sensitivity to visual gravitational motion cues and enforce the internal law of gravity on visual perception.
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[2T2A006] Practice rather than observation allows us to quickly learn to cope with acceleration when intercepting moving objects

Eli Brenner, Inés Abalo, Victor Estal and Jeroen B.J. Smeets
VU University Amsterdam, Netherlands; VU University Amsterdam, Netherlands; VU University Amsterdam, Netherlands; VU University Amsterdam, Netherlands

We effortlessly interact with moving objects despite being hopeless at visually judging acceleration. Moving objects that we encounter often accelerate due to gravity and friction, or to other people's actions such as handing us the object. How do we deal with these accelerations? Misjudging or ignoring acceleration can be compensated for by continuously adjusting movements on the basis of the latest visual information, but this mechanism is limited by visuomotor delays. Our study was designed to verify that people ignore acceleration, and examine whether it is enough to observe the motion to learn to fully compensate for this, or whether it is essential to interact with the object. We asked subjects to try to tap on targets moving at various randomly interleaved speeds. In alternating blocks of trials, the targets either accelerated or decelerated (at 1 m/s2). On the first trial of each block the tapping error was consistent with the new acceleration (or deceleration) being ignored. Within a few taps the error was negligible. Only observing the target's motion hardly influenced subsequent performance. Thus, people do not learn the object's acceleration,

but they learn how to adjust their movements to compensate for the error that arises from ignoring the acceleration.

Oral Presentations: Perceptual organisation, objects and shapes

[2T2B001] Frequency tuning of shape discrimination revealed by classification image analysis

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How does the human brain code shape? Theories abound, but a data-driven method may allow us to discover principal dimensions of this encoding. The classification image method has been applied effectively to contrast discrimination – can it also be applied to shape? A 2D shape can be represented as a cycle of points in the plane or alternatively as a vector of complex Fourier Descriptor (FD) coefficients (Zahn & Roskies, 1972). Observing that natural shapes are low-pass in this representation, we hypothesize that it may prove an efficient basis for classification image analysis. In a yes/no task, three observers were asked to distinguish animal shapes from an ellipse, both corrupted in the FD domain with additive Gaussian noise matched to the low-pass spectral density of the shapes, thus rendering each frequency equally informative for the task. Despite this noise equalization, the resulting classification templates are tuned primarily to lower frequencies. The templates estimated for each observer were found to be significantly more predictive of their responses than ideal templates ($p = .001$). Estimated templates were also more predictive than ideal templates when predicting across observers ($p = .03$). These results attest to the utility of the classification image methodology for shape discrimination.
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[2T2B002] Are saccades sensitive to the perceptual organization of surface structure?

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Saccades are used to reallocate attention to new targets. Because attentional processing and saccade behavior change in the presence of a distractor (e.g., RTs are slower and saccades exhibit greater curvature), these two systems may be fundamentally linked. Although it is known that attentional processing unfolds within surface-based representations, such that search for a target is unaffected by distractors on a different surface (e.g., Atchley et al., 1997), it is not known whether the saccade motor plan – executed in 2 dimensions – is also sensitive to 3D surface information. We ask whether saccades to targets are sensitive to surface structure. Exps. 1–3 manipulated the presence and absence of a distractor and different kinds of surface structure. Although saccades curved more in the presence of distractors, there was no main effect of surface structure even when surfaces were task-relevant, nor did surfaces modulate the effect of the distractor. In Exp. 4, however, oculomotor capture by a distractor singleton was significantly reduced when participants knew in advance on which surface (rather than which locations) a

target would appear. We tentatively conclude that both saccade programming and attentional selection benefit from surface structure only under high selection demands.
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[2T2B003] How visual working memory exploits environmental structure

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How do people use the structure of items when storing them in visual memory?
Experiment 1 asked what format visual working memory uses to encode objects and their structure. Subjects saw objects arranged in different spatial clustering structures and recalled their positions. Objects in the same cluster were misreported in similar directions, indicating that memory errors were shared within clusters. Additionally, the shared errors for clusters decreased when clusters were closer. These results are captured by a model that encodes object positions relative to an inferred grouping structure and recalls relative positions with Weber noise. Experiment 2 adopted an iterated learning paradigm to amplify biases due to people's prior expectations about spatial structure. Each subject saw 15 items and reported their positions; critically, the positions one subject reported served as the stimulus for the next subject. People converged to reporting items in few groups that are either tight clusters or lines, and multiple lines in a display with similar orientations and lengths. This effectively recovers visual memory's use of Gestalt principles to encode objects. Together, these results show how people use environmental structure to remember displays: what structures they expect and exploit, and what format encodes objects and their structure.

[2T2B004] Object Knowledge Shapes Properties of Early Feature-Detectors by Top-Down Modulation

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Early stages of information processing are thought to be carried out by static feature-detectors that operate independently of high-level representations of a stimulus. This notion is challenged by new perspectives that emphasise the role of feedback connections in shaping the properties of early visual function. Any experimental design trying to test this hypothesis has to ensure that sensory stimulation of early detectors remains identical while high-level representations of the stimulus are manipulated. Here, we used two-tone images of objects in a psychophysical procedure to achieve this and demonstrate a significant influence of high-level object knowledge on response properties of early edge-detectors. Two-tone images feature physically homogenous regions that are experienced as an object contour (somewhat similar to illusory contours in Kanizsa figures) once relevant image information is provided. We embedded edge-elements in these areas that were consistent or inconsistent with the high-level contour representation and measured absolute contrast detection-thresholds before and after providing relevant object knowledge. Results indicate that prior knowledge facilitates absolute contrast-threshold for

edge elements that are consistent with the high-level representation of a stimulus. Supported by computational simulations, these findings indicate that response properties of early information-processing units are shaped by top-down modulation from high-level image representations.
This research was funded by the Wellcome Trust.

[2T2B005] Brain networks for visual perceptual groupings

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Local visual elements are grouped into global objects seemingly without effort. Using a contour integration task and EEG source level analyses, we tested the hypothesis that visual perceptual grouping requires a top-down selection, rather than a passive pooling, of neural activity coding the local information. The participants were presented visual displays with or without a hidden contour. Two tasks were performed: a central luminance-change detection task and a peripheral contour detection task. Only in the contour-detection task could we find differential brain activity between contour and non-contour conditions, within a distributed brain network including parietal, lateral occipital and primary visual areas. Contour processing was associated with an inflow of information from lateral occipital into primary visual regions, as revealed from the slope of phase differences between source level oscillations within these areas. The findings suggest that contour integration results from a selection of neural information from lower visual areas, and that this selection is driven by the lateral occipital cortex.

[2T2B006] Spike synchrony reveals emergence of proto-objects in visual cortex

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Neurons at early stages of the visual cortex signal elemental features such as pieces of contour, but how these signals are organized into perceptual objects is unclear. Theories have proposed that spiking synchrony between these neurons encodes how features are grouped (binding-by-synchrony), but recent studies did not find the predicted increase in synchrony with binding. We propose that features are grouped to "proto-objects" by intrinsic feedback circuits that enhance the responses of the participating feature neurons. This hypothesis predicts synchrony exclusively between feature neurons that receive feedback from the same grouping circuit. We recorded from neurons in macaque visual cortex and used border ownership selectivity, an intrinsic property of the neurons, to infer if two neurons are part of the same grouping circuit or not. We found that binding produced synchrony between same-circuit neurons, but not between other pairs of neurons, as predicted by the grouping hypothesis. In a selective attention task, synchrony emerged with ignored as well as attended objects, and higher synchrony was associated with faster behavioral responses, as would be expected from early grouping mechanisms that provide the structure for object-based processing. Our results suggest a novel coding mechanism that might underlie the proto-objects of perception.
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Oral Presentations: Peripheral vision, binocular vision and crowding

[2T2C001] Temporal crowding and the effects of spatial attention

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Spatial crowding refers to impaired target identification when it is surrounded by flankers in space. In this study we demonstrate, for the first time with normal observers, temporal crowding: impaired target identification when it is surrounded by other stimuli in time. We presented a sequence of 3 letters to the same location, right or left of fixation, separated by varying ISI (100–450 ms). One of these letters was an oriented T. Observers indicated the T's orientation. We found that target identification was impaired by preceding and succeeding stimuli up to an ISI of 300 ms. Interestingly, we did not find an interaction between spatial and temporal crowding. In the second part of this study we examined whether spatial attention can alleviate temporal crowding, as it does with spatial crowding. Attentional precues (auditory or visual) that attract attention to the letters' location were added to the basic paradigm. As expected, with both types of cues precueing improved overall performance when the target appeared in the first display. Moreover, although with the auditory cue there was no cueing $\times$ ISI interaction, such an interaction emerged with the visual cue, suggesting that as with spatial crowding, spatial attention can reduce temporal crowding.

[2T2C002] Evolving the keys to visual crowding

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Peripheral vision can be severely impaired by nearby clutter. Decades of research using sparse displays have established that this phenomenon, known as visual crowding, follows Bouma's law: Interference occurs for target-distractor separations up to half the target's eccentricity. Although considered a fundamental constraint on human vision, Bouma's law has never been tested in more dense visual environments. Using a genetic algorithm we investigated crowding in densely cluttered displays. Participants were instructed to identify the orientation of a target line (6° eccentricity) among 284 distractor lines. Displays supporting highest accuracy were selected ("survival of the fittest") and combined to create new displays. Performance improved over generations, predominantly driven by the emergence of horizontal flankers within 1° of the near-vertical target, but with no evidence of interference beyond this radius. We conclude that Bouma's law does not necessarily hold in dense displays. Instead, a nearest-neighbour segmentation rule provides a better account.

[2T2C003] Higher-level effects in crowding falter when low-level attributes are controlled for

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Visual crowding impairs recognition of flanked objects in the periphery. Further, it is known that low-level feature differences between such objects (e.g., colour) weakens crowding. Recently, higher-level differences have also been posited to similarly modulate crowding: crowding has been shown to be weaker if objects differ in category membership or if the objects are familiar (meaningful). However, these effects of category and familiarity can be deemed to be higher-level influences only if all low-level differences between stimuli are controlled for, which has not been the case in previous research. In a series of experiments, we investigated the effects of a range of low-level attributes on higher-level crowding interactions. We found that the ostensible category effect was fully accounted for by differences in features and overlap between target and flanker stimulus sets. However, the effect of familiarity was persistent even when low-level attributes were controlled for. Thus, at least some of the so-called higher-level crowding interactions are a result of inadequate stimulus control, while others seem robust. Therefore, we strongly encourage caution and a thorough control of stimulus-level properties before higher-level effects are claimed to influence crowding.

[2T2C004] Portraying the periphery: studying peripheral vision with drawing tasks

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While the reduced ability to identify crowded objects in the periphery continues to be thoroughly studied, the specific nature of the perceptual degradation remains elusive. We utilized a novel drawing paradigm to probe the phenomenology of peripheral vision, using the Rey-Osterrieth Complex Figure. The figure was presented at 12 or 6 degrees in the right visual field. Eye tracking ensured that the figure was only presented when observers maintained stable fixation. Observers were asked to draw the figure with free viewing, capturing its peripheral appearance. To assess the drawings, two raters used a standard scoring system that evaluated feature positions, spatial distortions, and omission errors. A linear model revealed several characteristics of the errors. Error rates were higher at 12 compared to 6 degrees. Internal features which were adjacent to similar shapes were more likely to be omitted, especially at 12 degrees. Highly salient components that differed from surrounding shapes were generally depicted correctly at both eccentricities. We discuss methodological advantages of the drawing method over traditional forced-choice procedures, and present our empirical results in relation to appearance and error distributions in crowded peripheral vision.
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[2T2C005] Task-specific population coding determines the perception of position

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An object in the visual field will activate populations of neurons tuned to its various features. Theories of 'local sign' predict that its position is perceived via the centroid of this activity. In

contrast, the perception of other features (motion, orientation) has been shown to depend on the task. We sought to measure similar task dependencies in position perception. First, following adaptation, the detection of a small target dot (at 8 deg. eccentricity) was most impaired by adaptors that overlapped the target. Discrimination of the same dot in a three-dot Vernier stimulus ('was it left or right of the references?') was instead most impaired by adaptors displaced away from the target. Second, in a continuous-estimation paradigm, the perceived position of a target dot was largely veridical during detection judgements. During discrimination, the same dot appeared to be repulsed away from the decision boundary. Both results can be attributed to observers relying on the most informative channels for each task: those tuned to the stimulus (for detection) and those tuned away from the decision boundary (for discrimination). We conclude that perceived position is not simply given by the sensory distribution but rather reflects the read-out of these signals in a task-driven context.
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[2T2C006] Tilt aftereffect generated by isotropic adaptation stimuli: A counterintuitive prediction of Li and Atick's efficient binocular coding theory

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Li and Atick (1994) presented a theory of efficient binocular encoding in which the two eyes' signals are combined using separately adaptable binocular summation and differencing channels. We designed a dichoptic test stimulus for which the summation channel sees a grating tilted in one direction (clockwise or anticlockwise of horizontal), and the differencing channel sees a grating tilted in the opposite direction. The observer's perceived direction of tilt (summation or difference direction) should depend on the relative sensitivities of the two channels. We manipulated channel sensitivity using adaptation. In correlated adaptation, each eye received the same image, which selectively adapted the summation channel; in anticorrelated adaptation, each eye received the photographic negative of the other eye's image, which selectively adapted the differencing channel. These adaptation stimuli had equal energy at all orientations. Despite being isotropic, the adaptors influenced perceived tilt: The test stimulus usually appeared tilted in the difference direction after correlated adaptation, and usually appeared tilted in the summation direction after anticorrelated adaptation. This counterintuitive finding of a tilt aftereffect from isotropic adaptors is analogous to May, Zhaoping and Hibbard's (2012) finding of a motion aftereffect from static adaptors. These two results strongly support Li and Atick's theory.
This work was supported by a Grant to Li Zhaoping from the Gatsby Charitable Foundation

Oral Presentations: Perception and action

[2T3A001] The rubber hand illusion: long term effects and interoceptive training

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Embodiment is the experience of one's own body. The Rubber Hand Illusion (RHI) alters embodiment such that participants feel that a rubber hand becomes their own hand. Following the illusion participants also recognise the appearance of the rubber hand as being more like their own hand. This short term effect of the illusion is moderated by an individual's awareness of their internal body sensations or interoceptive sensitivity. To assess these effects over time we conducted the RHI and measured visual changes over two sessions, one week apart ($N = 40$). Each day participants listened to a 15 minute audio guide. Half listened to a Body Scan Meditation guide designed to increase awareness body (BSM-group) and half listened to a factual anatomy guide (control-group). Immediately following the illusion, both groups recognised the appearance of the rubber hand as more like their own hand. One week later this effect was still present in the control-group (8% vs. 6%, $p = .304$) but was significantly reduced in the BSM-group (9% vs. 1%, $p = .008$). The magnitude of the long term effect was negativity correlated with increases in interoceptive sensitivity (BSM-group: $r2 = 40.6\%$, $p = .011$, overall: $r2 = 23\%$, $p = .007$), indicating that focussing on internal body sensations reduces illusory body experiences.

[2T3A002] The role of action capacity in perceiving affordances and spatial properties

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Affordances reflect the relationship between action capacity (e.g., grasping ability) of the observer and action potentials (e.g., whether an object can be grasped). The action-specific account of perception suggests that our perception of spatial features of objects scales according to our perceived action capacity (Proffitt & Linkenauger, 2013). For example, Linkenauger, Witt and Proffitt (2011) reported that estimates of object size are scaled according to the perceived maximum grasp of the acting hand. We examined whether two independent judgements (affordances and object size) were conflated in Linkenauger et al's (2011) study, such that the reported scaling effects represented changes in perceived affordances rather than spatial perception. In the present studies, these two judgements were clearly distinguished. Participants estimated both their maximum grasping capacity for each hand in a perceived affordance task, and they also visually matched the physical size of objects in a spatial perception task. We found no effect of grasping capacity on object size perception. In addition, when action capacity was restricted, estimates of affordances reflected this change but object size estimates remained unchanged. Thus changes in action capacity influenced perception of affordances, but not spatial perception. Our results provide evidence against the action-specific account of perception.

[2T3A003] Residual visual processing in hemianopia: The role of conscious vision in obstacle avoidance

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Previous research found that a patient with cortical blindness (homonymous hemianopia) was able to successfully avoid an obstacle placed in his blind field, despite reporting no conscious awareness

of it (Striemer, Chapman & Goodale, 2010). This finding led to the suggestion that dorsal stream areas, that are assumed to mediate obstacle avoidance behaviour, obtain their visual input primarily from subcortical pathways. Thus, it was concluded that normal obstacle avoidance behaviour can proceed without input from the primary visual cortex (V1). Here we tried to replicate this finding in a larger patient population (N = 6) and also tested if obstacle avoidance behaviour still occurs when obstacles are placed simultaneously in the blind and intact visual field. We have found that even though patients successfully avoided obstacles placed in their intact visual field, they were not able to avoid obstacles in their blind field. These effects were not dependent on whether one or two obstacles were presented. Overall, our findings indicate that normal obstacle avoidance behaviour in the absence of V1 input is a rare occurrence.
RS Macdonald Charitable Trust

[2T3A004] Do we use temporal errors in interceptive timing?

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Much is known about spatial corrections to consecutive reaching movements, but little about the role of temporal error signals. We could use the temporal error (i.e. time-gap between the target and the hand at the aimed position) from previous trials to make adjustements. This requires judging the target speed which can be noisy. Alternatively, subjects could approximate this temporal error by combining the spatial error and the velocity of the hand at the moment of impact. We test this hypothesis in a interceptive task in which the target moved at different speeds and with a designated interceptive area (no spatial error). We analysed the dependency of the next movement on the previous physical temporal error and the proposed combination. First, hand speed combined with the spatial error explained most of the the temporal error, so it could be used to adjust future movements. By applying linear mixed models we analysed the sequential structure and revealed a significant dependency of hand speed at interception on the previous values of hand speed and spatial error, while the physical temporal error had no significant effect on the next movement velocity. The results suggest that subjects do not use previous temporal errors.
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[2T3A005] Mask-triggered thrust reversal in the Negative Compatibility Effect

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Rapid motor responses to visual stimuli can involve both activation and inhibition of motor responses. Here, we trace the early processing dynamics of response generation, examining whether activation and inhibition events form a strict sequence when elicited by sequential stimuli, as expected when motor events are carried by fast stimulus-triggered feedforward sweeps. We investigate response priming and negative compatibility effects (NCE) with primed

pointing movements going in ten possible directions with response-relevant, response-irrelevant, or no masks interleaved between primes and targets. We show that in response priming (short prime-target intervals, positive priming effects), initial responses are controlled exclusively by the prime. In contrast, in the negative compatibility effect (long prime-target intervals, negative priming effects), even the earliest movement phase is controlled jointly by prime, mask, and target information, and there is a massive force in counterdirection to the primed response that reverses priming effects specifically in slow responses. Thus, response priming reflects a strict sequence of feedforward response activations, while activation/inhibition events in the NCE are not strictly serial but integrate information from different stimuli over time. Even though mask features and visual attention modulate the NCE, its major source is a mask-induced, direction-specific thrust reversal of the initial response.
Deutsche Forschungsgemeinschaft

[2T3A006] Does experience shape the lower visual field advantage for action?

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Humans achieve better performance when reaching and grasping in the lower visual field (LVF) than in the upper visual field (UVF). Moreover, the brain regions involved in visuomotor control also show a LVF preference for hand actions (Rossit et al., 2013). It has been suggested that this LVF specialization for action is linked to experience, as most of our actions occur in our LVF, however this claim has never been directly investigated. Juggling involves intense practise of LVF movements and interestingly learning how to juggle produces structural changes in visuomotor brain regions (Scholtz et al., 2009). For the first time we investigated whether the LVF advantage for action is directly related to experience by comparing the performance of jugglers to non-jugglers. Participants were asked to grasp objects positioned in the LVF and UVF. In line with previous research, we found an advantage for grasping in the LVF: maximum grip aperture (MGA) was wider and more variable in the UVF than in the LVF. Remarkably, jugglers achieved MGA quicker and presented higher peak velocities than non-jugglers, particularly in the LVF. These results suggest that the LVF specialization for action is shaped by experience.

[2T3A007] Inversion of the Material-Weight Illusion in objects made of two materials

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The Material-Weight Illusion (MWI) is an example of how visually evoked expectations influence perception and action. Objects that appear to be made of a lighter-looking material, e.g. polystyrene, are perceived to be heavier than equally weighted and sized objects of a heavier-

looking material such as stone. Grip and load forces are initially driven by these visual expectations and soon adjusted to the actual mass of the objects (Buckingham, Cant, & Goodale, 2009). Real-world objects are often made of more than one material. In the present study we therefore investigated the perceived heaviness of symmetrical blocks whose two halves appeared to be made of different materials (polystyrene, wood and stone), whereby their true mass was identical (400 g) and evenly distributed around the geometric center. 48 participants lifted the bipartite objects at a central handle, while forces were recorded, and were then asked to judge the weight or center of mass of the objects. Prior expectations seemed to affect heaviness perception. In contrast to the classic MWI, the heavier-looking side of the object was perceived to weigh more. This perceptual illusion lasted until the end of the experiment. No analogous effect was observed on the forces applied to lift the objects.

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Oral Presentations: Clinical vision

[2T3B001] Representation of Body Size for Self and Other: simple-, cross- and contingent adaptation

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Body image disturbance is characteristic of individuals with eating disorders. While the role of media saturation with images of the "thin ideal" has been well documented, relatively little research has examined visual adaptation as a potential mechanism. We sought to examine the nature of body size representations for 'self' and 'others' using a visual adaptation paradigm. In Experiment 1, participants were adapted to either expanded or contracted images of either 'self' or 'other'. The resultant aftereffect was assessed using both 'self' and 'other'. While aftereffects were largest when the same body type was used for adaptation and testing, substantial aftereffects were also demonstrated for cross adaptation conditions, suggesting overlap in the representation of the two. In Experiment 2, participants were adapted to images of 'self' and 'other' that had been distorted in opposite directions (e.g. expanded self/contracted other). The direction of each aftereffect was contingent on the test stimulus, demonstrating differences in the representation for these body types. While body representations for self and other appear to be overlapping, yet distinct, the evidence of misperception of one's own body following exposure to "thin" others demonstrates the viability of visual adaptation as a model of body image disturbance.

[2T3B002] Audio-motor recalibration in blind

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A lack of vision at an early age results in some impairment in spatial representation. However, an auditory feedback about arm movements may help to recalibrate the spatial sense.

Here we studied the effect of an audio spatial training on the ability to reproduce a hand pointing task toward a moving sound and detect the final location. Forty subjects (20 early blind, 20 healthy blindfolded controls) performed the same task in two sessions. Between the two sessions 2 minutes inter-session was performed, that could either be 1) audio-motor training, i.e. moving the sound around the body mapping the peri-personal space or 2) passive training, i.e a complete rest. Subjects were randomized on the two conditions. The spatial accuracy was calculated for each participant and for each spatial position. In the first session, contrarily to blindfolded controls, early blind individuals showed a worse spatial accuracy, presenting impairment on the lower positions of the plane. After the audio-motor training, the spatial accuracy was highly improved ($P > 0.05$). No statistical difference was present in case of passive training or in blindfolded controls.

This result suggests that short audio motor training could improve audio spatial precision in early blind individuals.

This research has been supported by the European ABBI project (FP7-ICT 611452).

[2T3B003] Contextual Modulation of Effective Connectivity in Primary Visual Cortex in Schizophrenia

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Predictive coding theories explain core pathologies of schizophrenia as a result of false inference. Typically, higher-level symptoms such as delusions or hallucinations are considered to be the consequence of a misallocation of precision towards sensory evidence at the expense of prior beliefs (Adams et al., 2014). However, the predictive coding framework extends to the explanation of low-level deficits consistently reported in patients with schizophrenia (Fletcher and Frith, 2009), such as the reduced contextual modulation of BOLD–responses in primary visual cortex (Seymour et al., 2013). Here, we sought to probe the influence of contextual surround stimuli on the effective connectivity between retinotopically defined center- and surround-regions in primary visual cortex with Dynamic Causal Modeling in 18 schizophrenic patients and 16 control subjects. We assessed a modelspace of 20 DCMs using Bayesian Model Selection and compared parameter estimates with Bayesian Model Averaging. We found a reduced negative modulation of effective connectivity towards center-regions in primary visual cortex in the presence of a contextual surround in patients with schizophrenia. We conclude that the diminished contextual modulation of effective connectivity might reflect a failure to attenuate sensory precision at early processing stages in the visual hierarchy.

[2T3B004] "Lush" or "slime"? Atypical colour naming in Williams Syndrome

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Colour names are used to partition colour space into discrete colour categories. Individuals with Williams Syndrome (WS) have been shown to develop perceptual categories more slowly than typically developing (TD) individuals (Capirci et al., 1996). Yet the development of colour naming in WS is unclear, as is its relationship to sensory discrimination ability. Here we compared the performance of mental-age-matched TD children (4–7 y) and children with WS (8–18 y) on two tasks: 1) free colour naming using the Macbeth ColorChecker Chart; and 2) a computer-based chromatic discrimination (CD) threshold test, which isolates cone-opponent and luminance cardinal axes. The WS and TD groups differed significantly in: (1) the proportion of Basic Colour Terms (BCTs) and non-BCTs used (TDs use more modifiers (e.g. light/dark) but WS more combinations of BCTs with non-BCTs); (2) within-group consensus for naming desaturated and non-focal colours (WS less than TD), in particular for grey-scale, beige, turquoise and magenta colours. There were no significant differences in naming focal colours, nor were there differences in chromatic discrimination thresholds along any axis, between the groups. The results suggest that the atypicality and variability in colour naming for non-focal colours in WS is not explained by deficits in chromatic discrimination ability.
Newcastle Vision Fund and Estate of David Murray Garside

[2T3B005] Increasing cortical GABA levels through dietary intervention

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The balance of neural inhibition and excitation is key to healthy brain function, but may be abnormal in several clinical conditions, including epilepsy (Porciatti, Bonanni, Fiorentini & Guerrini, 2000). The brain's primary inhibitory neurotransmitter is gamma-aminobutyric acid (GABA). We investigated whether increasing availability of GABA precursors could affect neural responsivity, indexed by steady state visual evoked potentials (SSVEPs). Fourteen participants were shown sine wave gratings flickering at 7 Hz at a range of contrast levels, with and without an overlaid orthogonal mask flickering at 5 Hz. They then consumed a 5 ml daily dose of yeast extract, high in B vitamins and glutamate (both GABA precursors), over a four week period, before being retested using the same stimuli. The dependent variables were the SSVEP responses at the target and mask frequencies. A significant interaction between target contrast and yeast extract ($F(2.09,27.17) = 4.68$, $p < 0.02$) demonstrated that the intervention reduced neural responses at higher contrast levels by up to 20%, but did not affect baseline activity to a blank screen. This was confirmed by a main effect of the intervention on responses to the mask ($F(1,13) = 5.19$, $p < 0.05$). We conclude that dietary intake can influence neural activity, suggesting a potentially valuable supplement to seizure medications.
Part-funded by the Wellcome Trust [ref: 105624] through the Centre for Chronic Diseases and Disorders (C2D2) at the University of York

[2T3B006] Audiovisual temporal perception differences in autism spectrum disorder revealed by a model-based analysis

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The ability to integrate auditory and visual information is crucial to everyday life and results are mixed regarding how Autism Spectrum Disorder (ASD) influences audiovisual integration. To investigate this question we examined the Temporal Integration Window (TIW), which indicates how precisely sight and sound need to be temporally aligned so that a unitary audiovisual event can be perceived. A total of 26 adult males with ASD and age and IQ-matched typically developed males were presented with flash-beep, body-sound, and face-voice displays with varying degrees of asynchrony and asked to make Synchrony Judgements (SJ) and Temporal Order Judgements (TOJ). Analysis included fitting Gaussian functions as well as using an Independent Channels Model (ICM) to fit the data (Garcia-Perez & Alcala-Quintana, 2012). Curve fitting for SJs showed that the ASD group had a wider TIW, but for TOJ no group effect was found. The ICM supported these results and model parameters indicated that the wider TIW for SJs in the ASD group was not due to sensory processing at the unisensory level but rather due to decreased temporal resolution at a decisional level of combining sensory information.

[2T3B007] Perceptual and neural deficits in amblyopic sensitivity to naturalistic image structure

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Amblyopia is a developmental visual disorder that affects first-order metrics like acuity and contrast sensitivity. Many amblyopes also suffer losses on higher-order visual tasks, the neural bases of which remain unexplained. We recently reported that sensitivity to the higher-order statistics of naturalistic texture images provides a signature for processing in area V2 (Freeman et al., 2013). We therefore investigated whether amblyopes show deficiencies in detecting these statistics and whether there is a corresponding neural deficit in V2. We tested 5 amblyopes (4 macaques,1 human) using spatial 2AFC. They discriminated texture patterns retaining variable amounts of the higher-order statistical structure of original natural images from noise images that retain only the orientation and spatial frequency content. All amblyopes were impaired on the discrimination when viewing with their amblyopic eyes. To investigate any neural deficit, we measured sensitivity to naturalistic structure in recordings from 5 amblyopic macaques under anesthesia. We used 96-electrode "Utah" arrays to record multiunit activity and found that V2 sites driven by the amblyopic eye showed a reduced ability to distinguish naturalistic images from their noise counterparts relative to the fellow eye. We conclude that amblyopia modifies the processing of naturalistic visual structure.
NIH EY05864, EY22428

Oral Presentations: Gestalts, grouping and illusions

[2T3C001] The vista paradox

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An object seen through a window appears to shrink in apparent size as the observer approaches the window. Paradoxically, the distant object appears smaller as its visual angle increases. The effect was first reported by Cornish (1935) and baptized 'vista paradox' by Walker, Rupich, & Powell (1989), who investigated it experimentally in relation to approaching a window and looking at a scene outside the window. However, in this study there was no control over where the observers were fixating. We investigated the vista-paradox by varying object size, distance, point of fixation, texture of the frame and of the object. It turned out that fixation is essential for the illusion. Fixating the window frame led to an apparent shrinking of the object, whereas fixation on the object did not. Texture of the frame intensified the apparent shrinking of the object. Quite paradoxically, when separating the point of fixation from the frame, the illusion persisted. It also persists when removing the window altogether. That is, the window or frame is dispensable for the vista paradox.

[2T3C002] Non-retinotopic motion: Efference copies and Predictability

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Perception is usually non-retinotopic. For example, a reflector on the wheel of a bicycle is perceived to rotate on a circular orbit, while its retinotopic motion is cycloidal. To investigate non-retinotopic motion perception, we used the Ternus-Pikler display. Two disks are repeatedly flashed on a computer screen. A dot moves linearly up-down in the left disk and left-right in the right disk (retinotopic percept). If a third disk is added alternatingly to the left and right, the three disks form a group moving predictably back and forth horizontally. The dot in the central disk now appears to move on a circular orbit (non-retinotopic percept), because the brain subtracts the horizontal group motion from the up-down and left-right motion. Here, we show that predictability is not necessary to compute non-retinotopic motion. In experiment 1, the three disks moved randomly in any direction. In experiment 2, we additionally varied the shape and contrast polarity of the stimuli from frame to frame. In both cases, strong non-retinotopic rotation was perceived. Hence, the visual system can flexibly solve the non-retinotopic motion correspondence problem, even when the retinotopic reference motion is unpredictable and no efference copy-like signals can be used.
This work was supported by grant 153001, "Basics of visual processing: From retinotopic encoding to non-retinotopic representations", of the Swiss National Science Foundation (SNSF).

[2T3C003] Cross-Orientational Inhibition between real and virtual lines

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Alignment shifts in the Poggendorff figure (PF) have been explained by cross-orientational inhibition in visual cortex (Blakemore et al., 1970). Hotopf et al (1972a,b,1974) matched the orientation of a test line with a neutral line; Blakemore et al., rotated the line to point at a distant dot. In both cases the shift (<1 deg) was much too small to account for the PF in its entirety. We used a 2AFC task designed to reduce response biases. Observers ($n = 8$) saw 2 figures and had to decide in which of them a pointer was more aligned with another pointer or a distant dot. We confirmed Blakemore et al ($p = 0.0006$) but the mean effect was small (−0.92 deg over subjects), whereas in the PF it was much larger (5.2 deg; $p = .0002$). A small gap of the apex of the Blakemore et al stimulus reduced their effect still further (0.42 deg; $p = 0.18$). Hotopf et al note other factors that could boost the PE and we have discovered another: the perceived angle of virtual lines also shows repulsion from the vertical parallels (2.21 deg; $p = 0.007$). Like other 'illusions' the PF has evolved to be conspicuous rather than informative.
Wellcome Trust

[2T3C004] Size and distance as determinants of the Ebbinghaus illusion

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The Ebbinghaus illusion has been extensively studied, but there is no consensus about its explanation. The phenomenon was often described essentially as follows: identical targets look smaller/larger when surrounded by several larger/smaller figures. This description in terms of size contrast has inspired a corresponding class of explanations, which claims that size contrast is the cause of the phenomenon. However, the illusion can also be described in terms of the distances of the surrounding figures rather than their sizes: identical targets look smaller/larger when surrounded by several further/nearer figures. Distance has indeed long been recognized as an independent factor affecting the strength of the illusion. We report four experiments using variants of the Ebbinghaus display, whose purpose was to test whether size of surrounding figures as such is an independent causal factor. For better control of distances between the elements of the stimulus constellations, figures with straight contours were used instead of conventional circular shapes. We found that in one variant the illusion was reversed despite the presence of size contrast, whereas in another variant it was present despite the absence of size contrast. The results strongly suggest that size is not a separate causal factor of the Ebbinghaus illusion.
This research was supported in part by the Serbian Ministry of Science and Education, grant ON179033.

[2T3C005] Limits of perceptual organization in dynamic displays

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Images disjointed in space and time evoke the perception of moving objects by virtue of spatiotemporal grouping. We study how spatiotemporal proximity between image parts

determines the perception of motion and spatial configuration. We use two types of multistable motion displays: motion lattices and rotating dipoles. In motion lattices, alternative groupings underlie perception of motion in different directions (Gepshtein & Kubovy, 2000). In rotating dipoles, alternative groupings underlie perception of different spatial configurations: multiple spinning dot pairs vs. two pulsating rings of dots (Anstis & Kim, 2011). For perception of both motion and spatial configuration, we identify points of equilibrium: the conditions at which alternative percepts are equally likely. We find that individual points of equilibrium of perceptual organization are predicted from the individual limits of contrast detection summarized by individual spatiotemporal contrast sensitivity functions. Our results demonstrate that perception of motion and spatial configuration in high-contrast discrete visual displays fall under the same constraints as detection of continuous visual stimuli near the threshold of visibility.
This work was supported by Odysseus grant from the Flemish Society for research (FWO) (to CvL); by National Institutes of Health Grant EY018613 and National Science Foundation Grant 1027259 (to SG).

[2T3C006] Perceptual Organization and Visual Attention: Attentional Capture by Objecthood

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We have previously demonstrated that a perceptual object can attract attention automatically (Kimchi et al., 2007). Here we explored: (a) Does the attentional capture by an object involve a spatial component? (b) Which Gestalt factors suffice for an object to capture attention? (c) Does the strength of organization affect the object's ability to capture attention? Participants viewed multi-elements displays and identified the color of one element or responded to a Vernier target. On some trials, a subset of the elements grouped by Gestalt factors into an object that was irrelevant to the task and unpredictive of the target. Object effect – faster performance for targets within than outside the object – was found also when the target appeared after the object offset, suggesting deployment of attention to the object location. Object effects of similar magnitude were found for objects grouped by collinearity, closure, and symmetry combined, by closure and symmetry, or by collinerity, but not symmetry, suggesting that collinearity alone, and closure and symmetry, suffice for attentional capture by an object, but symmetry does not. Finally, grouping strength in modal completion, manipulated by varying contrast polarity between and within elements, affected the effectiveness of the attentional capture by the object.
This research was supported by Israel Science Foundation Grant 94/06 to R.K. and Y.Y. and by Max Wertheimer Minerva Center for Cognitive Processes and Human Performance, University of Haifa.

[2T3C007] Fast detection yet slow recognition of emerging images

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Visual object recognition typically happens very fast and it has therefore been difficult to disentangle its constituent processes. Extended recognition times have been observed for images with emergent properties, suggesting these may help examine perceptual and cognitive processes in object recognition. Until now, their use has been constrained by limited availability. Here, we used a new set of 15 stimuli with emergent properties – akin to the famous Gestalt image of a Dalmatian – in combination with eye tracking to examine the processes underlying human object recognition. Recognition times were relatively long (median $\sim$ 5 s), confirming the objects' emergent properties. Surprisingly, already within the first 500 ms, the majority of fixations were aimed at the hidden objects. Contemporary saliency models – that emulate the early feature processing stages of human vision – fail to predict these eye movements. The fast detection suggests that observers selected potentially relevant image sections based on image statistics presently not captured by these saliency models. The quick detection yet slow recognition of emergent images points towards discrete contributions of perceptual and cognitive processes to human object recognition. This may eventually aid the development of better biologically plausible computer vision algorithms.

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Wednesday August 26th

Posters

[3P1M001] Understanding parity: Is the odd-effect odd or even?

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Parity (odd/even) and magnitude are well accepted as two fundamental features in the representation and processing of numbers. It has been shown that odd numbers are processed slower relative to even numbers (the odd effect). One explanation of this effect comes from Linguistic Markedness (LM) which shows that marked adjectives are difficult to process compared to unmarked. Hines (1990) suggested that odd is marked because of the specific linguistic associations of that word. This seems contradictory to the idea that parity is a fundamental feature of numerical cognition. In the present study we test for this using a same-different classifications based on parity using odd-odd, even-even and even-odd pairs. If LM has a role in the odd effect, odd pairs would be judged slower than not just even pairs, but also odd-even pairs. The results showed that there was no difference in processing efficiency between odd-odd pairs and odd-even pairs whereas even-even pairs were classified relatively more efficiently. Hence, the odd effect seems to be, in fact, an even-effect wherein classification of even pairs is facilitated. This cannot be explained by the LM account. We propose that research on symmetry, specifically bilateral and translational symmetry, can explain the findings better.

[3P1M003] Distance and Time Estimation of Outdoor Routes Varying in Complexity and Encroachment

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More corners in a traversed route has been shown to increase the distance and time estimates of the route (Sadalla & Magel 1980). Also, the availability of optic flow information can influence distance perception resulting in larger estimates (Sun, H., et al 2004). 96 university undergraduates were shown 8 videos of outdoor walking routes from the 1st person perspective. The 4 critical routes contained either 1 or 7 corners (low/high complexity) and were either in an open park or in a forested trail (low/high encroachment). These routes were 200 meters long and took 175 seconds to view. Half of the participants had a GPS map in the corner of the video. Participants estimated the route length and route duration by providing a quantitative estimate. While watching the videos, eye-tracking data was collected. Results showed that the high encroachment conditions resulted in larger distance and time estimates. This is consistent with increases in the complexity of optic flow information, resulting in larger distance estimates. For both time and distance estimation, the high encroachment/high complexity condition produced significantly larger estimates. Also, high route complexity resulted in larger distance estimates. Eye-tracking data revealed several differences in gaze patterns across the experimental conditions.

[3P1M005] Temporal predictions in tone sequences

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Timing of stimulus onset is a key component of temporal judgements in daily life; however, human's sense of time is subjective. The present study aimed to understand how predictability of stimulus properties can improve perceived timing. We presented isochronous sequences of 3, 4, 5 or 6 auditory tones interspersed at random within each block. The timing of the last stimulus could deviate and participants reported whether it was either 'early' or 'late' relative to the expected regular timing. In the "scale" condition, the tones composed the musical scales. In the "shuffle" condition, the order of the tones was randomized. In all the sequences the last tone was 440 Hz to rule out perceptual distortions due to the frequency to be judged. Results indicate an overall better discrimination performance in the scale than in the random condition. Furthermore, the last stimulus in the sequence is perceptually accelerated with the longest sequence in the scale condition. These effects can be explained by hypothesizing that the melodic pattern acts as a predictive cue, thereby providing better discriminability also on stimulus onset timing. Expectations resulting from the combination of scale and sequence length leads also to a perceptual anticipation of the timing of stimuli.

[3P1M007] Number-space association in synaesthesia: An fMRI investigation

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Center, Mainz, Germany, Germany; Ben-Gurion University of the Negev, Israel; Ben-Gurion University of the Negev, Israel

Background: The laterality effect (LE) reflects the automatic classification of numbers in terms of left versus right in relation to the midpoint 5. Response times are faster for bilateral (e.g., 2–8) as opposed to unilateral (e.g., 1–4) pairs, illustrating the close link between numbers and space. Objectives: Here we look at the neural correlates of number-space association by examining the brain response in a spatial-form synaesthesteste (M.M) and sixteen non-synaesthete controls. Method: Participants reported the physically larger number in a size congruity task. Congruity and laterality were manipulated orthogonally. Congruent (e.g., numerical value and physical size match; 2 8) and (e.g., numerical value and physical size mismatch; 2 8) trials were presented for bilateral (e.g., 2 – 8) and unilateral number pairs (e.g., 2 – 4). M.M. represents numbers in the following manner: 8 6 4 2 0 1 3 5 7 9, so that large and small quantities are split against the midpoint zero. Results: Only for M.M. LE elicited significant activity in the supramarginal gyrus (bilateral) and in the left angular gyrus. Conclusions: These results strongly support the automatic activation of space by long-term numerical representation, and the role of the supramarginal gyrus in space-numerical coding.

[3P1M009] Effects upon magnitude estimation of the choices of modulus' values

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We used the magnitude estimation to investigate how the range of stimuli influences visual perception by changing the modulus value. Nineteen subjects with normal or corrected-to-normal visual acuity (mean age = 25.7yrs; SD = 3.9) were tested. The procedure consisted of two gray circles luminance of 165 cd/m2, 18.3 degrees apart from each other. On the left side was the reference circle (VA of 4.5 deg) in which was assigned four arbitrary values: (1) 20, (2) 50, (3) 100 and (4) 500. The subjects' task was to judge the size of the circles on the right side of the screen assigning the number proportional to the changed size, relative to the circle presented on the left side of the screen (modulus). In each trial, ten circle sizes (1.0, 1.9, 2.7, 3.6, 4.5, 5.4, 6.2, 7.2, 8.1, 9.0 degree of visual angle at 50 cm) were presented randomly. Our results shows a high correlation between the circle size judgment and different modulus sizes ($R = 0.9718$, $R = 0.9858$, $R = 0.9965$ and $R = 0.9904$).The Power Law exponents were (1) 1.28, (2) 1.34, (3) 1.29 and (4) 1.40. Increasing the size of modulus, bigger the exponent gets due the wide range of numbers available to judge the size.

[3P1M011] Simulated travelled distance in an immersive virtual environment is better estimated when adding biological oscillations to the optical flow

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Distance estimation from visually simulated self-motion is imprecise. Depending on the evaluation method, travelled distance can be under- or over-estimated. One particular method consists of asking a stationary observer, exposed to an immersive optical flow, simulating forward self-motion, to indicate when s/he thinks s/he has reached the remembered position of a previously seen distant target. In this case, subjective evaluation of travelled distance is generally overestimated (i.e., the subject undershoots the target). Recent studies suggest that a translational optical flow with biological additional oscillations (simulating the optical effects of natural locomotion) would increase the sensation of walking and improve spatial perception, as compared to a purely translational optical flow. In the present study we tested this hypothesis, by measuring travelled distance estimation, according to two conditions of visual simulation of forward self-motion, at constant speed, in a CAVE setup: (1) an optical flow simulating pure forward translation (2) an optical flow with added "biological" oscillations, reproducing the optical effects of the natural motion of the head during walking. Our results show that an optical flow containing additional biological information enhances the accuracy of travelled distance estimation. The perceptual advantage provided by the biological oscillations in the optical flow is discussed.

[3P1M013] Perceptual momentum influences bistable perception of the Lissajous figure

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We have recently re-introduced the Lissajous figure as a tool to study bistable perception (Weilnhammer, Ludwig, Hesselmann, & Sterzer, 2013). The Lissajous figure is an ambiguous depth-from-motion stimulus, first introduced to experimental psychology more than 80 years ago (Weber, 1930). The figure's complexity, line width, and rotational speed modulate its perceptual dynamics, and we found that longer self-occlusions resulted in shorter dominance durations, while higher rotational speed yielded increased dominance durations (Weilnhammer, Ludwig, Sterzer, & Hesselmann, 2014). We tentatively proposed that higher rotational speed resulted in larger 'momentum', thereby decreasing the probability of perceptual transitions (i.e., an inversion of rotation direction). Here, we sought to further investigate the 'momentum' account by manipulating the rotational speed and the size of the Lissajous figure, under the assumption that perceptual momentum is independent of stimulus size. We replicated a significant effect of speed, but found no effect of stimulus size. This pattern of results supports an influence of representational momentum on the perceptual dynamics of the Lissajous figure. Using a Bayesian modelling approach, we will also address the question of how increased rotational speed leads to higher estimates of stimulus stability and how this might act on the occurrence of perceptual transitions.

[3P1M015] Estimates of eye velocity are tuned for speed

Tom C Freeman, Maria Cucu and Laura Smith
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Estimating eye velocity helps convert retinal motion into movement with respect to the head and other coordinate frames. Models of these coordinate transforms assume that eye-velocity estimates encode speed – yet direct evidence is scant. We therefore measured the orientation of discrimination contours in the distance-duration plane for pursued stimuli. If speed dominates, stimuli moving over different distances and durations should be more difficult to discriminate when their speed is the same. Discrimination contours (ellipses) will therefore be oriented obliquely along iso-speed lines. Because extra-retinal signals and retinal flow may both contribute to eye velocity estimation, we measured discrimination with and without visible backgrounds. In Experiment 1, a horizontally-moving pursuit target was shown in the dark (no flow), with horizontal lines (reduced flow) or vertical lines (high flow). Resulting ellipses were oriented along the iso-speed line, suggesting speed was dominant in all conditions. But ellipses were less elongated in the presence of flow, suggesting backgrounds enhanced distance cues not speed. In Experiment 2, distance cues were downgraded using short-lifetime dots. Discrimination ellipses were now more stretched along the iso-speed line. The results suggest: (1) eye-velocity estimates are tuned for speed; (2) both extra-retinal and retinal-flow cues contribute.

[3P1M017] Spatial integration in dynamic random-dot patterns depicting either first-order or second-order global motion

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Previous studies have investigated the spatial integration limits for first-order (luminance-defined), but not second-order (contrast-defined), global motion in human vision. In the present study, we compared coherence thresholds for random-dot-kinematograms (RDKs) containing either luminance-defined (modulation depth 0.3) or contrast-defined dots (modulation depth 0.8) depicting translational, rotational or radial motion. The diameter of the circular aperture in which the dots were displayed was varied (in equal logarithmic steps) from 2 to 16 degrees. Regardless of the type of dots used and trajectory depicted, participants' ($N = 7$) thresholds decreased as image size increased. However sensitivity was greatest for rotational motion and least for radial motion, especially with the smallest RDKs tested. The minimum image size for which the direction of global motion was still reliably discernable was larger for RDKs composed of second-order dots than first-order dots. Nonetheless when differences in absolute sensitivity were taken into account, thresholds for first-order and second-order global motion fell at the same rate as RDK diameter increased. These findings reinforce the notion that if first-order and second-order local motions are detected separately, they are subsequently combined across space by a cue-invariant global motion mechanism, consistent with the properties of some neurons in extra-striate areas MT and MSTd.

[3P1M019] Electrophysiological correlates of motion extrapolation

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Motion extrapolation (ME), the ability to predict the future states of moving objects that are hidden by an occluder, is critical to interact with a dynamic environment. In a classical paradigm, participants are required to estimate time to contact (TTC) by pressing a button when the occluded moving target reaches a certain cue. Research using this paradigm showed that adapting the specific regions in which the target will be occluded produces a shift in the TTC estimate: adaptation in the same direction increases TTC, whereas adaptation in the opposite direction shortens it (GIlden et al., 1995). In this study, we asked whether the modulation of TTC by motion adaptation is reflected in the Contingent Negative Variation (CNV), a frontal electrophysiological component related to timing processing. Results showed a larger CNV amplitude after adaptation in the same direction of the target, possibly suggesting that visual and frontal areas interact during ME. Furthermore, we asked whether motion extrapolation could elicit an N2 component, which is normally elicited at the onset of visible motion at the posterior sites.Results showed a negative component peaking at 190 ms post-occlusion at posterior sites ipsilateral to the direction of ME, potentially indexing the "start" of the actual ME.

[3P1M021] Psychophysical approbation of an algorithm for coherent motion perception

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Moving dot stimuli are used to study mechanisms of motion perception. Unfortunately independent researches yields diverse threshold values e.g. 5.6 ± 0.39 (%) (Ridder, Borsting, Banton, 2001); 15.34 ± 4.71 (%) (Milne et al., 2002); 25% (Slaghuis, Ryan, 1998). Dissonance among results may rise because lack of joint conception of motion perception stimuli design as well as from individual experience of test participants. We have studied how threshold values are influenced by differences in stimuli design (shape of the test field, moving dot density) as well as type of protocol of psychophysical testing. Lowest thresholds values were obtained by test field with elliptical shape ($r = 6.2$ deg at 50 cm) having dot velocity vectors constant (2 deg/s) with limited fluctuations in dot density over the time. In case of constant stimuli coherent motion perception threshold was (5.0%, 0.4SD) and with adaptive staircase 4AFC psychophysical protocol it was (6.5%, 1.7SD).
Preliminary results suggest that perceptual learning do affect repeatability of test results as well as fatigue of participant (Lee, Lu, 2010).
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[3P1M023] Inter-scale suppression and facilitation in motion-discrimination are unaffected by dichoptic presentation

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The discrimination of motion direction of a fine-scale pattern is impaired when a static coarse-scale pattern is added to it. The strength of the impairment is unaffected by dichoptic presentation (Derrington et al., 1993), so it suggests that the interaction between different motion sensors tuned to high and low spatial frequencies is happening after binocular combination. Interestingly, discrimination of motion direction improves when a static fine-scale pattern is added to a moving coarse-scale pattern. In this work we tested whether this facilitation is also unaffected by dichoptic presentation. Using a mirror stereoscope, we measured duration thresholds of Gabor patches moving horizontally at 2 deg/sec. We tested four conditions, two dichoptic presentations: a) 1 c/deg moving in one eye and a static 3 c/deg in the other eye; b) 3 c/deg moving in one eye and 1 c/deg static, and two monocular presentations, both stimuli (the static and the moving pattern) presented in the same eye. Results of 4 subjects showed that impairment and facilitation effects in motion discrimination were present with the same strength in both monocular and dichoptic presentations. We suggest that facilitation in motion discrimination is caused, after binocular combination, by the interaction between two motion mechanisms tuned to coarse and fine scales.

[3P1M025] Comparing the effects of contrast on perceived speed for linear and radial gratings

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At low speeds, lower contrast linear gratings appear to move more slowly than higher contrast gratings. This effect is reduced and even reversed at higher speeds. Are similar effects observed for ring-like radial gratings? Although drifting linear and radial gratings can be matched for local spatio-temporal properties, radial gratings have more complex global structure, approximating optic flow associated with either self-movement or object-movement in depth. Using a standard 2IFC method we assessed perceived speed of a low contrast (8%) reference grating moving at 1, 4, 8 deg/s (Exp 1, $N = 19$) and 2, 6, 12 deg/s (Exp 2, $N = 18$) relative to a higher contrast (64%) comparison. Linear stimuli were gabor patches ($SF = 1$ cpd, $\sigma = 3.33$ deg) and radial stimuli had matched spatial parameters. Consistent with previous studies, participants judged lower contrast linear gratings as markedly slower than higher contrast gratings, except at the highest speeds tested. This was also true for radial gratings, however, biases in perceived speed for these stimuli were even more pronounced at low reference speeds (1–6 deg/s). Contrast-dependent effects on speed perception appear to vary depending on the global structure of the stimulus.

[3P1M027] Perceived speed of mixed-contrast random-dot kinematograms

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Perceived speed and subsequent driving behaviour are thought to be altered in conditions of low contrast, e.g. when driving in fog (Thompson, 1982; Snowden, Stimpson & Ruddle, 1998). Here, we investigate perceived speed in scenes containing both high- and low-contrast components (e.g. street lights/fog lights visible through the fog). We varied the proportions of high- and low-contrast dots in random-dot kinematograms (RDK) and investigated the effect on perceived stimulus speed.

We manipulated the proportion of high-contrast dots (20%, 50%, 80%, 100%) and the speed (4 deg/s and 8 deg/s) of the mixed-contrast RDK. Perceived speed was measured using a 2AFC design in which participants (N = 15) reported the faster of a mixed-contrast standard RDK and a low-contrast test RDK. RDKs were circular patches (diameter 7 cm, dot density 5.2 dots/cm2). Low-contrast dots (8% contrast) and high-contrast dots (64% contrast) were presented against a mid-grey background. Standard and test RDKs were presented simultaneously, with a separation of 10 cm, for 500 ms. Mixed-contrast RDKs were perceived as faster than low-contrast RDKs, however no significant effect of speed or proportion of high-contrast dots was found. These results suggest that high-contrast information determines perceived speed regardless of the relative proportion of high- to low-contrast components.

[3P1M029] Late, decision-related biases in reports of visual motion direction

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Following a fine-discrimination task of the direction of a field of moving dots relative to an oriented reference line, subjective reports of motion direction can be biased away from the reference (Jazayeri & Movshon, 2007). A decoding model that applies a weighting profile during stimulus decoding could quantitatively account for such a repulsion. Alternatively, this repulsion may reflect a relatively late response bias. Here, we manipulated the reference line during the task: in the first experiment subjects (n = 5) performed the same, fine-discrimination task in the presence of the reference, but subsequently estimated motion direction in its absence. The weighted decoding model predicts perceptual biases under these circumstances, but we found subjects' responses to be unbiased and veridical. In the second experiment, following the fine-discrimination task, a reference line was present during the estimation phase, but we manipulated its angular position (shifted by either -6°, 0° or $+6^\circ$ with respect to the discrimination phase). In this case, the directions reported by the subjects were biased, but were yoked to the location of the shifted reference line. Taken together, these results are better explained by a late, decision-related bias rather than an early, sensory or decoding bias.

[3P1M031] Impaired discrimination of radial motion in early-onset cannabis users

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Rationale: Early-onset cannabis use is associated with impaired visual processing.
Objectives: The present study investigated whether event-related potentials (ERPs) elicited in a radial motion discrimination task differ between early-onset cannabis users and non-user participants. Method: 18 early-onset cannabis users ($M = 22.44 \pm 5.01$; Age of onset $M = 15.11 \pm 1.28$) and 25 controls ($M = 22.04 \pm 3.46$) were evaluated. Stimuli were 50 low contrast (<16%) dots moving radially outward or inward in pseudo-random order. Five levels of motion coherence were tested: 6, 24, 30, 38 and 80%. Mixed measures ANOVAs were run with

Group (control, cannabis) as the between subject factor and Motion coherence (6, 24, 30, 36 and 80%) as the within subject factor. Dependant variables were accuracy and N2, P2 and P3 peak and latency. Results: N2, P2 and P3 amplitudes were significantly reduced in the early-onset cannabis group compared to the control group, but we found no significant differences for the latencies. The P2 peak amplitude reductions over the right parietal area correlated significantly and negatively with total number of years of cannabis use in the cannabis group. Conclusion: Prolonged cannabis use with early age of onset is associated with reduced neural correlates of motion processing.

[3P1M033] Elementary motion cues to animacy perception: speed changes elicit social preferences in naive domestic chicks (Gallus gallus domesticus)

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Motion cues, implying the presence of an internal energy source, elicit animacy perception in adults and preferential attention in infants. We investigated whether speed changes affecting adults' animacy ratings elicit spontaneous social preferences in visually-naïve chicks. Observers evaluated the similarity between the movement of a red blob and that of an animate living creature. The red blob entered the screen and moved along the azimut. Halfway through its trajectory the object could either continue to move at a constant speed and direction, or reverse its motion direction and/or linearly increase its speed. The average speed, the distance covered by the object and the overall motion duration were kept constant across stimuli. Subjects reported significantly higher animacy ratings for accelerating objects, regardless of whether they reverted their motion direction. Two-day-old chicks were tested for their spontaneous preference for approaching the red object moving at a constant speed and trajectory (inanimate stimulus) or an identical object, which suddenly accelerated and then decelerated again to the original speed (animate stimulus). Chicks showed a significant preference for the animate stimulus, indicating that motion cues causing animacy perception in humans elicit spontaneous preferences in naïve animals. *This research was founded by an ERC Advanced Grant (PREMESOR ERC-2011-ADG 20110406) to G.V.*

[3P1M035] Eccentricity effects in optic flow parsing

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Rushton & Warren (2005) proposed the existence of a flow parsing mechanism that globally subtracts optic flow resulting from self-movement. Any remaining motion can then be attributed to the movement of objects in the scene. Accordingly, stationary participants fixating the centre of a radial expansion field perceive an eccentric probe to move towards the centre, consistent with global subtraction of the outwards radial flow (Warren & Rushton, 2009). Furthermore, the perceived illusory movement is larger at 4 deg than 2 deg eccentricity, which is expected given the increase in flow speed with eccentricity. Here we investigate in more detail

the dependence of the magnitude of this effect on probe eccentricity. Stationary participants fixated the centre of an expanding radial field of limited lifetime dots simulating forward movement at 0.6 m/s. The perceived trajectory of a horizontally displaced ($\pm$1, $\pm$2, $\pm$3, $\pm$4, $\pm$5 deg), vertically moving probe was indicated by orientating an onscreen gauge. Potential contributions of local motion mechanisms were minimised by removing optic flow in an aperture (diameter = 6 deg) surrounding the probe. Perceived trajectory was biased towards the centre and this effect increased approximately linearly with eccentricity.

[3P1M037] White-matter pathway connecting sensory cortical regions involved in optic-flow processing

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Previous studies have reported concurrent activation in the visual, multisensory and vestibular areas during optic-flow stimulation (Cardin & Smith, 2010; 2011). This study aimed to investigate how those optic-flow selective areas communicate through white-matter pathways, by combining functional magnetic resonance imaging (fMRI) and diffusion-weighted imaging (DWI). Using fMRI, we localised the optic-flow selective sensory areas in six participants. We performed probabilistic fibre tractography (mrTrix toolbox; Tournier et al., 2012) on the DWI data obtained from the same participants, and identified a white-matter tract connecting the multisensory/vestibular areas in the parietal lobe (VIP, p2V, PcM) and the vestibular area in the temporal lobe (PIVC). The anatomical shape and location of this tract are consistent with those of that identified in post-mortem studies (Sachs, 1892; Vergani et al., 2014). Results of tractography were evaluated using Linear Fascicle Evaluation (LiFE; Pestilli et al., 2014), which yielded statistically significant evidence supporting the existence of this tract. These findings suggest that the multisensory/vestibular areas in the parietal lobe (VIP, p2V, PcM) and the vestibular area in the temporal lobe (PIVC) communicate through this pathway, and that this pathway may support sensory integration underlying optic-flow processing.

[3P1M039] Brain asymmetry influences biological motion perception in newborn chicks (Gallus gallus)

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A small number of light-points on the joints of a moving animal give the impression of biological motion (BM). Visually-naive chicks prefer BM to non-BM, suggesting a conserved predisposition to attend to moving animals. In humans and other mammals a network of regions, primarily in the right hemisphere, provides the neural substrate for BM perception. This has not been investigated

in avians. In birds the information from each eye is mainly feeding to the contralateral hemisphere. To study brain asymmetry, we recorded the eye spontaneously used by chicks to inspect point light displays (PLD). We also investigated the effect of lateralization, following light exposure of the embryos. In Experiment 1, highly-lateralized chicks aligned with the apparent direction of motion only when they were exposed to the PLD moving rightward first. Because an alignment with a rightward moving stimulus implies monitoring it with the left-eye-system, our results suggest a right hemisphere dominance in BM processing. In Experiment 2 weakly-lateralized chicks did not show any behavioral asymmetry. Moreover they counter aligned with the apparent direction of motion, suggesting a modulatory effect of brain lateralization on social interactions. Environmental factors (light stimulation) seem to affect the development of lateralization, and consequently social behavior.
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[3P1M041] Predicting curved motion during smooth pursuit and fixation

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Previous work has shown that motion prediction is enhanced during smooth pursuit of linear motions (Spering, Schütz, Braun, & Gegenfurtner, 2011). The current work extends those findings to certain curved motions. Subjects sat in front of a dark screen in a dark room. They were instructed that if the trial started with a green fixation spot, they should smoothly pursue the target and if the trial started with a red fixation spot, they should continue fixating that location during target motion. After a button press, there was a 350 ms delay and then the ball (1 deg blurred red circle) and a goal (red vertical line segment, 3 deg tall, 0.1 deg wide) appeared. Motion trajectories were constant curvature arcs. Five curvature levels were tested and curvature was blocked. Gap sizes (5 and 8 deg) and motion durations (500, 800, or 1500 ms) were randomly interleaved. Velocity was constant at 11 deg/s. Subjects had to predict if the ball would hit or miss the goal. Prediction performance was on average higher for the smaller gap size and longer motion durations. The benefits of smooth pursuit for motion prediction, as determined by d′, were not as clear as for linear motion.
SFB TRR 135

[3P1M043] Ambiguous motion perception in vision and touch

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Introduction: Von Schiller's Stroboscopic Alternative Motion (SAM) stimulus alternates two visual diagonal dot-pairs, inducing apparent motion. A linear increase of the SAM's aspect ratio ("AR": vertical divided by horizontal dot distances) causes a nonlinear change from horizontal to vertical motion perception with a vertical bias at AR = 1. We compared apparent motion perception evoked by visual versus tactile stimuli, with a focus on reference frames. Methods: For the tactile SAM stimulus we attached vibrotactile stimulators to participants' forearms and varied ARs by changing either the distance between forearms or between stimulators on each forearm. We further varied the relation between endogenous and exogenous reference frames by rotating the forearms (45° and 90°).Results: Visual SAM results reproduced previous findings. Tactile motion perception stayed ambiguous for small ARs, becoming biased towards vertical motion with increasing AR, but to a lesser extent than in vision. Surprisingly, a 90° forearm rotation had no effect, whereas 45° biased perception towards horizontal motion. Discussion: Similarly to vision we found a tactile vertical bias, being largely independent of the relation between reference frames, however with one surprising exception: A 45° forearm rotation biases perception to horizontal motion. Our results confirm Bayesian probability approaches of perception.

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[3P1M045] Equivalent noise (EN) analysis of motion direction discrimination in adults with Autism Spectrum Disorders (ASD)

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EN analysis differentiates the influence of local neural noise, affecting the precision of local directional estimates, from the efficiency with which these estimates are averaged (Dakin et al., 2005). Recent models of atypical perceptual processing in ASD propose differences in precision, possibly arising from altered endogenous neural noise (Pellicano & Burr, 2012; Simmons et al., 2009; Davis & Plaisted-Grant, 2014). This has recently been assessed in ASD using a rapid EN procedure (Manning et al., 2014). We adopted an extensive EN procedure allowing more detailed characterisation of the EN function. Sensitivity to average motion direction at increasing, multiple levels of stimulus noise was measured. Adults with ASD were at least equally as sensitive to global motion direction as neurotypical adults when local directional variability was low. At greater levels of stimulus noise, when multiplicative noise is the dominant influence on performance, our results suggest a reduced influence of multiplicative noise in ASD, consistent with Manning et al. (2014). These findings are discussed in the context of theoretical models of precision and atypical perception in ASD.

MRC doctoral training studentship

[3P1M047] The effect of simulated vision loss on walking paths

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Individuals with unilateral visual neglect have difficulties walking. They tend to pass through doorways off-centre, and collide with objects on the neglected side. Neglect is an attentional disorder associated with a reduced awareness of objects to one side of the body. Hemianopia, a sensory deficit, often co-occurs with neglect. In hemianopia there is a reduced awareness of objects to one side of fixation. We simulated the perceptual effects of neglect and hemianopia and examined their contribution to walking difficulties. Twelve healthy volunteers wore a head-mounted display and walked through free-roaming virtual environments. Trajectories were recorded as participants walked towards virtual targets located 7 m away in open, closed, empty and cluttered environments. Walking paths through empty space towards targets were unperturbed by simulated hemianopia or neglect. When walking through cluttered spaces, participants occasionally collided with obstacles. We conclude that the restriction of seen space associated with neglect or hemianopia is not responsible for the major difficulties experienced by patients with neglect.
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[3P1M049] Hand proximity effect: The role of Space, Object and Disengagement

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It has been argued that objects appearing near the hands enjoy enhanced visual processing. Enhanced spatial prioritization is thought to underlie the hand-proximity effect. It has also been suggested that a slower attentional disengagement from objects near the hands is more critical. In two experiments, we pit the two accounts against each other to better understand the hand proximity effect. Participants completed a visual search task with their hands either on the monitor or on their lap. When on the monitor, the target could appear near the hand or farther away. Consistent with the disengagement account, search was more efficient in the lap condition as compared with the hand condition. However, consistent with the spatial prioritization account, search was more efficient in the near as opposed to far condition. In Exp 2, where items crowded only near or far from the hand, rendering the respective far/near location empty, all three conditions showed the same search slopes, further discrediting slower disengagement as an explanation. It also shows that the objects, not space near the hands are prioritized. That is, when there are no objects near the hand, the far condition is as efficient as near and no-hand condition.

[3P1M051] Manual grips selectively influence visual, auditory and audiovisual speech categorization

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Activating speech motor system can affect speech perception. In addition, it has been previously shown that some articulations are systematically associated with specific grip representations, for example syllable [ke] with power grip, and syllable [te] with precision grip (Vainio, Schulman, Tiippana & Vainio, 2013). Consequently, it is possible that activating grip motor representations can affect speech perception via vision and audition. Hence, we studied whether performing manual grips could influence speech perception. Participants watched and listened to visual (talking face), auditory (voice) and audiovisual (face and voice together) syllables [ke] and [te] while performing either a power or precision grip. Grip performance influenced speech categorization by increasing visual and auditory categorizations of the syllable congruent with the performed grip, i.e. power grip increased [ke] responses and precision grip increased [te] responses. Signal detection theory analysis revealed that grips did not influence the detectability of the stimuli, but they shifted the response criterion. That is, the perceptual category boundary moved to favour [ke] when power grip was performed, and [te] when precision grip was performed. The current study is the first to show that manual actions can have an effect on speech categorization.
Academy of Finland

[3P1M053] Are spatial indexes used to identify thematic roles for language?

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The finding that participants can identify agents and patients in scenes of several identical moving objects (Gao, Newman & Scholl, 2009) suggests that role assignment involves the spatial indexes that support object tracking (Pylyshyn & Storm, 1988). A multiple object tracking paradigm was adapted to examine whether visual tracking limits (due to a finite number of spatial indexes) influence agent and patient recognition accuracy. Participants described pushing actions between two spheres (an agent and patient) amongst a display of nine identical objects that moved randomly before and after the events. Agents and patients were identified at above chance levels for even three separate push events, exceeding the five index capacity proposed in fixed-limit theories (Kahneman & Treisman, 1984). However, accuracy was highest for one-push and lowest for three-push events. There was also a strong positive relationship between agent and patient assignment, with participants being most likely to swap the labels than produce any other type of error. This suggests that participants overcame capacity limitations by grouping objects together and switching attention between the objects of different push events. Therefore, the limitations of the visual attention system appear to influence thematic role assignment in language production.
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[3P1M055] The role of mirror neuron mechanisms in the anticipation of others' actions: An EEG study

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The functional role of the mirror neuron mechanism (MNM), which becomes active during both action execution and action observation, is still hotly debated. The present study investigated whether the MNM becomes activated already prior to the onset of observed actions when, on the basis of contextual information, the occurrence of the action was anticipated. If so, this would suggest a specific role in action anticipation. Additionally, its relation with individual differences in autistic traits (AQ; Autistic-spectrum Quotient) was examined. EEG recordings of 23 typically-developed participants were made during the observation of video clips depicting hand actions. Reductions in the power of the sensory-motor alpha band (8–13 Hz; mu rhythm), which presumably reflect MNM activation, were determined. A significantly reduced power in the mu rhythm was found during action observation but not prior to the onset of actions. No significant correlation was found between mu rhythm suppression and the extent of autistic traits. The findings suggest that the MNM does not get activated during anticipation of upcoming actions. The relationship between MNM activity and AQ scores will be extended to include individuals with autism.
Hull University 2013 Studentship scheme

[3P1M057] Implied Motion Priming and Motor Expertise

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Visual perception of implied human actions was examined via a short term priming paradigm. First, we checked whether a visual priming effect was observed with visible primes depicting movements. The stimuli we employed were static stimuli that implied or not human motion. Second, we investigated whether the degree of motor prime-target congruency impinged on the perception of human movements and whether motor expertise impacted on priming effects. Twelve French elite female gymnasts and twelve matched controls performed a speeded two-choice response time task. They were presented with congruent and incongruent prime-target pairs and had to decide whether the target stimulus represented a movement or a static position. Moreover, we manipulated three levels of prime-target similarity to distinguish between: (i) low-level physical repetition, (ii) same movement, and (iii) different movement priming effects. A main effect of prime-target congruence was revealed: Regardless of expertise, the subjects responded 45.5 ms faster in congruent trials than in incongruent trials. Detailed analyses confirmed the existence of both low-level and abstract priming effects. Surprisingly, compared to controls, experts did not display superiority when performing the priming task. The lack of motor expertise influence on priming may be explained by the display of static stimuli.
No fundings

[3P1M059] Visual memory in reaching and grasping

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The accuracy with which humans execute goal-directed grasping movements depends on the availability of vision. To grasp a target successfully, its position in space as well as its size must be processed. If visual information about the target is unavailable, a stored target representation needs to be accessed. Previous research suggests that object position and object size are two distinct features which are processed and stored in different cortical areas and also show different decay characteristics. Here, we tested if typical alterations in grasping kinematics due to increased memory demands (i.e. larger grip opening) reflect a decay of position information or size information. We manipulated the availability of visual feedback during grasping and introduced two different pre-response delays. Additionally, the grasp position was varied, either requiring a long reach toward the target (far condition), a short reach (near condition) or no reach (fixed condition). If only information about target size was required (fixed condition), grasp kinematics were unaffected by the availability of vision. In contrast, grasp kinematics changed with increased memory demands in near and far conditions suggesting rapid decay of position information following visual occlusion and a more stable representation of object size.
Work was funded by the Carnegie Trust

[3P1M061] Inversion effects are stronger for subordinate than for basic-level action recognition

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Previous results showed that actions can be recognized in multiple ways suggesting that several recognition levels exist in action recognition (e.g. a waving action can be recognized as a greeting or a wave). Categorization tasks suggest that the recognition of social interactions is more accurate at the basic-level (e.g. greeting) than at the subordinate level (e.g. waving). What is the origin of the supremacy of basic-level recognition? Here we examined whether basic-level recognition relies to a larger degree on configural processing than subordinate social interaction recognition. To do so we probed basic-level and subordinate recognition performance (RT and discrimination ability (d′)) of 20 participants for upright and inverted social interactions. Larger inversion effects are typically associated with stronger configural processing. Participants saw a one image at a time and reported whether it matched a predefined action. Our results showed that – contrary to our initial hypothesis – subordinate recognition of social interactions was significantly more affected by stimulus inversion than basic-level recognition. Moreover, recognition performance was better for subordinate than basic-level recognition. We show that these results can be well explained by a top-down activation of snapshot templates.

[3P1M063] Reading social intention in movement kinematics

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Spatio-temporal parameters of voluntary motor action may help optimize human social interactions, yet it is unknown whether individuals spontaneously perceive informative social

cues borne by action. This study investigates for the first time if social intention can be implicitly detected from motor actions at the second-person perspective. In this study, an actor and a partner participated in a task consisting for one of them, depending on an auditory cue, in grasping and moving a wooden dowel under time constraint. Before this main action, the actor performed a preparatory action, viz., placing the dowel on a starting mark. The information about who would make the main action was provided only through the actor's headphones. Analysis of motor performances revealed that actors initiated the preparatory and main actions differently depending on whether or not they knew they had to do the main action. Strikingly, partners showed similar effects on the main action despite having received only irrelevant prior information. Our data then support that social intentions could be spontaneously perceived in voluntary motor actions and then suggest an implicit cognitive processing of the social scope of other's action during social interaction.

[3P1M065] Depth constancy in grasping is only apparent

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It is known that the distance at which objects are presented affects their perceived depth, which becomes smaller at larger object distances. A similar bias is found in grasping tasks when objects are located at eye-height and only stereo depth is available for their 3D structure. Since by viewing the top part of objects we can gather contour information important to reveal their structure, we ask whether the visuomotor system is immune to these biases when interacting with objects seen from above. Participants grasped an object presented at different distances and at two heights (eye-height and 130 mm below eye-height) along its depth axis. We found that the grip aperture was systematically biased by the object distance along most of the trajectory. However, whereas the bias persisted up to the end in the eye-height condition, it vanished towards the end in the below eye-height condition. These findings suggest that grasping actions are not immune to biases typically found in perceptual tasks. On-line visual control can counteract these biases only when direct vision of both digits and final contact points is available, as when objects are seen from above and the hand is in their close proximity.

[3P1M067] Automatic imitation of hand and foot movements is independent of observed body posture

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Automatic imitation describes a stimulus-response compatibility effect whereby we are faster to perform a movement that matches an observed movement than one that is incongruent with the observed movement. Here we test for automatic imitation of hand and foot movements across different (whole) body postures. Images of a seated person were projected onto wall so that the chair in the image appeared to touch the floor. We tested two observed body postures: the (moving) hand was either above the (moving) foot, or below. The participants' task was to perform a hand or foot response to a target letter presented superimposed on the body stimuli. The current results revealed significant automatic imitation effects for both types of

observed body posture. The effects cannot be accounted for by a match of observed body to spatial frames (such as vertical Simon-like effects for hand and foot responses) as these were only aligned in the hand-above but not the foot-above condition. These types of "whole body" automatic imitation effects could provide a potential experimental tool for developing links between automatic imitation and perception-action associations found in social contexts such as the unconscious copying of postures and mannerisms (motor mimicry).

[3P1M069] Use of online vision for reach-to-grasp movements in adolescents with autism spectrum disorders

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Movement disturbances in autism spectrum disorders (ASD) have been a focus of research in addition to their social communication problems (e.g., Leary & Hill, 1996). However, kinematics properties of reach-to-grasp movements in adolescents with ASD have not yet been revealed. Here, we investigated how online vision affects kinematics properties of reach-to-grasp movements in adolescents with ASD, compared to typically developing (TD) peers. Participants, wearing liquid crystal shutter goggles, reached for and grasped a cylinder with a diameter of 4 or 6 cm. Two visual conditions were tested: Full vision (FV) condition (the goggles remained transparent during the movement) and no vision (NV) condition (the goggles closed 0 ms after movement initiation). The two visual conditions were alternated with each trial in one experimental session (Alternated condition), or each condition was blocked in the session (Blocked condition). TD showed larger peak grip aperture (PGA) difference between NV and FV conditions in the Blocked condition than the Alternated one. The majority of ASD participants showed similar kinematics pattern to TD. The results suggest that movement disturbances in ASD could not be always explained by a lack of use of online vision for motor control.
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[3P1M071] Removing binocular cues disrupts the lower visual field advantage for grasping but obeys Weber's law

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Humans achieve better performance when grasping stimuli positioned in the lower than in the upper visual field (VF). Moreover, visuomotor brain regions (such as SPOC) also show a lower VF preference for hand actions (Rossit et al., 2013). The current study investigated whether the lower VF advantage for grasping is related to the availability of binocular cues. Right-handed participants were asked to grasp objects in their lower and upper VF under conditions of either monocular or binocular vision. Under binocular viewing there was a stronger relationship between object size and maximum grip aperture when objects were presented in the lower VF as compared to the upper VF, whereas no lower VF advantage was observed in the monocular condition. In addition, a striking dissociation was observed between monocular and binocular grasping: in the monocular

condition the 'just notable difference' (JND) increased with object size in accordance with Weber's law, but not in the binocular condition. These results suggest the existence of a fundamental distinction between the way that object size is computed under binocular and monocular viewing conditions. Moreover they indicate that the lower VF advantage for grasping is 'boosted' by the availability of binocular depth cues (stereopsis and vergence).

[3P1M073] The role of task in the interaction between gestures' and words' meaning

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This study aims to verify whether the priming effect of gesture on same meaning words is modulated by the activation of different types of information in words. The priming gestures' meanings prompt visuo-spatial information yielding a pictorial semantic context for the meaning of the target words. The meaning of the target words can be activated through different types of information depending on the task. Behavioral and electrophysiological evidence was collected in a lexical decision and image formation task. The behavioral data showed a priming effect of the meaning of gesture in both the tasks. The electrophysiological data confirmed this result showing a significant larger N400 during the lexical decision task. In the image formation task we found a N300 effect modulated by gestures' meaning. The early flexible integration of gestures' and words' meaning seems to depend on the type of information elicited in the target words by the task.

[3P1M075] Reaching and grasping with pliers-like tools: a kinematic analysis

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Evidence that tools are 'incorporated' into the body schema—and are controlled as if part of the body—is compelling, but relates mostly to tools that only extend the arm's reach. Yet, tools commonly alter the relationship between hand posture and the tool tips in more complex ways. We examined how the brain compensates for such 'tool geometry' by studying grasps made with pliers-like tools. We manipulated tool 'gain', using tools that opened more (1.4:1) or less (0.7:1) than the hand opening. A 1:1 tool controlled for effects of tool use vs. the hand per se. Kinematic parameters reflected variations in object properties in the normal way (maximum tool opening increased with object size, for example). We compared tool grasps to a simple model, assuming the brain controls the hand so as to produce the same end-effector opening for a given object, independent of tool geometry. Varying tool gain caused substantial changes in hand opening in the predicted direction. These were insufficient, however, to fully compensate for tool geometry. Haptic-only estimates of perceived size, acquired with the same tools, were similarly biased. Our results are consistent with the brain compensating for tool geometry, but using a biased internal model.

[3P1M077] Seeing actions in the fovea influences subsequent action recognition in the periphery

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Although actions often appear in the visual periphery, little is known about action recognition away from fixation. We showed in previous studies that action recognition of moving stick-figures is surprisingly good in peripheral vision even at 75° eccentricity. Furthermore, there was no decline of performance up to 45° eccentricity. This finding could be explained by action sensitive units in the fovea sampling also action information from the periphery. To investigate this possibility, we assessed the horizontal extent of the spatial sampling area (SSA) of action sensitive units in the fovea by using an action adaptation paradigm. Fifteen participants adapted to an action (handshake, punch) at the fovea were tested with an ambiguous action stimulus at 0°, 20°, 40° and 60° eccentricity left and right of fixation. We used a large screen display to cover the whole horizontal visual field of view. An adaptation effect was present in the periphery up to 20° eccentricity ($p < 0.001$), suggesting a large SSA of action sensitive units representing foveal space. Hence, action recognition in the visual periphery might benefit from a large SSA of foveal units.

[3P1M079] Attentional allocation to feedback locations in motor movements

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Prior to executing a movement, attention is allocated to the movement target (Baldauf, Wolf & Deubel, 2006). However, when executing skilled actions, such as driving, performance is often improved when attention is directed to the external locations of feedback (Prinz, 1997). In light of these findings we examined the role of feedback and attentional allocation in the planning and execution of both pointing movements and saccades. Participants were presented with a circular array of eight digital 8s. They were asked to point or saccade towards a movement target, as indicated by a central arrow, while simultaneously identifying a briefly-presented discrimination target. Visual feedback on the accuracy of movement was provided, in the form of a brief colour change in one of the 8s immediately following the end of the movement. The results show elevated discrimination accuracy at both movement targets and feedback locations for pointing, but only at the movement target for eye movements. We discuss these findings in light of the role of visual feedback from one's own hand during movement, as well as the changes in the expected retinotopic location of feedback across saccades.
James S. McDonnell Foundation

[3P1M081] Investigating the veridicality of shape from shading for real objects

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We investigated the accuracy with which observers can infer the shape of real 3D objects from shading cues. Observers viewed sinusoidal, triangular and trapezoidal corrugations, illuminated from either the top-left or the left by a point-light source. Depending on light-direction, the shape and shading profiles of objects could be quite different. Terminating contours and the light source were not visible to the observer. The objects were first viewed monocularly, then monocularly in the presence of a white matte sphere placed to help identify light direction, and finally binocularly. In each condition, observers were asked to draw the depth profile of the objects as if they were seen from above, and to indicate the light direction. Dynamic Time Warping was used to quantify the similarity between the drawn profiles and the shape and shading profiles of the objects. Perceived shapes were more similar to the actual shapes than to the shading profiles, in all three conditions. Simple rules, such as "dark is perceived as deeper", could not explain perceived shape as a function of shading profile. Instead, we present a heuristics-based model to link the perceived shape of an object to its shading variations.
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[3P1M083] Feedback contribution to collinear facilitation is group dependent

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Collinear facilitation refers to an increase in sensitivity for a low-contrast Gabor target when placed between nearby, similarly aligned supra-threshold flankers. Many studies have explored the spatial and temporal characteristics of this phenomenon, and there is general consensus that the facilitation could occur via two sources: i) a slower, sustained mechanism based on lateral connections in V1, ii) a more rapid, transient mechanism involving extra-striate feedback to V1. There is some debate, however, about whether facilitation can occur if the target precedes the flankers, a manipulation known as backward masking. Such effects, if present, are more likely to be driven by the more rapid transient feedback mechanism. Here, we shed light on this debate using forward, backward and simultaneous masking with a sample of 25 participants. We used a shorter stimulus presentation times (35 ms) and shorter stimulus onset asynchronies ($\pm$35–70 ms) than previous studies, to help isolate transient feedback facilitation. We found collinear facilitation with forward masking for all participants, but backward masking for only 60% of participants. We describe a simple model that predicts our data based on the relative contributions of lateral and feedback facilitation mechanisms.

[3P1M085] Crowding and Shape Representations

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In crowding, target perception deteriorates when flanking elements are added. Crowding is traditionally characterized by target-flanker interactions which are (1) deleterious, (2) spatially confined within Bouma's window, and (3) feature specific. Here, we show that none of these

assumptions universally hold true. We determined vernier offset discrimination thresholds at 9° of eccentricity. When the vernier was embedded in a square, thresholds increased compared to the unflanked threshold. Surprisingly, when the vernier was flanked by three additional squares on either side, crowding strongly decreased. Similar results hold true for other shapes, including unfamiliar, irregular shapes. In addition, changing the flanking shapes' orientations led to increases in crowding. These results show that (1) more flankers can decrease crowding, (2) crowding strength can be determined by elements outside Bouma's window and (3) shape processing can determine vernier offset thresholds. We propose that visual acuity for each element in the visual scene depends on all elements in the entire visual field and, on top of that, on the overall spatial configuration. In addition, these results provoke the question of whether the human brain is, indeed, coding any type of shapes at all locations in the visual field.
Mauro Manassi was supported by the Swiss National Science Foundation fellowship P2ELP3_158876.

[3P1M087] Effect of local salience on the collinear masking effect

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Searching for a target in a salient region is considered to be easier than in a non-salient region. However, our previous study (Jingling and Tseng, 2013) found that a local target on a salient collinear structure is actually harder to find, termed "the collinear masking effect". In this case, the salient location was defined by collinear grouping, which creates a global salient structure. This study tested whether increase perceptual salience of the local target could reverse the collinear masking effect. In three experiments, we increased target salience in three different dimensions respectively: color, luminance, and temporal duration. Nevertheless, all of these manipulations still elicited the collinear masking effect. Our data suggest that this large well-grouped structure can alter perceptual salience of a local element, implying that global grouping preceded the computation of local salience. We argue that the collinear masking effect may not be due to the perceptual salience induced by the global structure, rather, may depend on collinear grouping of the structure.
MOST103-2628-H-039-001-MY3

[3P1M089] Illusory motion in an afterimage formed by gradation patches and the stimulus luminance as the determinant of the motion direction

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It is known that some kinds of repetitive gradation patches induce illusory motion perception, and the luminance of the background of the patches influences the motion direction. In this regard, Naor-Raz and Sekuler (2000) have briefly mentioned that a similar illusory motion could be observed in an afterimage produced by a sequential contrast in which the gradation stimulus was abruptly changed to a blank screen. However, the manner in which the background luminance and blank luminance specify the motion direction in an afterimage is unknown. In this study, we systematically manipulated both background luminance and blank screen luminance and

inspected the perceived direction of the illusory motion in the afterimage. The results revealed that the motion direction in the afterimage was not specified by either background or blank screen luminance alone but by a ratio of the two. This finding is discussed in terms of how the recovery from an adaptation of the primary stimulus and input of ray of the blank screen may produce the motion signals in the afterimage.

[3P1M091] The effects of contrast dissimilarity on crowding

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Visual crowding is a phenomenon in which peripheral object recognition deteriorates in clutter. Target-flanker dissimilarity generally facilitates object recognition in crowded conditions and reduces the spatial extent of crowding. However, Rashal and Yeshurun (2014) reported an exception to this rule when they found that low contrast targets are strongly crowded by high contrast flankers, even though they are dissimilar to each other. This might be because their stimuli used at-threshold display durations and backward masking, which are known to further increase crowding (Vickery, Shim, Chakravarthi, Jiang & Luedeman, 2009). In order to examine whether the unconventional contrast dissimilarity effects reported by Rashal and Yeshurun (2014) are of a general nature or specific to situations with backward masking, we systematically manipulated flanker contrast (high or low) and the presence of a backward mask. We observed increased crowding effects in conditions with masking and when low contrast targets were surrounded by high contrast flankers. However, these effects were not as prominent as reported by Rashal and Yeshurun (2014), even though we used a larger contrast difference. Nevertheless, the contrast dissimilarity effect on crowding was also present without masking, albeit in a weaker form, confirming the generality of this effect.
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[3P1M093] Sliding motion by different edge contrast

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Pinna and Spillmann (2005) showed that in an array of grey square-shaped checks which have different black and white edges in the central area from those in the surround, apparent sliding motion of the central area is perceived by keeping the gaze fixed on the moving dot. We systematically examined the role of edge contrast by using all four adjacent patterns; (a) black edges on the right and bottom, white edges on the left and top, (b) black edges on the left and bottom, (c) reversed edge polarity of (a), and (d) reversed (b). Patterns (a) and (b) can be perceived as convex, whereas (c) and (d), as concave. All the combinations of the four patterns in the central and the surround were presented with a horizontally moving dot, and the direction and magnitude of apparent sliding motion were measured. Results demonstrated that the direction of sliding motion changed when the pattern of the central and that of the surround were switched, and sliding motion was perceived independently of concavity and convexity but not perceived when the surround area was level with the background. We discuss our results from the viewpoint of the integration of the local light direction.

[3P1M095] The colorful stranger in the mirror – the strange-face-in-the-mirror illusion revisited

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The "strange-face-in-the-mirror-illusion" is a rather broad perceptive phenomenon, summing up different illusionary impressions, such as perceived deformations of one's own face, or seeing unknown, animal or archetypal faces, which seem to occur when gazing at one's own reflection in the mirror for a longer amount of time (Caputo, 2010). The present study investigated whether different colored ambient light would affect occurrence and intensity of the illusion. All participants gazed at their own face for five minutes under red, green and blue plus neutral ambient light and had to describe their impressions after each gazing interval. In addition they had to rate the intensity of perceived illusionary impressions while gazing at their face. To test for any relation of the strength of the perceptual impression and top-down mechanisms, e.g. the general tendency to be susceptible of paranormal phenomena we employed the Revised Paranormal Belief Scale (Tobacyk, 2004). Perceived intensity of the illusion was stronger for red and blue than for green and neutral light (large effects for greatest perceived intensity during the gazing intervals)—with people susceptible for paranormal beliefs showing higher amounts of illusionary perceptions in general.

[3P1M097] Visual processing of average size by chimpanzees

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Many studies have argued that the human visual system can compute the mean size of sets of circles (e.g., Chong and Treisman, 2003). Is such statistical processing of visual information unique to humans? Although comparative studies have implied that humans' perceptual grouping ability is superior to that of other species, it remains unknown whether other species can represent the overall statistical properties of multiple similar objects. We presented chimpanzees and humans with contrasting pairs of arrays consisting of either one circle or a set of 12 circles. The mean size of the circles was larger in one array than in the other. There were three experimental conditions: the heterogeneous (circles within each array were different sizes), homogeneous (circles within each array were the same size), and single (only one circle in each array) conditions. Chimpanzees and humans were required to touch the array containing the larger circle(s). The results show that there was little difference in accuracy between the two conditions for chimpanzees or humans. In addition, performance under these conditions was superior to that under the single condition. This is consistent with the results of Chong and Treisman (2003). This study suggests that chimpanzees can represent overall statistical properties.
This study was supported by the JSPS-MEXT Grants-in-Aid for Scientific Research (23220006, 15K16012, 26705009), and the Cooperation Research Program of Wildlife Research Center, Kyoto University.

[3P1M099] Perceived junction changes in crowding revealed with a drawing paradigm

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In crowding, objects that are discernible when presented alone become indiscernible when flanked by close-by objects. Here, we investigated appearance changes in crowding with a drawing paradigm. Participants drew stimuli presented in the visual periphery. Eye tracking assured that stimuli were only viewed when participants kept fixation. The drawings, made under free viewing conditions, were aimed at making the peripherally viewed stimuli and the freely viewed drawings appear as similar as possible. Targets consisted of line configurations and letters with various junctions between line elements. Targets were presented with or without flankers. To quantify junction changes in the resulting drawings compared to the stimuli, the drawings were evaluated with a recently developed scoring system. We found high rates of junction changes in crowding. Most changes were omissions: Junctions present in the stimuli were missing in the drawings. This was due to the frequent 'error' of not depicting presented line elements. L-junctions were more often added than X- or T-junctions. Flanker junctions determined perceived target junctions: X-junction were more often added to targets when present in the flankers. We propose that drawing is a useful tool to investigate crowding, providing a fine-grained characterization of appearance changes in crowded peripheral vision.

[3P1M101] The influence of object history on correspondence in the Ternus display

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How is the visual system able to know which elements belong together despite the input being ambiguous and incomplete? This correspondence problem could be solved on the basis of low-level factors, as for example motion energy based on luminance contrast, or by taking into account higher-level object representations. To investigate this question, we used the Ternus display, in which three elements are presented from one frame to the next, shifted by one position. Depending on how correspondence between the elements is resolved, this ambiguous apparent motion display can be perceived as one element jumping across the other two (element motion) or as all three elements moving together as a group (group motion). We manipulated the object history of the Ternus elements by presenting the elements in the beginning of each trial before starting the actual Ternus display either as moving together as a group along the same random motion trajectory or as moving independently, each following different motion trajectories. Participants perceived more group motion when the elements had a common than an independent motion history, suggesting that object history had an effect on how correspondence was solved. These results imply that higher-level object representations can influence correspondence.

[3P1M103] Vibration to increase or decrease strength of illusory motions

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The Fraser–Wilcox optical illusion (1979) is an illusory figure that is still in reality but is perceived to be moving. Kitaoka (2010) created color-dependent variants of this optical illusion. Meanwhile, Yanaka et al. (2011) pointed out that the color-dependent Fraser-Wilcox illusion is strongly perceived as an illusory motion when it is vibrated by a PC program or by hand etc. at several Hz. Under vibration via a computer, the illusion can be affected by limited frame rates and the afterimage of the computer display. With regard to vibration by hand, the challenge lies in determining stroke conditions and vibration frequency at which the strength of an optical illusion increases or decreases. In this work, we developed vibration equipment using a linear motor whose stroke and vibration frequency are set and controlled through a PC program. This equipment facilitates the observation of the effects of stroke conditions and vibration frequency. Illusory motions, such as that of the color-independent "waterfall" and "UFO" optical illusions of Kitaoka, which are classified as CDI, as well as drifting triangles illusion, are reinforced by the vibration that is perpendicular to an illusory motion. During vibration of the scintillating Hermann's grid, optical illusions become extinct.

[3P1M105] Color cast hypothesis of color-dependent Fraser-Wilcox optical illusion

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A reddish variant of the Fraser-Wilcox illusion (1979) was created by Kitaoka (2010). Kitaoka also proposed an empirical rule of the illusory motion direction based on the color layout. I found a more general and fundamental rule explaining the phenomenon. The retina has three types of cones which correspond to the three primary colors (i.e., red, green, and blue). A retina image is frequently renewed by eyeball movement, such as saccade. If the response time differs among the three kinds of cones, then apparent motion would occur. However, this hypothesis alone does not fully explain the phenomenon. Therefore, I introduced an additional hypothesis that the color of the color cast among the three primary colors is perceived more slowly compared with the two other colors. For example, in Kitaoka's reddish pattern, in which only two prime colors (i.e., red and blue) are used, red is perceived slower than blue because red is the color of the color cast. If the image is bluish, the direction of motion is reversed even if the two colors used are the same. This rule applies also in the cases wherein the two primary colors combined are red and green or green and blue.

[3P1M107] Decoding perceived and imperceptible feature conjunctions in human early visual cortex

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Studies in humans using functional magnetic resonance imaging (fMRI) indicate that feature conjunctions are represented as early as primary visual, or striate, cortex (V1). However, a remaining challenge is to disentangle the perception of these conjunctions from their simple presence in the stimulus, an important distinction when identifying brain regions that correlate with feature binding per se. We investigated the neural correlates of both perceived and imperceptible conjunctions in human visual cortex. We used temporally-alternating stimulus displays consisting of differently-coloured perpendicular gratings, or a novel checked stimulus where the colour-orientation conjunction information was distributed over time. The colour-orientation conjunction could be reliably discriminated at all but the highest frequency tested (30 Hz) in the gratings. However, in the checked stimulus it was discriminable only within an intermediate range of temporal frequencies (7.5–15 Hz). We adapted these stimuli for fMRI and probed the response in striate and extrastriate cortex using multivariate pattern analysis. Feature conjunctions in all stimulus displays could be reliably decoded from patterns of activity in striate and extrastriate cortex, even when those conjunctions were imperceptible. Together, our results indicate that the binding of colour and orientation is not fully resolved by early visual processes. *Supported by an Australian Research Council (ARC) Future Fellowship (C.W.G.C.; FT110100150), an Australian National Health and Medical Research Council grant (C.W.G.C.; APP1027258), and the ARC Centre of Excellence in Vision Science.*

[3P1M109] An aperture synthesis variant of the Müller-Lyer-Illusion is sensitive to visual reference frame manipulation

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We created a variant of the Müller-Lyer (ML) illusion combining the two classical ML figures into a bisected double arrow surrounded by a rectangular reference frame. The double arrow was revealed only within a small Gaussian aperture around gaze position, while the frame was always drawn in its entirety. As subjects could see only one of the three arrowhead elements at a time, judgments of figure symmetry required synthesis of visual information across sequential fixations. Either a visual reference frame or oculomotor information is required to achieve such synthesis.

We measured the size of the ML illusion with a two alternative forced choice method with a roving pedestal (Morgan, Melmoth and Solomon, 2013), which minimizes the effect of any cognitive biases. Measured illusion size in our aperture stimuli is comparable to that for completely visible controls.

To differentiate between visual and oculomotor synthesis, we introduced eye position based changes in the position of the reference frame which would reduce the size of the illusion for visual, but not for oculomotor synthesis. This manipulation produces a consistent reduction in the size of the ML illusion, suggesting that synthesis is at least in part based on purely visual references.

[3P1M111] The Influence of Familiar Size on Simple Reaction Times

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It has been shown that simple reaction times (SRTs) respond to the perceived rather than the retinal size of objects (Sperandio et al., 2009). It has also been shown, using a Stroop-like paradigm, a RT advantage to objects that are congruent to their real-world size (Konkle & Oliva, 2012). It is well known that familiar size influences the perceived size of objects, however, it remains unclear if and how SRTs are affected by object familiarity. Three experiments were carried out where participants were asked to react as fast as possible to pictures of familiar objects equated for luminance and angular size on the retina. A variety of objects were used with varying real-world sizes. Stimuli were observed under natural (experiment 1) and reduced viewing conditions (experiments 2 and 3). We found that SRTs decreased in response to objects that were presented at a size that was closer to their real-world size (experiment 2) and become progressively slower with increasing incongruence to their real-world size (experiment 3), but only under restricted conditions. These findings indicate that when visual and oculomotor cues are reduced, SRT is affected by previous knowledge of object size in a manner that reflects congruence with real-world information.

[3P1M113] GLM-based decoding of contour classification from EEG signals

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As our brain makes sense of continuously changing stimuli from the environment, parsing the precise time-course of a cognitive task remains a challenge (King & Dehaene, 2014). Here, we present a GLM-based decoding method that allows to test at which moment a specific neural feature becomes a predictor of a cognitive state on a single-trial basis.
For that, we will analyse electro-encephalographic responses of human subjects performing a 2AFC contour classification task (involving 11 Gabor, Mathes et. al, 2006), where local stimulus features are integrated into a coherent visual percept and further categorized into two classes. By using both contour and non-contour trials, we compute the probability of a stimulus being presented given a neural response, trial by trial. While contour integration can be decoded from occipital areas with 57.7% accuracy, oscillatory activity within frontal-parietal areas predict contour classification with 65.7% accuracy. With these results, we will argue that characterizing the neural correlates of a particular cognitive task, in a time-resolved fashion, sheds light on the temporal organization of cognitive processes, and is a novel method for understanding how neural representations are manipulated and transformed over time.

[3P1M115] Is implied flow necessary for global shape coding in textured contours?

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Radial frequency (RF) patterns, shapes formed by the sinusoidal modulation of the radius of a circle allow for the demonstration of global integration of local information around a shape. Textures with RF modulation of orientation are also globally processed, with the impression of a flow implying closure (flowsure) being observed to be critical for such integration to occur (Tan, Bowden, Dickinson, & Badcock, 2015). Psychophysical methods with four experienced observers were used to measure shape-deformation thresholds to determine whether this same requirement was necessary for global integration to occur in a textured (or second-order) RF contour. Gabor sampled RF patterns were utilized where the orientation of the patches on the path were either coincident with the path, orthogonal to the path, or randomly oriented around the pattern. Even when patches had orientations that were not tangential to the radius of a circle (as in conventional sampled RF patterns), global integration was observed. Textured RF patterns did not conform to the same requirements as modulated textures and flowsure of elements was not observed to be required for global integration to occur in such textured RF patterns.

[3P1M117] Figure and ground from 2D surfaces with ambiguous border ownership

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Image segregation into foreground and background requires information relative to which border in the image is likely to belong to which surface. Receptive field structures of cortical neurons likely to deliver the border ownership code have been identified. To clarify how the human perceptual system resolves ambiguous border ownership, configurations with contours bridging gaps between edge inducers with varying contrast polarity where presented in random order to human observers. The contours could be interpreted as belonging to the surface in the center of the configuration, or the surface surrounding the center. Control configurations consisted of surfaces (dark-on-light surround and light-on-dark surround) with unambiguous border ownership. Observers had to judge whether they perceived the central surface in front, behind, or in the same place with the surrounding one. Results show that response probabilities are determined by the theoretically predicted direction of filling-in in the ambiguous configurations, irrespective of the contrast polarity of the inducing elements. In the control configurations where border ownership is unambiguous, the polarity of contrast is found to predict the perceived relative depth of the two surfaces.
CNRS "Actions Interdisciplinaires 2015"

[3P1M119] Conscious perception of local elements enforces their global integration and vice versa

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The primary task for the visual system is to organize the disparate retinal input into integrated perceptual representations. The extent to which conscious perception is required for visual organization to persist, and vice versa is yet unclear. We addressed this question using a

continuous flash suppression (CFS) paradigm. In experiment 1, we tested whether a visible and invisible global context differentially modulates the perceived motion direction of a visible aperture stimulus (i.e., a stimulus that appears to move behind an aperture.) We found that the global context influenced perceived motion direction only when the context was visible. In experiment 2, a variant of the bistable diamond was used, consisting of four drifting gratings, which can be perceived as drifting independently, or as a global diamond shape moving behind occluders. The drifting gratings were presented in one eye in a square arrangement around fixation, while masks presented in the contralateral eye perceptually suppressed two of the gratings. We observed that a global perceptual interpretation of the visible gratings boosted the suppressed gratings into awareness faster, relative to when the gratings were perceived to drift independently. These results emphasize the mutual reciprocal reinforcement between conscious perception and global visual integration.

[3P1M121] Seeing the forest or seeing the trees: The role of urbanisation in the development of perceptual bias

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Global perceptual bias has been reported to emerge around 6 yr in Western populations (e.g. Poirel, Mellet, Houdé, & Pineau, 2008) and is thought to be a universal characteristic of perception in adulthood. In contrast, a remote Namibian population called the Himba demonstrate a strikingly local bias even in adulthood.This local bias diminishes with limited urban exposure in adulthood: Himba raised traditionally but relocated to town in adulthood are substantially more global than Himba remaining in the villages (Caparos, Ahmed, Bremner, de Fockert, Linnell, & Davidoff, 2012). Here we show that from as early as 6 yr urbanised Himba children already show a greater global bias than Himba adults raised traditionally but relocated to town in early adulthood. Furthermore we show that, within adults, both exposure to the urban environment earlier in life and exposure over a longer period of time are associated with a global perceptual bias comparable to that of Western adult populations.We conclude that global bias is not a universal characteristic of adult perception but requires urban exposure, or factors associated with such exposure, to be expressed.
Economic and Social Research Council UK and British Academy

[3P1M123] Colour induced enhancement of perception of global versus local movement

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Local and global perception of moving objects was studied psychophysically and neurologically (Anstis, Kim, 2011, J Vision 11(3);1–12; Zaretskaya et al., 2013, J Neuroscience 33, 523–531). Authors hypothesise prevalence principles of perceptual "local "vs. "global "grouping that depends

on stimuli geometry, lightness polarity, complexity. Previously elementary elements were gray-scaled and arranged in groups in various manners. We introduced: a)colour contrast between stimuli groups and between stimuli and background, b)viewing eccentricity of scene. We used spot doublets that can be perceived rotating around their symmetry centre ("local" motion) – organized at vertices of two squares that can be perceived sliding over each other along circular paths ("global" motion). Doublets were shown as red and green spots on yellowish background, further the colour saturation was minimized during trials. During onset of scene the local motion prevailed that further turned to global sliding of two squares. We measured with 2-AFC paradigm the time course of the first switching event to global motion in dependence of spot colour distances ΔK in La*b*space both for chromatic and achromatic scene and contribution of chromaticity into facilitation of switching. Facilitation of switching was observed increasing eccentricity of viewing continuously moving the fixation point from the doublet centre to centre of scene.
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[3P1M125] Unconscious priming effect in visual scene with multiscale objects

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Biederman and Cooper (2001) showed that priming effect in naming task remains the same regardless the differences in size of primer and target. However in this and similar works the size difference was small, or the used sizes were from the same diapason of sizes. There are two differently perceived diapasons of object sizes. Perception of objects larger than 1–1.5 deg (depending on objects class) is scale invariant, while objects, which size is smaller than 1.5 deg, are perceived poorer with stimulus diminution. In this work we investigated whether primer of a large size can prime the target, which size is smaller than 0.5 deg in match-to-sample task.
Object-sample appeared for 200 msec, SOA between sample object and test-event was 1200 msec. It was four-alternative forced choice task. Object-sample size was 0.1 or 0.2 degree, and noise level was 0 or 40%; SOA between primer and test-event was 300 msec. Object-prime appeared for 150 msec. Primer was masked and mask renewed every 150 msec. Presentation of the congruent primer caused reduction of the reaction times in the most uncertain conditions (stimuli size 0.1 deg and noise level 40%) comparing to conditions without primer or with incongruent primer.

[3P1M127] The Role of the Magnocellular Visual Pathway in Object Recognition

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Visual categorization plays an important role in the fast and efficient processing of information surrounding us, still the neuronal basis of fast categorization has not been established. Two main

hypotheses are known, both agree that the primary impressions are based on information acquired through the magnocellular pathway. It is unclear whether this information is due to the magnocellular pathway running parallel to the ventral pathway or to top-down mechanisms executed through the connections of the dorsal pathway and the frontal cortex. A categorization task was performed by 39 subjects, who decided about the size of objects based on the first impression. Stimuli used for the magno- and parvocellular pathways were discriminated by their spatial frequency content. Transcranial direct-current anodal, cathodal and sham stimulation were used to assess the role of frontal areas. Stimulation did not bias the accuracy of decision for stimuli optimized for the parvocellular pathway. In case of stimuli optimized for the magnocellular pathway, cathodal stimulation decreased the subjects' performance, whereas the anodal stimulation increased the performance. Our results support the hypothesis that top-down mechanisms, which promote fast predictions through coarse information carried to the orbitofrontal cortex by the magnocellular pathway, is crucial in fast categorization processes.
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[3P1M129] An Experimentally Constrained Theory For Levelt's Propositions and The Scalar Property Of Multistable Perception

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Reversal time distributions in multistable perception exhibit a characteristic gamma-like shape, which remains largely invariant across displays, observers, and stimulation levels, whereas distributions mean span over two orders of magnitude and feature a somewhat paradoxal input-dependences known as Levelt's propositions (Levelt, 1967; Pastukhov and Braun, 2007; Blake et al., 1971; Murata et al., 2003; Walker, 1975). This implies deterministic and stochastic contributions to the dynamical process underlying the alternation statistics must satisfy a peculiar balance (Kim, Grabowecky, Suzuki, 2007; Van Ee, 2009; Brascamp, Van Ee, Noest, Jacobs, Van den Berg, 2008; Pastukhov et al., 2013). Our hierarchical model of stimulus integration by ensembles of stochastic bistable nodes, fully constrained from experimental observations, can account for the shape and scalar property of reversal time distributions at all orders (Cao et al., 2015, in preparation) as well as numerous other properties. We show that successive truncations of the higher-order dynamics can provide with important insights; in particular, the reduction to a second-order diffusion process reveals that the scalar property relies on adequate input-dependence of the step distribution, while further reduction to a first-order leaky-integrate-and-fire model uncovers possible mechanisms for each of Levelt's propositions.

[3P1M131] Characterising shape aftereffects using composite radial frequency patterns

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Adaptation to radial frequency (RF) patterns has been used extensively to interrogate the properties of early level shape encoding mechanisms. However, little research has explored how multiple RF patterns can be combined to create a single composite stimulus that can reflect more realistic shapes. Such stimuli can be used to investigate what RF information is important for the detection and analysis of real world objects. For example we analysed the RF content of the outline head shape of a 3D head model and found that the phase of the third RF component was strongly correlated with the viewpoint of the head. We then replicated the face viewpoint aftereffect using a composite RF pattern to model outline head shape where viewpoint was cued by the phase of the RF3 component. This aftereffect was fairly tolerant to changes in size, where a 50% change in size resulted in a ~50% reduction in aftereffect magnitude. Further stimulus manipulations revealed this aftereffect was replicable with inverted face and non-face stimuli. Overall our experiments suggest a generic shape encoding mechanism that is highly sensitive to manipulations in the RF domain, which is also tolerant to size changes meaning it likely resides in extrastriate visual cortex.
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[3P1M133] On the shape properties affecting the detection of tilt

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If an object has vertical or horizontal edges in its shape, we would easily detect the tilt of the object. Conversely, if an object has the shape that lacks the edges, it would be difficult to detect the tilt. The shape without edges sometimes causes the tilt blindness. However, it is not impossible to detect the tilt of the object that has no clear edges. The purpose of this study was to examine the characteristics of the object shape that affect the tilt judgment. In the experiment, participants observed several different figures with respect to the length of vertical or horizontal edges, and they were required to judge whether a figure was tilted. The result showed that the clarity of edges affected the tilt judgment. At the same time, as to the figures without edges, changes in the aspect ratio of the shape also affected the tilt detectability. These results suggested that other characteristics as well as the edges also act as a cue for detecting the tilt of an object.

[3P1M135] Using the intermodulation term as a measure of selective responses to coherent plaids

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Mid-level neural mechanisms that combine signals encoding low-level visual features are still relatively poorly understood. Steady state visual evoked potentials (SSVEPS) were recorded to measure the nonlinear combination of two sinusoidal gratings (1cpd and 3cpd in spatial frequency, respectively). They were orthogonally overlapped by themselves or by each other to form spatial frequency-matched ('coherent') or non-matched ('incoherent') plaids. While fundamental SSVEP responses directly represent the components of a presented stimulus, intermodulation responses represent their nonlinear combination at the point of or after summation (Spekreijse & Oosting, 1970; Spekreijse & Reits, 1982; Zemon & Ratliff, 1984). Grating components were simultaneously

flickered at different frequencies (4.6 Hz, 7.5 Hz) resulting in fundamental component-based responses at these frequencies, as well as intermodulation responses at their difference (7.5 – 4.6 = 2.9 Hz) and sum (7.5 + 4.6 = 12.1 Hz). When the grating components formed an incoherent plaid, the sum intermodulation responses were small (if present) compared to when they formed a coherent plaid. This may represent differences in suppression from cross-orientation masking between the plaid conditions, or it may reflect selectivity for stimulus coherence. In support of the latter, the extent of fundamental response suppression that occurred for coherent and incoherent plaids was similar.
EPSRC

[3P1M137] Enhancing the world with the mind: Shape adaptation exaggerates shape differences

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Adaptation to different visual properties can produce distinct patterns of perceptual aftereffects. Some, like those following adaptation to colour saturation, seem to arise from recalibrative processes, in which adaptation updates a perceptual norm. As all relevant inputs are encoded relative to a single norm, recalibration affects the appearance of all inputs similarly, including the adaptor. Other aftereffects seem to arise from contrastive processes that exaggerate differences between the adaptor and test stimuli without affecting the adaptor's appearance. Recently it has been suggested that norm-based coding is a common strategy for complex spatial patterns, such as shapes and faces. We therefore decided to determine whether a recalibrative or contrastive process underlies the shape aspect ratio aftereffect. We mitigated retinal contributions by adapting to an oval that jittered over a range of retinal positions. We found that adapting to a moderately elongated shape made narrower shapes appear even narrower, while simultaneously making more elongated shapes appear even more elongated. These data suggest that aspect ratio aftereffects arise from a contrastive process that exaggerates differences between the adapted and other values. More generally, spatial adaptation may enhance the salience of novel stimuli, rather than recalibrate our sense of what constitutes a 'normal' shape.
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[3P2M002] Mechanisms of short interval timing: The influence of interval filling on perceived duration and discrimination performance

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The ability to estimate temporal properties like interval duration is crucial for our successful interaction with the environment. Quantifying how factors other than physical duration can distort duration estimates helps understanding the mechanisms underlying temporal perception. Previous research has shown that intervals defined by two temporal markers (empty intervals) are perceived shorter and less precise than intervals consisting of a continuous stimulus or of a sequence of stimuli (filled intervals, e.g., Rammsayer & Lima, 1991; Thomas & Brown, 1974).

Here, we present a systematic investigation of perceived duration and discrimination performance using continuously filled, isochronously filled, anisochronously filled, and empty intervals (Horr & Di Luca, 2015). Participants compared intervals of different duration, indicating which of two is longer. We find duration discrimination to be most precise when two continuous or isochronous intervals are compared and it is worst for anisochronous intervals. Duration of filled intervals is overestimated compared to empty intervals, and this effect is higher for stimulus sequences (isochronous and anisochronous) than for continuous intervals. Quantitative analysis of the duration distortions with different intervals suggests that an explanation based solely on individual intervals is not sufficient, as the difference in the types of intervals compared also biases duration estimates.

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[3P2M004] An effect of noise on numerosity comparison

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In a typical numerosity estimation task, where one has to compare two sets of objects, the visual system can have access to activation of relevant feature maps, e. g., color. The question is whether such activation can modulate the number of incorrect responses. We simultaneously presented two sets of red squares (2 sizes) in the left/right visual fields, so that that total perimeters on both sides were equal. The subjects ($N = 21$) were asked to choose the larger side. We manipulated the color (red/grey) and the proportion of noise in the left and right visual fields (0/30/50/70%). Only relevant (red) noise led to an increase in incorrect responses in the condition with 70% of noise on the "smaller side" as compared with 50% ($p < 0.05$) and 30% ($p < 0.01$). Irrelevant (grey) noise had no effect on the responses. Also, no differences in RTs were found, assuming that the change in the number of incorrect responses was not caused by an increased task difficulty. The number of correct responses was significantly different from chance ($p < 0.01$) for all conditions except the condition with 70% of red noise on the "smaller side". Results suggest that activation of color feature map can modulate approximate estimation of numerosity.

[3P2M006] The effect of proximity in numerosity judgements

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The human ability to estimate the numerosity of large sets of visual elements is well known. We present a study on combinatorial properties that affect human numerosity judgements. We used patterns of elements (between 22 and 40) placed at random within a circular region. We asked a sample of observers ($N = 24$) to compare two patterns of equal cardinality (presented in two intervals) and choose the one that appeared as more numerous. Observers also had to judge which pattern appeared more dispersed, and which appeared more clustered. We then compared the human answers to the section based on spatial properties of the patterns: the area of its convex hull, the occupancy area, the total degree of connectivity, and its local clustering. Note that all indices except the convex hull depend on the notion of proximity between pairs of elements.

Our experiments investigate the effect of such parameters on perception. The results suggest that estimates of numerosity, dispersion and clustering are based on diverse spatial information, that there are alternative approaches to quantifying clustering, and that in all cases clustering is linked to a decrease in perceived numerosity. The alternative measures have different properties and different practical and computational advantages.

[3P2M008] Verbal working memory influences time perception in explicit time estimation

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In this set of two experiments we tried to study how two different systems, a rhythmic and a memory-based one, can work together to generate explicit time perceptions. Using a time estimation task, participants were asked to report the duration of a visual stimulus appearing for a random interval ranging from 1 to 8 seconds. In one condition participants had to count the seconds before responding. In a different block participants were told not to count and simply guess the time. Both strategies produced greatly different performance functions: 1) the counting strategy presented similarly fast reaction times as a function of interval and better discrimination in general; 2) the non-counting condition produced an inverted U-shape distribution in which extremes were responded to faster than intermediate values. This function was also linked to a pattern of poor discrimination in the extreme intervals, with clear overshooting in the shorter and undershooting in the longer ones. More importantly, manipulation of verbal distraction and alterations to a rhythm produced an impact in the counting condition only, but not in the non-counting one. The results are interpreted under a combination of clock-based and memory-based systems that coexist to produce explicit time estimations.

[3P2M010] A study of magnitude estimation with depth cues changing visual perception of circle's size judgment

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We used magnitude estimation to obtain apparent size of circles under four different experimental conditions: (1) black background, and gradients to evoke depth perception ((2) vertical, (3) radial and (4) horizontal lines). Thirty subjects with normal or corrected-to-normal visual acuity (mean age = 28.4yrs; SD = 5.5) were tested. The procedure consisted of two gray circles luminance of 151 cd/m2, 18.3° apart from each other. On the left side was the reference circle (VA of 4.5 deg) in which was assigned an arbitrary value of 50. The subjects' task was to judge the size of the circles in the right side of the monitor screen assigning the number proportional to the changed size, relative to the reference circle. Ten sizes (1.0, 1.9, 2.7, 3.6, 4.5, 5.4, 6.2, 7.2, 8.1, 9.0 deg at 50 cm) were presented in each condition randomly. Our results have shown a high correlation for circle size and depth conditions ($R = 0.994$, $R = 0.992$, $R = 0.995$ and $R = 0.998$) between the logs of the stimuli and the subject response. The Power Law exponents were (1) 1.28, (2) 1.40, (3) 1.27 and (4) 1.26. The circle size was judged subjectively closer to the physical size in all conditions except in that son with vertical lines as visual cues.

[3P2M012] Changes in the apparent speed of human locomotion: Norm-based coding of speed

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We report a new after-effect of visual motion in which the apparent speed of human locomotion is affected by prior exposure to speeded-up or slowed-down motion. In each trial participants were shown short video clips of running human figures (recorded from the London Marathon) and asked to report whether the speed of movement was 'slower than natural' or 'faster than natural', by pressing one of two response buttons. The clips were displayed at different playback speeds ranging from slow-motion (0.48x natural speed) to fast-forward (1.44x natural speed). Adaptation to stimuli played at normal speed resulted in the P50 of the psychometric function falling close to normal-speed playback. However after adaptation to 1.44x playback, normal-speed playback appeared too slow, so the P50 shifted significantly towards a higher playback speed; after adaptation to 0.48xplayback, normal-speed playback appeared too fast, so the P50 shifted significantly towards a lower playback speed. The shifts in apparent speed were obtained using both same- and opposite-direction adaptation-test stimulus pairs, indicating that the effect is a speed adaptation effect rather than a directional velocity after-effect. These findings are consistent with norm-based coding of the speed of movement.
Economic and Social Research Council Grant ES/K006088/1

[3P2M014] The Component Level Feature Model of Motion Computes Direction for Random Dot Patterns

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Bowns (2011) describes a biologically inspired motion model – the Component Level Feature Model (CLFM). The model uses similar filters to motion energy models, and computes the Intersection of Constraints (IOC) from the component information, however, it differs from energy models because it is a phase based model. Output from CLFM reliably computes the motion of two component (plaid) stimuli, and provides new explanations for challenging plaid results (Bowns, 2011; Bowns, 2013). In this presentation, CLFM direction output is reported for random dot patterns varying in 8 different directions. Ten new random dot patterns were produced for each direction. The dots had 1% dot density and were displaced by 2 pixels on each frame over 20 frames. To facilitate comparison with human data, percent accuracy was calculated as follows: 90-error (in degrees of angle) / 90 * 100 (Pilly & Seitz, 2009). These preliminary results look promising with CLFM performing at over 85% accuracy on all 8 directions, with performance on the cardinals over 90%, consistent with human data on the motion oblique effect. All parameters of the model were the same as those used for previous simulations.

[3P2M016] Second-order chromatic plaid-motion perception mediated by s-cone channel signal

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Plaid motion perception has been investigated to clarify whether genuine chromatic information can produce motion perception, the same as luminance information can do. We therefore tested whether s-cone second-order motion was integrated with the achromatic second-order motion. Our motion stimuli consisted of second-order chromatic and achromatic patterns, in which spatial frequencies of envelope and carrier component were 0.2 cpd and 1 cpd, respectively. Contrast of both the motion patterns was five-fold of each motion discrimination threshold. We measured probabilities of coherent motion perception as a function of temporal frequency (TF) of envelope component. In the identical TF-chromatic and -achromatic motion patterns, the probability functions reached the maximum in all conditions. And these functions decreased as the difference of TF between the chromatic and achromatic motion stimuli increased. These indicate that the s-cone second-order motion signal can be integrated with the achromatic second-order motion signal in a specific neural site and that its temporal tuning could be determined by physical parameters but not by perceived speed. This result corresponds with our previous study (Yoshizawa et al., 2005). We conclude that the second-order chromatic motion signal can be mediated by a different process from that for the first-order chromatic motion.

[3P2M018] Visual search for objects with different direction variability and speed

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Previous research found that visual search for a static target among moving targets is slower then reversed condition (Dick, 1989). Moreover, people are able to find moving target following a different trajectory than distractors (Horowitz et al., 2007). Varying object speed and direction variability is an important aspect in other cognitive tasks (e.g., Multiple Object Tracking). In two experiments, we studied how sensitive participants were in the search for a target differing in higher/lower direction variability (exp 1) and faster/slower speed (exp 2). In both experiments, 8 objects moved for 8 seconds and one of the objects differed in variability of direction (exp 1) or speed (exp 2). We tested the performance over eight levels of variability/speed for targets and two levels for distractors. Participants were able to detect successfully both faster/slower targets, but the performance for direction variability was asymmetrical: more variable directions (Von Mises kappa $>$ 16, sampled 100 fps) were difficult to distinguish from each other. Overall performance was lower in experiment 1 showing that detecting variability of motion direction is harder than detecting difference in speeds.

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[3P2M020] Parameters that modulate the interaction between target and background patterning in speed perception

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'Motion dazzle' is a phenomenon where high contrast patterns on moving targets are hypothesised to cause errors in speed and direction perception, and has been suggested to provide an explanation for why striped patterning has evolved in animals such as zebras. In nature, predators may be trying to pick out one zebra from many in a herd, meaning that the pattern on the target is similar to the pattern of the background. We have previously shown that the perception of speed of striped targets on striped backgrounds is different from the perception of grey targets on the same background. Here, we extend this work using two alternative forced choice paradigms to show that these effects seem to be strongest with backgrounds with alternating black and white stripes (in comparison to average luminance matched random striped backgrounds) and also depend upon the spatial frequency of striped targets, with the largest effects being seen at intermediate spatial frequencies. We also show that the effects seen differ depending on whether subjects fixate or track the targets. We discuss what these findings may mean in terms of the underlying mechanisms of motion perception and the purpose of striped patterning in the natural world.
BBSRC/DstI CASE studentship to AH

[3P2M022] Dance expertise modulates the visuomotor perception of body motion

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The modulation of visuomotor processing of various body movements by motor expertise due to dance practice was investigated in 12 professional contemporary dancers and 12 right-handed controls. 212 video pairs of dance actions lasting 3 seconds were shown to participants, while their event-related brain potentials (ERPs) were recorded. The second video of each pair might be either the repetition of the previous one, or a slight variation of it, along 3 main dimensions (time, space and body). The task consisted in responding to static images of a dance action by pressing a button. A repetition suppression (RS) effect elicited by a repetition of the same video was visible in both groups, whereas only in dancers it was found a significant modulation of brain responses to deviant stimuli indexing a strong effect of neural plasticity due to motor practice. SwLORETA source reconstruction, performed on the ERPs difference waves "different" minus "same" videos (450–550 ms) recorded in dancers, showed a widespread network of activations related to visuomotor perception including the limbic (BA 38, 23) and the fronto-parietal systems (BA 40, 3, 4, 9), plus areas devoted to biological motion (BA 20, 21, 41), face and body processing (BA 20, 37).

[3P2M024] The role of orientation information in motion perception

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Increasing psychophysical evidence shows that the orientation of a moving stimulus directly affects its perceived direction of motion. Here, we analyzed this orientation- induced motion shifts (OIMS) for a variety of stimulus conditions. In our general procedure, a single Gabor pattern was horizontally displaced for several frames with a particular frame duration and ISI, and the observers indicated if the Gabor pattern appeared to move upward or downward. The apparent bias in motion trajectory was measured as a function of the orientation of the Gabor patch. The results showed that the apparent motion trajectory was systematically attracted toward the orientation of the pattern. The bias was large when the frame duration was short and the number of frames was small, but no bias was found when the stimulus moved continuously (i.e., ISI = 0).The subsequent experiment using the tilt aftereffect revealed that the motion shift depended upon the perceived, but not physical, orientation of the pattern. We also found that the second-order orientation as defined by the contrast envelope of a pattern can induce the direction shift. These results indicate that local orientation information is used for motion integration in a relatively higher-order motion processing.
This work was supported by JSPS KAKENHI Grant Number 24530921

[3P2M026] Side view dynamic cue for gender recognition of Point-Light Walker based on information from spectral component analysis

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Previous studies have demonstrated gender-specific lateral body sway in the frontal view of a Point-Light Walker (PLW). However, this dynamic cue is obscured, especially in lateral view. This study aimed to find another dynamic cue for gender discrimination in lateral view of PLW. Twenty-one undergraduates (10 males, 11 females) served as walkers. Seven viewers were asked to judge the gender of 21 PLWs 10 times in a random order and finally identified 7 males and 7 females above chance. In these 14 PLWs, cross-correlation function showed that left hip motion correlated inversely with ipsilateral shoulder motion. Fast Fourier transform of hip and shoulder swing demonstrated two large spectral components; the first component corresponded to a step cycle and the second rapid component, to a half step cycle. The first component amplitude was greater in female hips (3.89 vs. 1.75 arbitrary unit, $p < 0.001$) and shoulders (7.73 vs. 3.70, $p < 0.01$) than in males. The second component was also greater in female hips (4.27 vs. 2.21, $p < 0.01$) than in males, while there was no gender difference in the second component of shoulder motion. Thus, the feminine gait in lateral view could be characterized by the rapid hip swing with a half step-cycle length.

[3P2M028] Is adaptation to human motion necessary to change the apparent speed of locomotion?

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Adaptation to videos of human locomotion (recorded at the London Marathon) affects observers' subsequent perception of human locomotion speed; normal speed test stimuli are perceived as being played in slow-motion after adaptation to fast-forward stimuli and conversely are perceived as being played in fast-forward after adaptation to slow-motion stimuli. In this study we investigated whether the presence of recognisable human motion in the adapting stimulus is necessary for this effect to occur. The adapting stimuli were spatially scrambled; horizontal pixel rows were randomly shuffled. The same shuffled order was used for all frames preserving horizontal motion information, but ensuring no human form could be recognised. Results showed that the after-effect persisted despite spatially scrambling the adapting stimuli; human motion is not a necessary requirement. The after-effect seems to be driven by adaptation in relatively low-level visual channels rather than the high-level processes that encode human motion.
ESRC

[3P2M030] Motion dazzle camouflage in groups; evidence for an interaction between high contrast patterns and the confusion effect

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Research into animal camouflage has implications that are relevant to many fields. One hypothesis for a class of apparently conspicuous animal colourations, high contrast stripes, is that they represent 'dazzle camouflage'. Thayer (1909) hypothesised that such patterns may disrupt an observer's perception of the trajectory or speed of a moving animal. Psychological research with human participants in computer based tasks has found support for this hypothesis with single targets (Scott-Samuel, Baddeley, Palmer & Cuthill, 2011; Stevens et al., 2011). However, the ways in which camouflage affects the capture of moving individuals in groups is unknown. One advantage of grouping behaviour is the 'confusion effect' which describes reduced predator attack success with increasing prey group size, possibly due to the increased sensory challenge of tracking one target among many distractors (Landeau & Terborgh, 1986). We investigated the hypothesis that the confusion effect can be compounded by the effects of dazzle camouflage. Our results suggest that some high contrast colourations are superior to background matching colourations as a defence against predator tracking in groups, and that these patterns interact with the confusion effect to a greater degree than background matching colourations. These findings will impact future understanding of camouflage and movement.
Research undertaken as part of a BBSRC funded South West Biosciences Doctoral Training Partnership studentship.

[3P2M032] Up-down asymmetry in vertical vection

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Research has reported close relations between mechanisms underlying vection and optokinetic nystagmus (OKN). In the present study, we investigated whether up-down asymmetry, similar to that found in vertical OKN, i.e., larger OKN responses for upward motion than for downward motion, would appear in vertical vection. In the present study, we conducted two experiments. In both experiments, participants viewed a vertically moving random-dot pattern and reported vection by using a joystick whenever they experienced the vection. After each trial, they also rated the vection magnitude. In Experiment 1, vection was measured with or without a fixation stimulus. In Experiment 2, the time course of the vection magnitude (with a fixation stimulus) was examined. Experiment 1 showed larger vection for the upward motion than for the downward motion, irrespective of the presence or absence of the fixation stimulus. However, the vection onset latency did not change with the stimulus motion direction. Experiment 2 showed that the up-down asymmetry in vection manifested progressively during the later part of the stimulus presentation period. These results clearly indicate up-down asymmetry in vertical vection, and suggest an overlap in the mechanisms underlying vection and OKN.

[3P2M034] Orientation Decoding in V1 During Motion Induced Blindness

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During Motion-Induced-Blindness (MIB), a target surrounded by a coherent motion field becomes perceptually invisible even though the target remains physically present (Bonneh et al., 2001). Scholvinck and Rees (2010) found increased V1 and V5 BOLD activity during target invisibility, suggesting that target representation in V1 is overwritten by feedback from V5 which actively completes the motion field. However, perceptually invisible targets retain orientation adaptation properties (Montaser-Kouhsari et al., 2004), suggesting target representation in V1 is actually preserved, by feedforward processing. Using Gabors (45°/135°) as targets during a 3T fMRI experiment, we investigated whether the target is overwritten by completion of the motion field in V1, or if target properties are preserved. If target orientation is present in V1, feedback from V5 does not overwrite the feedforward processing of orientation. If orientation is not present, feedback from V5 completes the motion field, extinguishing target representation in V1. We confirmed that Gabors function as MIB targets at 7.1° and 5.8° eccentricity, but not 4.2°. We retinotopically mapped the target region in V1 and, using multivariate classifiers, decoded orientation when target was either visible or perceptually invisible (MIB). We provide evidence for both feedforward processing of target orientation and feedback processing of motion.
Work was supported by ESRC PhD AQM Studentship Funding and ERC-grant (ERC StG 2012_311751).

[3P2M036] Relationship between vection and body sway

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When observers view a large visual stimulus that moves uniformly, they often perceive illusory self-motion (vection). A vection-inducing stimulus is also known to induce postural responses and many studies have used visually evoked postural responses (VEPRs) as objective measures of vection. In the present study, to investigate the relationship between vection and VEPRs, we measured vection and center of foot pressure (COP). In an experiment, participants were asked to stand still with their arms at their sides while viewing a vertically or horizontally moving random-dot pattern. They were also asked to rate vection magnitude (from 0 to 100) after each trial. The results showed stronger vection to vertically moving stimuli than horizontally moving stimuli. Vection was also stronger for upward motion than for downward motion. COP started to move in the inducing stimulus direction immediately after the onset of the inducing stimulus, and its magnitude (difference from the baseline, i.e., COP data before the stimulus presentation) gradually became larger during the stimulus presentation. The mean COP during 1-s intervals before and after vection onset showed larger COP after the onset than before it. This suggests that, at least to some degree, mechanisms underlying vection and VEPRs are related.

[3P2M038] Perception of biological motion in central and peripheral visual field

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Studies analyzing motion perception in peripheral visual field demonstrate that central retina is more specialized for motion perception (Finlay, 1982). In the current research we used biological motion stimuli (consistent with and extending the paradigm by Johansson, 1973) with a two-fold aim: first, to explore the perception of biological motion when limited information of object's movement is given; second, to analyze whether a stimulus magnification can compensate for reduced motion perception in the peripheral visual field (Gurnsey et. al., 2010; Ikeda et. al., 2005). Participants were instructed to determine whether the presented stimulus is a biological object (walking in any of five different directions) or a scrambled version of it. The number of dots representing the motion varied from 1 to 13 according to psychophysical staircase method.The results indicate that perception of biological motion in the central visual field is highly individual (average thresholds range from 3.8–7.1 points). Stimulus magnification can compensate for the performance of the task only for smaller eccentricities (up to 8 degrees), but cannot compensate for larger eccentricities (16 degrees), thus demonstrating that the central retina is also specialized for biological motion perception additionally to e.g. detection of just noticeable object displacement.
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[3P2M040] Motion-induce position shifts smaller across the vertical and horizontal meridians

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When a Gabor patch drifts across the screen while its internal pattern drifts in the orthogonal direction, the perceived direction of motion is the combination of the two motion vectors (Infinite Regress Illusion, Tse and Hsieh, 2006; Lisi and Cavanagh, 2014). If the Gabor patch oscillates sinusoidally back and forth on a linear path while the speed of the internal pattern is modulated sinusoidally 90° out of phase with the path motion, the path is perceived as elliptical. In the present study we measure the strength of this motion-induced illusion by asking subjects to add a physical shift orthogonal to the path (adding to the illusion) until the perceived path appeared circular. The initial physical path was centered 10° in the periphery and oriented in one of four directions (−45°, 0°, 45°, 90° where 0° is vertical) at one of the eight possible locations around the fixation point. The results show that that for the vertically oriented stimuli the illusion is significantly weaker when presented at the vertical meridian, while for the horizontally oriented stimuli the illusion weakens at the horizontal meridian. These results suggest that the integration of the motion vectors is disrupted in the viscinity of the meridians.
This project was funded by ERC grant to P.C.

[3P2M042] Suggested Independence between Perceived Size and Distance in the Optical Tunnel

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Introduction. Regarding perception of size at a distance, two models explain the relationship between perceived size (S′) and perceived distance (D′): the mediational model and the direct perception model. The former assumes S' is inferred from D′ and visual angle (θ), while the latter suggests S′ and D′ are tied to different higher-order variables in the optic array. To compare them, an optical tunnel was constructed to manipulate optical environments. Independence of S′ from D′ was investigated. Method. One of three objects differed in size was hung in the middle of tunnel at four locations. Either the tunnel terminated or continued behind it. Participants viewed it monocularly, and reproduced its size and distance by adjusting comparison objects. Results. Participants underestimated S′ and D′ more at further locations. The termination did not change D′, but changed S′. Different power functions of θ described S′/D′ between termination and continuation. Partial correlation analysis showed that S′ and D′ were not correlated when other variables were controlled.
Discussion/Conclusion. S′ was different between optical conditions when both θ and D′ remained the same. Insignificant partial correlation implied that D′ was not a mediator of S′. S′ and D′ were independent, supporting the direct perception model.

[3P2M044] Auditory rhythms influence perceived distance of an occluded moving object

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Using displays in which a moving disk disappeared behind an occluder, we examined whether an accompanying auditory rhythm influenced the perceived displacement of the disk while being occluded. Starting with an auditory rhythm (the baseline rhythm), comprising a relatively fast alternation of equal sound and pause lengths, we had two different manipulations to create auditory sequences with a slower rhythm; either the pause lengths (block-1) or the sound lengths (block-2) were increased. During a trial, a disk moved at a constant speed, and was accompanied by a sound sequence. Participants were instructed to judge the expected position of the disk the moment the auditory sequence ended (indicated by a higher tone) by touching the judged position on the touch screen. Additionally, we included a no-rhythm condition that ended with a single high tone. We found that the baseline rhythm led to much more accurate distance judgments as compared to the no-rhythm condition. Slower rhythms generally led to an underestimation of the distance for both pause length and sound length variations, with a larger differentiation between the pause lengths. We will discuss implications of the results in terms of crossmodal processing and timing of external events.
Royal Thai Government

[3P2M046] Population code modelling of grating detectability along the apparent motion path

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Apparent motion masking refers to the decreased detectability of stimuli when presented along the path of apparent motion. This masking is typically attributed to activation in primary visual cortex: V1 neurons presumably represent apparent motion by showing an increased activation along the motion path. This activation masks the perception of target stimuli that are presented in the motion path and that match the apparent motion inducing stimuli. Previous studies have measured target detectability at a single stimulus intensity level. In the present study, we measured full psychometric functions, relating the detectability of grating targets to their contrast. We find that apparent motion has a strong masking effect. The masking is tuned: detectability is only impaired when target orientation matches the orientation of the apparent motion stimuli, suggesting that masking is indeed related to activation in primary visual cortex. However, we found that masking is particularly strong at large contrast levels. We use computational modelling to show that such an effect is not expected when assuming a mere increase in V1 activation along the apparent motion path. We propose a new population code model that relies on strong V1 inhibition instead of excitation to account for our results.
Funding of the Research Foundation-Flanders (FWO) awarded to Nathalie Van Humbeeck; Funding of the Flemisch government awarded to Johan Wagemans (METH/02/08)

[3P2M048] Visual adaptation distorts judgments of human behaviour during naturalistic viewing

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Observing the behaviour of other individuals allows us to infer the goals of their actions and to derive information about their internal thought processes. A network of brain areas sub-serves these processes that contain neurons that respond selectively to specific visual actions. Visual adaptation results in a selective reduction of the sensitivity of neurons tuned to a visual stimulus and results in perceptual aftereffects. The extent to which adaptation influences processing of actions and human behaviour at increasingly higher stages of processing is unknown. We show that processing of action kinematics for action recognition is biased by visual adaptation leading to incorrect judgments of human actions. Visual adaptation also biases more complex inferences about the mental states of individuals in the social scene, but this is due to downstream effects of visual processing biases, rather than adaptation operating within mentalizing or simulation systems. Our research overcomes previous limitations resulting from the use of unrealistic or simplistic stimuli by using Virtual Reality to present life-sized, photorealistic and 3D actors within naturally unfolding social scenes. Judgments of human behaviour are dependent on a combination of what an individual is doing and the adaptive effect of other individuals within the social environment.
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[3P2M050] Intentional action expands Time perception: An ERP study

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While studies on Intentional binding have mainly focused on the effect of intentional action on the perception of time between the action and its outcome, not many studies have focused on the temporal perception of outcome itself. We conducted an ERP study to understand the neural mechanisms involved in changes in time perception due to intention by using a temporal bisection task. To manipulate intention, before each trial participants were asked to choose what color circle (red/ green) they want to see. The probability of participants getting the intended color was kept at chance level. Participants were trained for two extreme durations (300 ms/700ms). In each trial, a test duration was randomly presented out of nine duration levels (300 ms, 350 ms . . . 650 ms, 700 ms). Participants reported whether they perceived the test duration to be closer to the short or long anchor duration. Psychophysical results showed that participants perceived the duration of intended outcome to be longer compared to unintended outcome. A similar temporal expansion effect was observed in CNV component, indicating that intention enhances the neural representation of time. Further studies are needed to understand the underlying processes which mediate the effect of intentional action on time perception.

[3P2M052] Reach trajectories curve away from remembered, past, and present distractor locations

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Previous research indicates that reaching movements curve away from to be ignored and inhibited distractors while they curve toward facilitated distractors. Here we investigated how the trajectory of a target-directed reaching movement is affected by different distractor conditions: (a) spatial memory of a distractor location, (b) automatic encoding of a distractor location, and (c) perceptual presence of a distractor. Participants performed vertical reaching movements to a visual target after an audio Go-signal with their right index finger on a computer monitor. They either had to remember the location of a previously presented distractor (remembered), ignore the location of a previously presented distractor (past), or ignore the location of a currently presented distractor (present). Distractors were always presented laterally, either left or right of the target. Our results showed that irrespective of the distractor condition reaches curved away from the distractor location. Additionally, latencies of the reaching movement differed between distractor conditions ($a > b > c$). The present results are in line with previous findings on saccadic eye movements and suggest that distractor related movement plans are inhibited and thus the competition with target related movement plans are successfully resolved causing reaching movements to curve away from task relevant and irrelevant distractor locations.
DFG IRTG 1901 "The Brain in Action"

[3P2M054] Motor coding of visual objects in peripersonal space is task dependent: an EEG study

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Previous studies have shown that visual perception of manipulable objects spontaneously involves the sensorimotor system, but predominantly in peripersonal space. It was also suggested that motor coding of manipulable objects in peripersonal space depends on the intention to act on them. The present study aims at unravelling this issue by recording EEG activity on the centro-parietal region while judging the reachability or shape of visual objects presented at different distances in a virtual environment. Visual objects were either real objects with a prototypical shape or distorted objects with an altered shape resulting from a Gaussian blur filter. Time-frequency decomposition of EEG signals was performed and event-related-desynchronization of μ rhythm was computed using the 200 ms pre-stimuli period as baseline. In the reachability judgment task, EEG analysis showed a desynchronization of μ rhythm starting 315 ms after object presentation when objects were presented in peripersonal space with a prototypical shape. Desynchronization of μ rhythm reduced progressively from peripersonal to extrapersonal space. By contrast, no such gradation was observed in the shape judgment task. These data indicate that motor coding of visual objects expressed in the μ rhythm depends on both their location in space and the intention to interact with them.
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[3P2M056] Spatial and motion stimulus-response correspondence effects under cognitive load

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Previous studies show that spatial stimulus-response correspondence (spatial SRC) and motion stimulus-response correspondence (motion SRC) are separate phenomena with regard to the interaction between perception and motor actions. In the first experiment, we tested this hypothesis by designing a visuo-motor task in which we pitted both SRC effects against each other. Participants moved leftward or rightward with two joysticks held in left or right hand in response to a stimulus with leftward or rightward motion that could be located on the left or right side. The results showed that spatial and motion SRCs are independent. Since it has been claimed that SRC effects are based on automatic processes we expected that both SRCs should not be affected by cognitive load. We verified this hypothesis in the second experiment by testing both SRC effects in a single task under working memory load. Participants had to maintain in working memory either additional spatial or alphabetic information while performing the task with the joysticks. Results showed that working memory load led to interaction between spatial and motion SRC effects. Our findings demonstrate the role of cognitive load in SRC phenomena as well as constraints to the idea of automaticity underlying SRCs.
This research has been supported by the National Science Centre (Poland), and funded under the NSC decision DEC-2011/03/B/HS6/01022 to Piotr Styrkowiec.

[3P2M058] Subcortical influences in tool processing – the case for the magnocellular processing under high temporal frequencies

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Within the retina, parasol and midget ganglion cells differ in their temporal resolution. This distinction gives rise to the parvocellular (P) and magnocellular (M) pathways, respectively. Neurons within these pathways retain the same physiological response profiles of their respective ganglion cells: the M-pathway prefers fast moving stimuli, whereas the P-pathway prefers static or slow moving stimuli. Here, we investigated the role of the M and P-pathways on manipulable object recognition. We collected fMRI data using rapid serial visual presentation (RSVP) of tool and animal images at different presentation rates (5 Hz, 10 Hz, 15 Hz, 30 Hz) to bias processing towards the M or P-pathways. Previously we showed that tool preferences in the inferior parietal lobule (IPL) are driven by P-inputs, whereas in the superior parietal lobule (SPL) tool preferences are driven by M-input (Mahon, Kumar, & Almeida, 2013). In the current study, we found that the tool selective responses in these two areas are modulated by the presentation rate. Specifically, we demonstrated that the SPL, dominated by M-input, shows a preference for fast moving stimuli, whereas the IPL, dominated by parvocellular input prefers slow moving or static stimuli. Our findings illustrate how these anatomical pathways influence the organization of the tool processing networks.
PTDC/MHC-PCN/3575/2012

[3P2M060] Within- and between-individual integration across visual perspectives in an object location task

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Humans combine multiple visual cues in order to form more reliable percepts (Ernst and Banks, 2002; Ernst and Bulthoff, 2004), including integration of information from varying perspectives (Avraamides et al., 2012). Recent studies in group psychophysics (Bahrami et al., 2010, 2012) have demonstrated that different individuals can achieve a similar integration. The present study asked how efficient different individuals are in integrating location information across different spatial dimensions with different reliability by comparing group performance to individual performance. Participants were asked to locate objects in 2D projections of a 3D layout. We generated projections from different camera view angles to simulate different perspectives on the same layout. In a series of experiments we systematically manipulated: a) angular difference between two individual views; b) possibility to verbally communicate; c) presence of feedback.
The results showed that the opportunity to combine information with a partner resulted in increased accuracy and reduced variability of location judgments. Importantly, cross-individual integration of spatial information was as efficient as within-individual integration. Our results also suggest that complementarity of individual uncertainties is a sufficient condition for dyads to reliably outperform individuals even in an absence of feedback and verbal communication.

[3P2M062] Floor pattern orientations impact on human-human spatial interaction

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Last year, we reported that floor pattern orientations such as those of paving stones can induce lateral veering (Leonards et al., 2014). Here, we wondered whether veer-inducing floor patterns facilitate spatial interactions between two people when passing each other in a corridor in opposite directions. Seven pairs of participants passed each other repeatedly in a corridor, walking as straight as possible but without bumping into each other, while we varied the orientation of the floor patterns from trial-to-trial. 3D-motion capture allowed estimation of the distance between the two participants at the time of cross-over. In conditions, in which participants had no prior instructions on which side they should pass the oncoming person, the orientation of veer-inducing floor pattern did not only predict the side participants passed each other, but also produced bigger distances between participants at the time of cross-over than non-veer inducing patterns. In conditions, in which one of the participants received instructions on which side to pass the oncoming person, instructions congruent with pattern orientations lead to significantly bigger passing distances than instructions incongruent with pattern orientations. Together, these data suggest that floor pattern orientations indeed facilitate spatial interactions between people when passing each other in opposite directions.

[3P2M064] Relationship between reaction time and ball catching in vision-restricted conditions in elite sportspeople

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What aspects of vision are important for the exceptional visuomotor skills needed in many sports? We compared performance on reaction times to visual stimuli and ball-catching under restricted vision, with elite cricketers, elite rugby league players, and controls. Balls were delivered by bowling machine; participants wore Plato liquid crystal goggles to occlude portions of ball flight. We have previously shown elite cricketers have faster reaction times to visual stimuli, and excel at tasks requiring rapid pickup of visual information (Cruickshank et al 2014). We again find cricketers have faster reaction times than controls to visual stimuli presented centrally ($\Delta RT = 17$ ms, $t(55.3) = 2.16$, $p = 0.035$) and peripherally ($\Delta RT = 15$ ms, $t(54.1) = 2.301$, $p = 0.025$). Rugby league players' reaction times fall between the two groups, but are not significantly different from either. Peripheral and central reaction times correlate with ability to catch a ball when only the first quarter of the flight is visible (central $r = -0.27$, $p = 0.023$; peripheral $r = -0.354$, $p = 0.002$). This task distinguishes between cricketers and the other groups (cricketers catch around 10% more balls, $t(31.8) = 2.901$, $p = 0.007$). Faster reaction times correlate with more catches, despite approximately 600 ms delay between last available visual information and catch. Further research will focus on tasks probing fast pickup of visual information and visual working memory.
BBSRC

[3P2M066] An action to an object does not improve its episodic encoding, but removes distraction

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There is some debate as to whether responding to objects in our environment improves episodic memory or not. Some authors claim that actively encoding objects improves their representation in episodic memory. Conversely, episodic memory has also been shown to improve in passive conditions, suggesting that the action itself could interfere with the encoding process. This study looks at the impact of attention and action on episodic memory using a novel WWW task that includes information about object identity (What), spatial (Where) and temporal (When) properties. With this approach we studied the episodic memory of two types of object: Target, where attention or an action is defined, and Distractor, object to be ignored, following two selective states: active vs. passive selection. When targets were actively selected, we found no evidence of episodic memory enhancement; but instead memory from irrelevant sources was suppressed. The pattern was replicated across a 2D static display and a more realistic 3D virtual environment. This selective attention effect on episodic memory was not observed on non-episodic measures, demonstrating a link between attention and the encoding of episodic experiences.

[3P2M068] Louder voice for bigger physical movement: Compatibility between vocalization and action production

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Previous researches have shown that attributes of perceived stimulus influences the produced manual force in stimulus-response compatibility paradigm (e.g., Romaiguère, Hasbroucq, Possamdi, & Seal, 1993). The present study investigated a response-response compatibility between vocalization and manual movements. The task of participants was to draw a circle on a touch-screen display while vocalizing one of Japanese vowel sounds (close to "a" in International Phonetic Alphabet). The level of vocalization was fixed either below 55 or over 70 dB in each block (background sound level was 45 dB). Participants drew a circle so that it inscribes in a virtual square consisted of a set of briefly (500 ms) presented vertices of small, middle, or large square. Results indicated that the area of the drawn circles was larger with louder vocalization than with lower one regardless of the size of the cue. We suggest that the information related to the magnitude of physical movements was shared with different kinds of actions, leading to interferences between them.

[3P2M070] Perceiving and acting upon weight illusions in the absence of somatosensory information

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When lifting novel objects, the fingertip forces employed are influenced by a variety of visual cues such as object volume and apparent material. This means that heavy-looking objects tend to be lifted with more force than lighter-looking objects, even when they weigh the same amount as one another. Expectations about object weight based on visual appearance also influence how heavy an object feels when it is lifted. For example, in the 'size-weight illusion', small objects feel heavier than equally-weighted large objects. Further, in the 'material-weight illusion', objects which seem to be made from light-looking materials feel heavier than objects of the same weight which appear to be made from heavy-looking materials. Here, we investigated the degree to which peripheral somatosensory information contributes to these perceptual and sensorimotor effects in IW, an individual with peripheral deafferentation (i.e., a complete loss of haptic and proprioception feedback). We examined his perception of heaviness and fingertip force application over repeated lifts of identically-weighted objects which varied in size or material properties. Despite being able to judge real weight differences, IW neither appeared to experience the size or material weight illusions nor showed any evidence of sensorimotor prediction based on size and material cues.

[3P2M072] Is proprioceptive perception of distance affected by exercise?

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Distance perceived both by visual and proprioceptive information is shown to be anisotropic: distances toward zenith are perceived as greater than distances toward the ground. Furthermore, perception of effort depends on the direction of movement: effort invested in movment is perceived as greater when it opposes the direction of gravity relative to movement in the opposite direction. Aim of this resarch was to examine if these two phenomena are related. Namely, will proprioceptively perceived distance change if arm muscles are fatigued? Stimuli were presented to subjects in two directions: horizontal (arm was orthogonal to the body) or vertical (arm raised up); 20, 40, or 60 cm away from the participants' shoulders. Participants task was to match horizontal and vertical distances by moving their arm. Twenty blindfolded participants performed the task before and after exercise, during which they raised weight of 2,5 kg up (vertical direction), or pushed it away from the body (horizontal direction). Results showed effect of distance ($F(1, 17) = 52.6$, $p < 0.01$), and direction ($F(1, 17) = 1051$, $p < 0.01$), but no effect of fatigue. Participants perceived distances in vertical direction as greater, regardless of fatigue. These are not in line with the hypothesis that anisotropy of perceived distance and effort are related.

[3P2M074] Action video game play increases the coupling between visual motion processing and visuomotor control

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We previously found that action video game play improves visuomotor control. Here we examined whether the improvement is related to visual motion processing. We tested 12 male action gamers and 11 male non-gamers with a manual control task in which they used a joystick to keep a target moving randomly along the horizontal axis centered on the display under two controller dynamics that required them to primarily rely on target position or target motion information to generate control responses. Action gamers had better control precision and higher response amplitude for both control dynamics than non-gamers. We then examined visual motion processing of these participants using an oculomotor pursuit task in which participants tracked randomized radial motion of a step-ramp target. Action gamers did not differ from non-gamers in their performance on this task. However, action gamers' pursuit latency, initial acceleration, steady-state gain, pursuit direction- and speed-tuning were significantly correlated with their superior control precision when the use of target motion information was required for the control task (Pearson's r: 0.61–0.77, $p < 0.05$). No such correlations were found in non-gamers. Action video game play increases the coupling between visual motion processing and the sensory-motor system that uses motion information for visuomotor control.
Hong Kong Research Grant Council, HKU 7460/13H, 7482/12H.

[3P2M076] Point me in the Right Direction: Same and Cross Category Adaptation Aftereffects to Hand Pointing Direction

Sarah Cooney, Nuala Brady and Alanna Oshea O'Shea
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Comprehension of the pointing gesture is integral to developing shared attention. Using the index finger, the pointing gesture permits us to indicate non-verbally to another an object or event of interest. Very little consideration has been given to adult visual perception of hand pointing gestures. Across two studies we use an adaptation paradigm to explore the mechanisms underlying the perception of proto-declarative hand pointing. Fourteen participants judged whether 3D modeled left and right hands, from an allocentric visual perspective, pointed in depth, at or to the left or right of a target (test angles of 0°, 0.75° and 1.5° left and right) before and after adapting to either hands (left and right) or arrows which pointed 10° to the right or left of the target. After adaptation, the perception of the pointing direction of the test hands shifted with respect to the adapted direction, revealing separate mechanisms for coding right and leftward pointing directions. The considerable cross adaptation found when arrows were used as adapting stimuli and the asymmetry in aftereffects to left and right hands suggests that the adaptation aftereffects are reliant on fine tuned visual discrimination of the morphological structure of both the pointed index finger and hand.
Irish Research Council postgraduate scholarship

[3P2M078] Effect of search strategy on tactile change detection

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Haptic perception of two-dimensional images can make heavy demands on our working memory. During active exploration, we need to store not only the latest local sensory information, but also integrate this with kinaesthetic information of hand and finger locations to generate a coherent percept. We tested the active search process and working memory storage of tactile exploration as measured in a tactile search for change task. We previously reported an extremely small estimated tactile memory (1 ± 1) suggesting little or no cross-position integration in tactile perception (Yoshida, Yamaguchi, Tsutsui, & Wake, 2015). Here, we tested possible contributions of the hand movements or information sampling strategies on this small estimated memory storage. The index finger movements of the participants during haptic search for change were recorded. Analysis showed that participants repeatedly stopped and moved their finger similarly to fixations and saccadic eye-movements. Most stopped positions were near stimulus item positions, suggesting participants' strategy was to compare only one item at a time. When this strategy was inhibited by using a one-shot change detection task, participants held a maximum of 3 items in memory. These results show that haptic working memory can hold multiple items, but shows reduced capacity due to sensory limitations.
COI & JST

[3P2M080] Visuo-motor delay in fast and slow ball sports

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Visuo-motor delay (VMD) is the time taken to process and respond to a change in the visual environment. Given the demands of fast-ball sports, one might expect athletes to have shorter VMDs as this could convey a performance advantage. Previous research has shown that elite tennis players have shorter VMDs than controls. However, at present, little is known about the magnitude or significance of VMDs across a wider range of sports. Here we determined the VMDs in elite-level athletes (high-level cricketers, professional rugby league players) and controls in a go/no-go, coincidence task. In our task, participants were instructed to press a button when a horizontally moving target contacted a stationary, vertical line, but to inhibit the button-press if the target disappeared before contact. Cricketers' average VMDs were shorter (139 ms) than both rugby-league players' (156 ms) and controls' (159 ms). Overall, there was a main effect between groups ($F(2,53) = 3.226$, $p < .05$). Fisher's LSD post-hoc analysis revealed a significant difference between cricketers and controls, ($p < .05$) but other differences were not statistically significant. This suggests that competing in fast-ball sports may require, or enhance, the ability to inhibit responses to changes within the visual environment.
BBSRC

[3P2M082] Imagining Circles: A perceptual model for the Arc-Size Illusion

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An essential part of visual object recognition is the evaluation of the curvature of both an object's outline as well as the contours on its surface. We show that a little-known and poorly understood illusion of visual curvature – the arc-size illusion – reveals fundamental truths about the visual coding of curvature. In the arc-size illusion, short arcs of a circle appear less curved than longer arcs, even though the arcs have the same physical curvature. Using new data and a model of the arc-size illusion we show that perceived curvature is scale-invariant, that is a curve appears similarly curved irrespective of viewing distance, even though its curvature in the retinal image changes with viewing distance. Second we show that curvature is computed only for arcs up to a sixth of a circle in length. These two properties of curvature perception are shown to predict a number of other illusions of curvature.

[3P2M084] Weight allocation in summary statistics

Joshua Solomon and Christopher Tyler
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The visual system can rapidly estimate statistics like the average size of circles and the regularity of dot patterns, but its estimates aren't always very good. In particular, its estimates of average orientation are notoriously inefficient. Last year we reported that most observers effectively use just two or three randomly selected items in their estimates of average orientation. We now report that observers do not select items completely at random. This conclusion stems from an experiment in which observers were asked to reproduce the average orientation in an array of 8 Gabor patterns, regularly positioned in a circle around fixation. Reproductions were better correlated with the orientations of some Gabor patterns, because observers had idiosyncratic preferences for certain positions. However, the reproductions of all our observers were better correlated with the orientations of those Gabor patterns positioned closest to an imaginary line through fixation whose orientation matched each sample's mean. In other words, visual estimates of average orientation are weighted averages, where the assignation of weights is determined in conjunction with the estimate, not prior to it.

[3P2M086] No correlations between the strength of visual illusions

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In cognition, audition, and somatosensation, performance correlates strongly between different paradigms suggesting the existence of common factors. Surprisingly, this does not hold true for vision. For example, performance in line bisection and visual acuity (FrACT) correlate very weakly ($r2 = 0.001$). Here, we show similar results for visual illusions. For 143 participants (69 females), aged from 8 to 81, we measured the strength of six illusions using the method of adjustment. Correlations were very low and mostly non-significant. For example, the correlation between the Ebbinghaus and Ponzo illusion was $r2 = 0.08$, i.e., only 8% of the variability in the Ebbinghaus illusion is explained by variability in the Ponzo illusion. Results for males and females did not differ significantly. Interestingly, illusion magnitude decreased with age for the Ebbinghaus, Ponzo, and Tilt illusions. Our null results are supported by good test-retest reliability and a Bayesian analysis. Factorial analysis revealed no common factor.
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[3P2M088] Does It Really Exist? Creating the collinear masking effect by illusory contours

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Usually objects on a salient line should be easier to be found due to the obvious position these objects located. However, Jingling and Tseng (2013) discovered that when objects are arranged regularly to form a collinear line, a target on this line is harder to be found. This phenomenon is called the collinear masking effect. One possibility that creates the collinear masking effect is a filling-in process of the collinear grouping, making an illusory contour and smearing the visibility of

the target. To test the conjecture, we designed several search displays formed by different illusory contours (e.g., Kaniza type and abutting line illusory contours) to examine whether the illusory contour can mask a local target. The results of three experiments showed that targets on an illusory contour actually easier to be found (i.e., faster RT and higher accuracy) than those not on illusory contours. In other words, the collinear masking effect was not due to a perceptual filling-in on illusory contours. This experiment may improve our understanding about the underlying mechanism of the collinear masking effect.
MOST103-2628-H-039-001-MY3

[3P2M090] When do we need attention for grouping?

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Grouping processes aid the construction of bits and pieces of visual information into a coherent percept of the environment. Previous studies have yielded contradicting findings regarding the role of attention in grouping, some suggesting that grouping requires attention while others indicating that it does not. The current study aimed to discover in which circumstances grouping requires attention, using an inattention paradigm. Participants engaged in an attentionally demanding change detection task on a small matrix presented on a background of task-irrelevant organized elements. The background organization stayed the same or changed, independently of any change in the target. If the background organization is accomplished without attention, changes in background organization should produce congruency effects on target-change judgments. The results showed that attention was required for grouping elements by shape similarity but not by proximity, and for grouping organizations that involved element segregation and configuring into a shape but not configuring alone. Interestingly, attention was not required when grouping organizations were in competition, demonstrating congruency effects for only one of the competing organizations. These results support the view that perceptual organization is a multiplicity of processes, and provide evidence that attentional requirements vary as a function of the processes involved in grouping.
Israel Foundations Trustees (IFT)

[3P2M092] The effect of inter-stimulus interval on the partially occluded slalom illusion

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The slalom effect is a kinetic illusion of direction where the straight trajectory of a dot is perceived as sinusoidal due to its intersection with static tilted lines. The illusion has been explained as a global integration of local distortions occurring at each dot-line intersection (Cesaro & Agostini, 1998). When the dot trajectory is partially occluded by replacing the inducing lines with solid black triangles, the magnitude of the effect increases (Soranzo, Gheorghes & Reidy, 2014). A possible explanation is that the inferred motion path behind the occluder is longer than that perceived directly; Kim, Feldman & Singh (2012) showed that when two objects are alternately presented at the ends of an occluder, the reported path of the object varies with the inter-stimulus interval (ISI), in that a longer ISI induces a longer reported path. The present study investigates whether the

magnitude of the slalom illusion depends on the time spent by the dot behind the occluding triangles. To test this, the dot speed is kept constant when the trajectory is visible, but manipulated when the dot is occluded. Results are discussed in relation to apparent motion and amodal completion as well as possible delayed global integration of local distortions.

[3P2M094] The Piling Illusion

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Prepare 4 bank notes. Pile three of them on your left in such a way that no bills is occluded completely, and place the rest on your right. Then you will observe that the bill on the top of the pile appears smaller than the right one. This is a typical example of what we call the piling illusion, which we have found recently. The illusion magnitude is small, but the effect can be observed in various 2D and 3D objects. Try coins, books, boxes, containers, and geometrical figures. We checked its basic phenomenal properties by making variations. The exploratory observation revealed that the illusion is robust across objects and their configurations but disappeared when the object was complex or non geometrical (e.g., faces, animals). The piling illusion looks similar to the occlusion illusion (Palmer, 2007). The difference lies in that in the piling illusion no amodal completion is needed and the occluder shrinks, while in the occlusion illusion the occluded object expands in comparison with the isolated control object. It seems plausible that the piling illusion occurs because the distance between the observer and the occluder was perceived smaller relative to the standard, thereby rendering the perceived size smaller.

[3P2M096] How to study geometrical perceptual illusions

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Using Titchener's (1901) inverted T as my prime example, I discuss two approaches to the study of geometrical perceptual illusions, aimed at discovering their causes: In the context approach, the illusion-inducing figure is put into different contexts of other illusion or non-illusion figures, and in the variation approach, the critical figure itself is modified in various ways. In nine recent experiments, I let naïve observers verbally compare the lengths of the T's two lines and, by spreading thumb and index finger appropriately, haptically indicate the lengths of target lines of Ts. The visual T-illusion, which always consisted in an overestimation of the T's undivided line, survived in Ts, the lines of which had been replaced by dashed lines or dots; it was hardly affected by self-similar contexts of other Ts, and it even existed in plane figures, for which the T constituted a skeleton. The haptic illusion vanished in delimited branching patterns, in which Ts had been embedded, and in a periodic discrete pattern of symmetry group pmm when all Ts were in lateral orientation. The visual illusion seems to be caused by the T's dihedral symmetry; the haptic illusion depends on stimulus conditions.
Deutsche Forschungsgemeinschaft LA 487/6-1

[3P2M098] Limitations of the ODOG filter in special cases of brightness perception illusions

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The Oriented Difference of Gaussian (ODOG) filter of Blakeslee & McCourt (1999) has been successfully employed to explain several brightness perception illusions which include illusions of both brightness-contrast type, e.g. Simultaneous Brightness Contrast (SBC) and Grating Induction (GI) (McCourt 1982), and brightness-assimilation type, e.g. White effect and shifted White effect. We demonstrate some limitations of ODOG filter in predicting perceived brightness through a study involving specific parameters such as test patch length and spatial frequency in the White and shifted White illusions. More specifically we find that for very long grey patch lengths the ODOG filter fails to correctly predict the direction of brightness change and this failure persists for a wide range of frequencies.
[We are grateful to Alan Robinson of University of California, San Diego, for providing his MATLAB implementation of the ODOG filter]
Ashish Bakshi would like to thank the Council of Scientific and Industrial Research (CSIR), India, for financial support.

[3P2M100] The decay of perceptual grouping by collinearity

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Through grouping processes, the visual system continuously builds coherent wholes out of its local input descriptors. However, it must at the same time deal with regular interruptions of this input, such as blinks, saccades or occlusions. Here we investigate the persistence profile of perceptual groupings across an interruption. Subjects were briefly presented with meaningless object outlines defined by the collinearity of Gabor elements, placed on this contour in a field of randomly oriented distractor elements. After a variable ISI without orientation information, only part of the contour was re-aligned. Subjects were instructed to respond to which side of the display, left or right, the re-aligned contour fragment could be seen. A two-stage persisting benefit to contour detection was observed, consisting of an early stage specific to the local element positions of the first stimulus ($<$200 ms) and a later stage independent of it. We conclude that the grouping by collinearity of local orientations can indeed survive brief input interruptions, to the benefit of subsequent grouping processes.
M.D. is a postdoctoral fellow of the Fund for Scientific Research Flanders (FWO)

[3P2M102] The impact of eye movements on perception of "spine drift" illusion

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It was shown that drift illusions are strongly affected by eye movements (Kitaoka, 2010). The aim of our study was to reveal the role of eye movements in "spine drift" illusion perception. The original display of the illusion was changed to construct four modified variants: each spine of the central square was rotated at 30°, 60°, 90° for the 1–3 variants respectively and all spines of the central square were oriented in random order for the 4th variant. The observers were asked to look at each displays for 10 sec and then to estimate the illusion strength on a scale of 1–5. During the performance eye movements were recorded. The results revealed that the illusion strength was highest for the original display and then decreased gradually from the 1st to the 3rd variants. The data for the 4th variant were medium in value. Differences in fixation durations and microsaccade counts were correlated with subjective ratings. No significant differences for saccade counts were found. Our results indicate that the measured micro and macro movements may be considered as reliable indicators of the illusion perception.
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[3P2M104] The shape of opto-kinetic nystagmus as indicator of perception of vection illusion

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Motion sickness symptoms can occur in the absence of real physical motion of the observer. Specifically, the vection illusion (VI) often ensues as a result of exposure to dynamic visual displays. We developed a method of quantitative evaluation of the vection illusion strength based on optokinetic nystagmus (OKN) characteristics. We studied the VI strength depending on viewing angle values of dynamic visual displays. The VI was initiated using the CAVE virtual reality system. The VI strength was analyzed using the SSQ questionnaire and OKN characteristics. Results revealed complex links between viewing angle values, the VI strength and OKN characteristics. When dynamic visual displays were occupying half of the visual field, the VI strength and OKN characteristics were not very pronounced. For displays which occupied the whole visual field the VI strength was greatly higher and the OKN characteristics were significantly changed: there were a lot of low-amplitude saccades in the slow OKN phase and high-amplitude high-frequency saccades in the fast OKN phase. Our result showed that the OKN characteristics were tightly linked with the VI strength, so it would be possible to use them as real time indicators of the VI perception.

[3P2M106] The Helmholtz size illusion is processed by extrastriate visual cortex

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Neuroimaging research has indicated that for some illusions of size, there are commensurate distortions of retinotopy in V1. It remains unclear whether these distortions in retinotopy arise from processing within V1 or feedback from higher visual areas. Here, we examined the extent of activity within V1 in response to the Helmholtz illusion, in which physically square, horizontally lined stimuli, are perceived as taller than their physically square, vertically lined counterparts. This illusory percept can be neutralised by extending the lines to make the stimuli appear square. We found that the spatial extent of activity in V1 followed the physical rather than the perceptual dimensions of the stimulus, suggesting an extrastriate locus for the illusion. To explore the causal role of extrastriate cortex further we performed a TMS experiment in which participants made judgements about the aspect ratio of rectangular stimuli that were perceptually square. We stimulated V1 and two extrastriate areas, LO1 and LO2. Only stimulation of LO1 resulted in a significant release from the illusion. We show that extrastriate, rather than primary visual cortex plays a causal role in our perception of illusory size.
This work was supported by the BBSRC and the Welcome Trust

[3P2M108] Characteristics of target appearance changes in crowding

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An important limiting factor of peripheral vision is crowding – the inability to identify targets in clutter that are easily identified in isolation. Recent results suggest that a common 'crowding error' is that target elements are not perceived ('omission errors'). Here, we show detailed characteristics of omission errors in crowding. Observers were presented with targets consisting of 3 horizontal and 3 vertical lines in different square-like arrangements. There were two types of flankers: 1) one vertical & two horizontal lines 2) one horizontal & two vertical lines. The target was presented for 150 ms at an eccentricity of 10 degrees to the left or right of fixation. Following stimulus offset, participants were shown six alternative items and asked to choose which one resembled the target the most. In each of the alternatives, one of the six lines of the target was missing. We found that vertical lines were perceived to be missing more often than horizontal lines, and outer vertical lines more often than inner vertical lines. Alternatives without an X-junction (as present in the target) were rarely chosen. The flanker type had no effect. We suggest that detailed characterizations of target appearance changes will help to understand crowding.

[3P2M110] Natural districts of pictorial relief

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Is the structure of pictorial relief globally coherent? From local measurements of surface attitude one constructs global pictorial reliefs that reveal a rich landscape of hills and dales. But do the observers indeed have a "bird's-eye view" of the landscape? We studied this in a two-point depth comparison task, where the points might be at considerable mutual distance. We find that variability depends strongly on the mutual locations of the points, though not necessarily on their mutual distance per se. Depths can be compared very well when the points are located

on a single hill side, but much less so if there is a stream separating them. Phenomenologically, it is as if the pictorial relief were partitioned into "natural districts" that are individually well defined, but globally only roughly assembled in a quilt-like assembly. This might be the reason why a depth inverted relief appears so different. In that case the hills and dales exchange place, thus the natural districts map changes qualitatively.
supported by the Methusalem program by the Flemish Government (METH/08/02), awarded to Johan Wagemans.

[3P2M112] The influence of segmentation on rapid scene categorization

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Scene categorization is performed extremely rapidly suggesting that an efficient, feedforward coding system is in place. Converging evidence from behavioral, neural, and computational investigations indicate that this system may rely on the extraction of simple features and does not require the segmentation of these features into coherent objects, or surfaces. This is consistent with the idea that image segmentation is a computationally expensive process requiring feedback. However, are there truly no grouping and image segmentation processes occurring during the fast feedforward processing? In a series of three experiments, we investigated the influence of segmentation cues on scene categorization. We presented participants with two scenes divided into four parts using different segmentation cues displayed for 300 ms prior to image onset. These cues established either a congruent (supporting the correct image segmentation into two scenes) or incongruent (prompting observers to incorrectly group scene segments) segmentation. Participants were less accurate in scene categorization when incongruent segmentation cues were presented, indicating the segmentation can influence categorization. Moreover, the effect remained robust even when the cues were presented concurrently with the images, suggesting that, whilst scene categorization might be rapid, it can also be influenced by segmentation mechanisms.
Fonds Wetenschappelijk Onderzoek (FWO) and Methusalem program by the Flemish government (METH/08/02)

[3P2M114] Neural responses to symmetry presented in the visual hemifields

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Symmetry ERP work has identified a difference wave called the Sustained Posterior Negativity (SPN); amplitudes in posterior electrodes are more negative for symmetrical than random patterns from around 250 ms after stimulus onset (Bertamini & Makin, 2014). Based on the psychophysical and electrophysiological evidence, it seems logical to suggest that a specialized network spanning both hemispheres generates the SPN. Due to its interhemispheric connections, the fibres of the corpus callosum may play a role in mediating symmetry detection

between the hemispheres (Herbet & Humphrey, 1996). We examined whether the SPN was produced only by reflectional symmetry presented at fixation, or whether each hemisphere could produce a SPN specific to the pattern presented in the respective hemifield. Symmetrical and random dot patterns were presented to each hemisphere by positioning them either side of the fixation cross. Participants were then required to make a colour discrimination about the presented patterns (were the patterns light or dark red). A SPN was produced in each hemisphere for the pattern that was in the contralateral visual hemifield. Our results, therefore demonstrate that each hemisphere has an independent symmetry detector and that interhemispheric connections do not play a role in producing the SPN.

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[3P2M116] Tilt aftereffect from perception of global form from Glass Patterns

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Glass Patterns (GPs) contains randomly distributed dot pairs (dipoles) whose orientations are determined by certain geometric transforms. In this psychophysical study we measured the tilt aftereffect (TAE) following adaptation to oriented GPs. Adapting stimuli were parallel GPs which global orientation was varied between 0° (vertical) and 90° (horizontal). The test pattern was a circular grating presented for 33 ms and observers judged whether it was tilted clockwise or anticlockwise from vertical. The results showed that adaptation to GPs produces an angular function similar to that reported in previous TAE studies, peaking at 15° (TAE: 1.73°). Moreover, we measured the inter-ocular transfer (IOT) of the GP-induced TAE and found an almost complete transfer (88.1%). In additional experiments we assessed the role of attention in TAE from GPs. The rationale was that if attention play a role in extracting the global form from local oriented dipoles, then diverting attention away from the adapter TAE should be dramatically reduced. The results show an attention-related reduction of 83%. We conclude that TAE from GPs depends on a lateral inhibitory mechanism implemented at a level in which neurons are binocular, selective for orientation and their activity is strongly modulated by attention (e.g., V3A and V4).

[3P2M118] The Leuven Embedded Figures Test (L-EFT): Measuring perception or cognition?

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Our visual system prioritizes global structures above local elements (Navon, 1977). A myriad of tasks claim to dissociate global from local perception, but the constructs underlying these tasks remain unclear. One paradigm commonly used in this field is the Embedded Figures Test (EFT; Witkin, Ottman, Raskin & Karp, 1971) but its results have been prone to a wide variety of

interpretations. In the current study, testing over 130 participants, we aimed at a better understanding of what is measured by the EFT. Therefore, a new EFT was designed where local features at the target level (e.g., symmetry or closure), and global features at the pattern level (e.g., number of lines continuing from target into context) were independently manipulated in order to dissociate local from global processing. Secondly, the association between EFT performance, non-verbal intelligence and several executive functions was assessed to evaluate the impact of both perceptual and cognitive aspects on EFT performance. These data could clarify the construct validity of this paradigmatic task of global/local processing. In addition, our newly designed EFT may offer a more controlled measure, which is better able to differentiate between genuine perceptual, as opposed to executive contributions to EFT performance.
FWO and Methusalem program of the Flemish Government (METH/08/02)

[3P2M120] Effects of stimulus ambiguity on task-related ERP components

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During observation of an ambiguous figure (e.g. the Necker cube) our perception is unstable and alternates spontaneously between two interpretations. Tiny low-level changes can disambiguate the ambiguous stimulus and evoke two large ERP positivities ("ambiguity effect"). These components show larger amplitudes in the go compared to the nogo trials of a go-nogo paradigm, indicating an involvement of attentional processes. In the current study we compared the ambiguity effects between the go-nogo and a forced choice paradigm variants.
Methods: Ambiguous and disambiguated lattice variants were presented discontinuously in separate experimental blocks. In Experiment 1 (forced choice) participants reported both perceptual reversals and perceptual stability, in Experiment 2 they only reported perceptual reversals (go-nogo) between successively presented stimuli (go-nogo experiment). EEG data were selectively averaged for stimulus and response type.
Results: We found the ERP ambiguity effect in both experiments. In Experiment 1 we found an additional fronto-central positivity around 400 ms after onset ("P400fc") of disambiguated but not of ambiguous stimuli.
Discussion: The novel P400fc is strongly determined by both stimulus ambiguity and task. It may represent a time stamp of task-related decision processes and show their dependence on stimulus ambiguity. Interestingly, reaction times cannot explain the ERP effects.
Financial support from Deutsche Forschungsgemeinschaft (KO 4764/1-1, TE 280/8-1) is gratefully acknowledged

[3P2M122] Representational similarity analysis of contour shape processing in the visual cortex

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Psychophysical studies suggest that human visual system analyses the shape of a closed contour on the basis of radial frequency (RF) components, consisting of sinusoidal modulations of the circle radius. We studied contour shape representations in the visual cortex using functional magnetic resonance imaging (fMRI). We used event-related design and measured activity patterns for 65 different shapes. We varied RF (3–6 cycles/perimeter), orientation (polar phase 0–270 deg) and amplitude (0–0.5 in proportion to radius) of the shapes. We used a searchlight-based representational similarity analysis together with a probabilistic atlas of the visual areas. First we calculated representational dissimilarity matrices (RDMs) for RF, orientation, local curvature, contrast energy and spatial frequency (SF) spectrum. Then these model RDMs were compared to the measured RDMs. The resulting correlation maps revealed RF specific activity patterns in areas V2d, V3d, V3AB, and IPS0, but not in areas hV4 and LOC. Orientation and local curvature did not show such specificity. Positive correlation maps were also found for SF-spectrum and contrast energy, but these showed no selectivity across areas. The results provide further support for the RF analysis of contour shapes and suggest that RF is represented in a subset of the mid-level visual areas.

[3P2M124] Impacts of fatigue on mental rotation

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According to Shepard & Metzler (1971) and Cooper (1975, 1976) reaction time (RT) for recognizing the identity of an object increases corresponding to the increase of rotational angle of this three- and two-dimensional objects. The purpose of our study is to explore possible impacts of the fatigue on mental rotation. Therefore, our study has a two-fold aim: to estimate a possible correlation between the time of being awake and RT; to explore the impact of fatigue on the RT in mental rotation task. To analyze the RT for recognizing rotated objects we have constructed a digitized test consisting of 256 object pairs (128 two- and 128 three-dimensional). According to our results RT is longer for mental rotation of mirrored objects in both 2D and 3D stimuli. The error rate is higher in 3D (18.3%) than in 2D objects (10.7%) but it does not depend on the time when the test is conducted. The average RT of the 2D and 3D objects' rotation is faster in the period 5–10 hours after awakening. Although we can observe that fatigued subjects have fewer errors, there is no the impact of fatigue on the RT in mental rotation.
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[3P2M126] A new principle of figure-ground segregation and object formation: The accentuation

Katia Deiana, Jan Koenderink, Andrea van Doorn, Adam Reeves and Baingio Pinna
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In this work we explored phenomenologically a new principle of figure-ground segregation and object formation: The accentuation. This principle, first suggested in previous works (Pinna 2010; Pinna & Sirigu, under revision), is now extended systematically to new visual domains going from the figure-ground segregation to the part-whole organization. The effectiveness of the principle of accentuation has been studied in the same spirit of Gestalt psychologists and demonstrated through new phenomena. It was also demonstrated that this principle is independent and autonomous and that it can be pitted against or in favor of other Gestalt principles of grouping and figure-ground segregation. Moreover, the accentuation has been extended from simple drawings to biological conditions, where the appearance and the evolutionary success of a living organism depend on the accentuation of single parts of the body aimed to hide, show, deceive, attract, repel other organisms. Our results suggest that the accentuation can be considered as one of the biological key elements aimed to improve more strongly the biological adaptive fitness.

[3P2M128] Using Visual Search to assess cues for Object shape

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The visual system determines the shape of closed contours and can find a target among a set of distractors very rapidly if it contains a unique cue. Search speed and asymmetries in performance that can arise when target- and distractor-element roles are reversed were used to determine elements of the visual system's code for globally-integrated shape. Kristjansson and Tse (2001) argued curvature discontinuities (CDs) are critical local cues to shape, supporting rapid visual search with minimal distractor interference when present in the target but absent in the distractors. However, studies using Radial Frequency contours have suggested the internal polar angle between adjacent corners plays an elementary role. Two search experiments will be presented in which performance within-observers ($n = 5$) is contrasted for patterns differing in curvature, CD, corner numerosity and internal polar angle. The results show that efficient search does not depend on the presence or absence of CDs, nor on differences in corner curvature or numerosity but that the angle separating corners was a primary feature driving both 'pop-out' and search asymmetry. The results support the conclusion that polar angles are labelled cues to shape in human vision and therefore a critical element in the code for object shape.
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[3P2M130] The interference effect of color in amodal completion

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We investigated possible influences of surface color in amodal completion using a sequential matching task. During this task, participants had to judge whether a test shape could be a previously shown partly occluded shape. Similar to De Wit et al. (2006), we used two different shape completions (global, local) but now combined these with different color completions (global, local, anomalous). Global completions extended the global shape and color regularities (e.g.

repetition of protrusions and colored patches), whereas local completions extended the local shape and color properties at the occlusion boundaries. We compared the response time of correct judgments in match pairs. To account for shape complexity, and focus on the effect of color context, we used stimuli with the same overall shape but without colored patches as a baseline. We found a strong effect of color, with faster response times for global color completions relative to local and anomalous color completions. Additionally, when comparing global and local color completions, color marginally interacted with shape, revealing the highest facilitation for global color / global shape completions. We will discuss implications of the current results in a framework that accounts for both shape and color completions.

[3P2M132] The role of shape complexity in the lateral occipital complex

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We investigated the relationship between the physical properties of three animal silhouettes and the BOLD signals from early visual cortex through to the object-selective lateral occipital complex (LOC). Complexity of the three silhouettes was manipulated by effectively low-pass filtering the outer contours, creating low, mid and high complexity images. These stimuli were then presented to participants in a rapid event-related design, allowing us to identify patterns of neural activity specific to each shape. We correlated this neural activity with various physical and more abstract measures of shape similarity to identify which shape properties may be influencing the activation in the various visual ROIs. We found the strictly physical measures were the best predictors of activation in earlier visual areas, likely due to their retinotopic organisation. For extrastriate areas (LOC/pFs), we found measures of complexity were the best predictors. These data appear to reflect the trend away from physical tuning towards more abstract shape representations in higher-level visual areas.
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[3P2M134] Interaction mechanisms of global and local image analysis in visual systems of observers with field-dependent and field-independent cognitive style

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We investigated the effectiveness of identification of fragmented figures in people with field-dependent and field-independent cognitive styles. We used our computerised version of the

Gollin-test and showed 75 contour images of objects. Contour lines of an object formed on the screen by progressive accumulation, via the addition of random blocks of pixels. At the time of identification of the object the accumulation of fragments was stopped. We recorded the minimum total area derived fragments in terms of the percentage of the total area of the image outline and also the time taken for image formation. It was established that participants with field-independent cognitive styles needed more contour fragments for identification of the object than those with field-dependent cognitive styles. The hypothesis of the study is based on the notion of spatial-frequency filtering, selection of signal from noise and a matched filtering model. The data indicate the dominance in individuals with field-independent cognitive style of the local analysis, but in individuals with field-dependent cognitive style, more global image analysis. Searching for masked figures by patients with schizophrenia demonstrated field dependence. For the perception of fragmented figures they needed more elements. This result demonstrates their dysfunction in the mechanism of global analysis.
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[3P2M136] Feature integration in plaid revealed by visual search

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Plaid is composed of two orthogonal oriented gratings but may be perceived as a checkerboard with an oblique orientation. It is not clear whether the detection of a plaid is mediated by a plaid-specific mechanism or by a combination of two oriented filters. We used a visual search paradigm, which is sensitive to feature integration, to investigate this issue. The stimuli were either grating or plaid patches. The salience of the plaid structure was manipulated by varying the contrast (low vs. high), spatial frequency (Low-Low SF, High-High SF and Low-High SF) and orientation (same vs. oblique) of the components. The participants ($N = 8$) were asked to search for a grating among distractor plaids or a plaid among grating distractors. The results were consistent with a parallel search in searching for grating among plaids, with the exception of plaid distractors having mixed SFs and the same component orientation. This indicates the existence of a grating-sensitive mechanism. When searching for plaid, serial search characteristics were observed at Low-Low SFs and mixed SFs, and their component orientation was the same as that of the distractors. This orientation and spatial frequency -dependent performance indicates that plaid detection is based on the processing of its components.
This work was supported by NSC 102-2420-H-006 -010 -MY2 to PCH

[3P2M138] Determination of relevant component parts of an object in a discrimination task with the bubbles method

Justin Plantier, Charles-Antoine Salasc, Alain Bichot, Corinne Roumes and Sylvie Lelandais
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To perform some tasks, like detection, recognition, discrimination or identification of objects in natural environment by day or by night, it is possible to use images acquired from different sensors: images recorded by visible image sensor, thermal images from infrared sensor or images acquired

during the night with light intensifier. Related to the environment and sensors characteristics, the quality of images may be very different, the object appearance is also different according to the sensors. The aim of this work is to evaluate the observer performances to discriminate objects related to different sensors and to determine what part of objects is useful in a discrimination task. To obtain this knowledge, we have developed a psychovisual experiment to discriminate vehicles, by using the method of bubbles [Gosselin, Schyns, 2001, Vision Research 41, 2261–2271]. Stimuli presented to the observers are constructed by filtering the original image at different scales signal [Lelandais, Plantier, BIOSIGNALS 2013, Spain] and multiplied by Gaussian "bubbles" that partially obscure the signal [Lelandais, Roumes, Plantier, ECVP 2013, Bremen]. Previous results of experiment give the number of bubbles necessary to perform the task. Now, we determine the useful parts of vehicles for their discrimination which highlight differences between sensors.

Symposium: Interactive social perception and action

[3S1A001] Against the Unobservability Principle

Cristina Becchio
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A generally unexpressed assumption behind much current social cognition research is the so-called "unobservability principle" (UP). According to the UP, minds are composed of exclusively intracranial phenomena, perceptually inaccessible and thus unobservable to everyone but their owner (Krueger, 2012). Mental states, such as beliefs and intentions, are private, internal, and not observable in others. Contrary to the UP, I will argue that intentions are indeed visible in others' movements. First, I will present evidence that intentions influence response properties and shape movement kinematics during movement execution (Becchio, Manera, Sartori, Cavallo, & Castiello, 2012). Next, I will show that observers are especially attuned to kinematic information and can use early differences in visual kinematics to anticipate another person's goal (Ansuini, Cavallo, Bertone, Becchio, 2015). This ability is crucial not only for interpreting the actions of individual agents, but also to predict how, in the context of a social interaction between two agents, the actions of one agent relate to the actions of a second agent.
This work received funding from the European Research Council under the European Union's Seventh Framework Programme (FP7/2007–2013) / ERC grant agreement n. 312919.

[3S1A002] Sensorimotor learning influences understanding of others' actions

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The discovery of 'mirror' neurons (motor-related neurons which fire during both the performance of an action and the observation of another conspecific performing the same action; di Pellegrino, Fadiga, Fogassi, Gallese, & Rizzolatti, 1992), has led to renewed interest in the role of motor processes in social perception. In particular, it has been suggested that mirror neurons subserve the 'understanding' of others' actions via the observer's motor system (Rizzolatti, Fadiga, Gallese, & Fogassi, 1996). However, even if mirror neurons do contribute to action understanding, their

properties may be the result of learning to associate the perceptual representation of an action with the motor program for that action (Cook, Bird, Catmur, Press, & Heyes, 2014). Participants completed an action understanding task (Pobric & Hamilton, 2006) in which they judged the weight of boxes lifted by another person, before and after a period of 'counter-mirror' sensorimotor training, wherein they lifted heavy boxes while observing light boxes being lifted, and vice-versa. Compared to a control group, this training significantly reduced participants' performance on the action understanding task. Performance on a duration judgement task was unaffected by training. These data suggest that the ability to understand others' actions is the result of sensorimotor learning.

[3S1A003] Interpersonal integration of perceptual judgments in joint object location

Guenther Knoblich, Pavel Voinov and Natalie Sebanz
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Prior research has shown that the ability to communicate the confidence associated with individual perceptual judgments predicts the accuracy of perceptual group judgements (Bahrami et al., 2010; Fusaroli et al., 2012). The present study asked whether there are additional processes of information integration across individuals that depend on integrating location information across different viewpoints on the same scene in the environment. Pairs of participants located an object in a virtual 3D environment. Two participants in a pair had different viewpoints so that the relative uncertainty of location judgments on different spatial dimensions differed between them. Importantly, the uncertainty of locating objects was much higher on the depth dimension than on the orthogonal dimension. Three experiments investigated whether participants' use of location information provided by their partners would be weighted depending on the partner's uncertainty on a particular spatial dimension. The results confirmed that participants incorporated location information provided by their partners not simply by averaging but by flexibly weighing location information on particular spatial dimensions according to their partners' uncertainties. Thus, groups of people are able to improve their joint perceptual accuracy by selectively weighing information with another's perceived or estimated uncertainty.

[3S1A004] The influence of dyadic gaze dynamics on joint and individual decisions

Bert Timmermans, Iva Barisic, Frouke Hermens and Leonhard Schilbach
University of Aberdeen, UK; ETH Zürich, Switzerland; University of Lincoln, UK; Max Planck Institute for Psychiatry, Germany

How do interpersonal behavioural dynamics predict individual and joint decisions? Recent interactionist views on social cognition suggest that the most under-studied and important aspect of social cognition may be interaction dynamics. However, it has hitherto proven extremely difficult to devise a controlled setup in which social cues, such as eye gaze, are subject to unconstrained interaction. To address these issues, we use a dual interactive eye-tracking paradigm. Participants are presented with the face of an anthropomorphic avatar, the

eye movements of which are linked in real-time to another participant's eye-gaze. This allows for control of interaction aspects that are not related to the experience of gaze contingency. Participants have to choose which one out of two spheres on either side of the avatar face is the largest. These spheres can have a medium, small, and no difference. Specifically in the latter condition, gaze dynamics guide choices. Using cross-recurrence quantification, we analyse the time course of the gaze interactions and look at how this predicts individual and joint decisions about sphere size, which participant will follow the other, and assess collaboration in a subsequent "stag hunt" game, a variation on the prisoner's dilemma game.
Funded by Marie Curie CIG "DUALGAZE"

[3S1A005] From action observation to social interaction: Top-down influences on motor interactions

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When shaking hands or catching a ball, humans not only need to perceive, understand and predict the interacting partner's actions, but also timely coordinate their own actions to successfully interact. Thus far, such social interactions have typically been investigated using paradigms that neglected the active part of the so-called observer; that is, participants passively observed the confederate's action without actively reacting to or interacting with the observed action. This raises the question to what degree findings from passive observation experiments are transferable to situations in which participants actively engage in motor interactions. Secondly, predictions of an observed action are not only informed by online visual information, but are often influenced by prior assumptions and expectations. Therefore, the second question we address is to what degree motor control in social interactions is mediated by top-down influences. We present a series of studies examining the processes of social perception and action in truly interactive experimental setups. The results of these studies support the ecological validity of earlier findings and they show that prior expectations powerfully influence/ bias motor control in social interactions. We advocate the use virtual reality to create interactive setups that are under high experimental control and allow natural interactions.

Symposium: Brain responses to visual symmetry

[3S1B001] Brain Activity in Response to Visual Symmetry

Marco Bertamini and Alexis Makin
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There has been much progress on the study of the neural basis of symmetry perception. ERP studies reliably show a sustained posterior negativity (SPN), with lower amplitude for symmetrical than random patterns at occipital electrodes, from 250 ms after onset. The SPN is an automatic and sustained response and is broadly unaffected by task. The extended symmetry-sensitive network involves extrastriate visual areas and LOC with consistent evidence from fMRI and TMS. Reflection is the optimal stimulus for a general regularity-sensitive network that responds also to rotation and translation. We tested whether response to symmetry is dependent of view

angle. When people classify patterns as symmetrical or random, response to symmetry is view-invariant. When people attend to other dimensions, the network responds to residual regularity. Neural response to symmetry also scales with noise: Proportion of symmetrically positioned elements predicts the size of SPN and fMRI responses. Connections between the hemispheres are not critical because SPN amplitude increases with the number of axes, and is comparable for horizontal and vertical symmetry. The same ERP response to symmetry can come from either hemisphere, but it is stronger in the right hemisphere. Overall, there is a consistent link between brain activity and sensitivity.

[3S1B002] Symmetry Detection in typically and atypically lateralized individuals: A visual half-field study

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Visuospatial functions are typically lateralized to the right cerebral hemisphere, giving rise to a left visual field advantage in visual half-field tasks. In a first study we investigated whether this is also true for symmetry detection off fixation. Twenty right-handed participants with left hemisphere speech dominance took part in a visual half-field experiment requiring them to judge the symmetry of 2-dimensional figures made by joining rectangles in symmetrical or asymmetrical ways. As expected, a significant left visual field advantage was observed for the symmetrical figures. In a second study, we replicated the study with 37 left-handed participants and left hemisphere speech dominance. We again found a left visual field advantage. Finally, in a third study, we included 17 participants with known right hemisphere dominance for speech (speech dominance had been identified with fMRI in an earlier study; Van der Haegen et al., 2011). Around half of these individuals showed a reversed pattern, i.e. a right visual half-field advantage for symmetric figures while the other half replicated the left visual-field advantage. These findings suggest that symmetry detection is indeed a cognitive function lateralized to the right hemisphere for the majority of the population.

[3S1B003] The causal role of right lateral occipital (LO) cortex and right occipital face area (OFA) in symmetry detection: evidences from fMRI-guided TMS data

Silvia Bona, Juha Silvanto and Zaira Cattaneo
Aalto University School of Science, Finland; University of Westminster, UK; University of Milano-Bicocca, Italy

Despite the salience of bilateral mirror symmetry in the visual world, its neural correlates are not established. We investigated the brain areas underlying symmetry detection in low-level stimuli (dot configurations) and high-level stimuli (faces) with fMRI-guided transcranial magnetic stimulation (TMS). We focused on lateral occipital (LO) cortex and occipital face area (OFA) because of their relevant role in object/shape and face processing respectively, for which symmetry represents a critical cue. In Study 1, we applied TMS over rightLO, leftLO, or two control sites

while participants discriminated between symmetric and asymmetric dot patterns. TMS over both rightLO and leftLO impaired performance with a greater effect following rightLO TMS, revealing that symmetry detection is right-lateralized. In Study 2, TMS was applied over rightLO, rightOFA, leftOFA (control site) and Vertex (baseline) while participants discriminated between symmetric and asymmetric dot configurations (as in Study 1) and judged whether a face was either perfectly symmetric or not. Symmetry detection in dot patterns recruited both rightLO and rightOFA, whereas symmetry detection in faces selectively involved rightOFA. Overall, we suggest the co-existence of low-level/general and high-level/face specific symmetry encoding mechanisms, with symmetry as a low-level feature recruiting both rightLO and rightOFA whereas facial symmetry involving solely rightOFA.

[3S1B004] Symmetry interactions in perceptual organization

Peter A. van der Helm
University of Leuven (KU Leuven), Belgium

I discuss several psychophysical findings, starting from the holographic approach to symmetry perception (van der Helm & Leeuwenberg, 1996). This approach explains that mirror symmetries and Glass patterns are about equally detectable and better detectable than repetitions, and that detection of imperfect mirror symmetries and Glass patterns follows a psychophysical law which improves on Weber's law. Against this background, I consider interactions between symmetry and other factors in perceptual organization, such as perceived depth, temporal aspects, and relative orientation. The latter, in particular, seems relevant to the perception of multiple symmetries, and presumably therefore, also to their skewed distribution in flowers and decorative art (van der Helm, 2011). The findings suggest specific neural mechanisms and hopefully inspire further research into these mechanisms.

[3S1B005] The emergence of symmetry in the distributed response patterns in the ventral visual stream

Annelies Baeck, Johan Wagemans and Hans Op de Beeck
University of Leuven, Belgium; University of Leuven, Belgium; University of Leuven, Belgium

Symmetry is a very salient feature of visual patterns. With this study, we wanted to investigate where and how the percept of symmetry emerges in the visual ventral stream. Participants are scanned while observing small dot patterns or larger stimuli that consist of two of the smaller dot patterns. These composed stimuli are either symmetric or non-symmetric. Using multi-voxel pattern analyses, we investigated the relationship between the response patterns of the larger dot patterns and their constituting smaller parts. We found that the lateral occipital complex (LOC) could discriminate well between symmetric and non-symmetric patterns, better than between patterns of the same category. Classification was also better between two symmetric patterns than between two non-symmetric patterns. Decoding accuracy in LOC to discriminate between symmetric and non-symmetric patterns was not influenced by whether or not a part of the two dot patterns was shared, while two non-symmetric dot patterns were better classified when the two patterns did not share a smaller part. In early visual cortex, a different pattern was

found: decoding accuracy was generally very good, and depended on whether or not the patterns had one part in common, regardless the type of classification.

[3S1B006] The Holographic model predicts amplitude of the brain's symmetry response

Alexis Makin, Giulia Rampone and Damien Wright
University of Liverpool, UK; University of Liverpool, UK; University of Liverpool, UK

Helm and Leewenberg (1996) developed a 'holographic weight of evidence model' that quantifies 'perceptual goodness' (i.e. salience, detectability) of different visual patterns. They state that W = E/N, where W is goodness, E is evidence of regularity, and N is the total information. We tested whether the W-load of different visual symmetries predicts the amplitude of the neural response. We recorded a symmetry-related ERP called the Sustained Posterior Negativity (SPN, see Supplementary Material Panels A-D) in six experiments. 1) SPN amplitude was greater for reflection than translation or rotation patterns. 2) The number of dots differentially modulated the SPN generated by reflection and translation. 3) The SPN scaled with the proportion of paired/unpaired dots. 4) The SPN scaled with the number of reflection axes. 5) The SPN was similar for symmetry and anti-symmetry, but again scaled with number of axes. Across these experiments, the correlation between W and SPN amplitude was very strong (Supplementary Material Panel E). Finally, we show that the brain can switch between coding goodness of objects, and goodness in the image. We conclude that the holographic model captures most aspects of the neural response to symmetry.
Leverhulme Trust Early Carreer Fellowship (ECF-2012–721)

[3S1B007] Measuring symmetry responses across time and cortical area in the human brain

Anthony Norcia and Peter Kohler
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Most of what we know about brain mechanisms of symmetry perception has come from studies of point symmetries, especially mirror symmetry. Here we used a broader class of stimuli – wallpaper groups – to study the temporal evolution (using EEG) and spatial localization (fMRI and EEG) of brain responses to symmetric stimuli. Wallpaper groups contain the point symmetries, but repeat themselves in two directions, tiling the plane. The magnitude of EEG responses depends on the number of subgroups present, with more complex groups leading to larger responses. In a subset of wallpaper groups that differed only in the number of rotation axes, both EEG and fMRI responses scaled with the number of rotation axes. This parametric relationship was seen as early as V3 and V4 in fRMI, and was also present in the lateral occipital complex (LOC) and VO1, a ventral surface area anterior to V4. Responses were weak in dorsal areas MT, V3A and IPS0. The latency of the symmetry evoked response was earlier in V3/V4 than in the LOC indicating that sensitivity in these areas developed in a feed-forward fashion, rather than being due to feedback from LOC.
NSF INSPIRE 1248076

Symposium: Clinical visual pshychophysics: from bench to bedside and beyond

[3S1C001] Contrast Sensitivity

John Robson
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Since the introduction of standardised printed letter charts by Herman Snellen in 1862, the ubiquitous measure of visual competence in optometric and ophthalmic practice has been visual acuity. While there are good reasons for using this simple measure to assess the deleterious effects of refractive error, it was realised from the beginning that it was less well suited to characterising the visual defects associated with retinal or more central nervous dysfunction. Thus we find in 1881 a Norwegian ophthalmologist, Ole Bull, proposing a chart with large letters of decreasing contrast that could be used in clinical practice to measure a patient's "light sense" as easily as a Snellen chart could be used to measure their "form sense". Unfortunately Bull was unable to make such a chart and it was not until the late 1980s that technological developments made it possible to print and calibrate such charts.
In 2015 we may ask whether the measurement of contrast sensitivity should not have a greater place in the routine visual assessment of retinal disease and whether the use of printed letter charts may still have advantages in a clinical context compared with methods of measuring contrast sensitivity based on gratings and electronic displays.

[3S1C002] Visual Function Self-Testing for Remote Monitoring of Maculopathy

Yi-Zhong Wang
Retina Foundation of the Southwest, USA

Maculopathy, including age-related macular degeneration (AMD) and diabetic retinopathy (DR), is the leading cause of severe visual impairment. Changes in lifestyle can slow the progression of maculopathy, and new anti-VEGF treatments can preserve vision in patients with neovascular AMD and diabetic macular edema (DME). For these interventions to be optimally effective, frequent monitoring of maculopathy is required, which, in turn, depends on timely detection of disease condition changes. Because annual or semiannual eye examinations may not be sufficient to ensure an early diagnosis, the preferred practice for maculopathy management must include self-testing by patients for remote monitoring of disease onset or progression. This presentation discusses desirable characteristics of visual-function tests that can be used by patients with maculopathy for self-testing (Liu, Wang & Bedell, 2014), and reports the results of clinical studies that employed a mobile shape discrimination hyperacuity test for remote monitoring of maculopathy (Wang et al., 2013; Kaiser et al., 2013). It also discusses the potential and challenges of self-testing, remote monitoring tools for the detection of visual function changes associated with clinically significant changes of disease condition.
1R43EY020016-01, 2R44EY020016-02

[3S1C003] Visual field testing for the detection and management of glaucoma

David Henson
University of Manchester, UK

The developer of visual field tests for glaucoma has to balance a number of factors; speed, accuracy and discriminatory power. The test needs to acknowledge that most patients are unreliable and that test-retest variability is dependent upon threshold sensitivity. The test needs to be fast as patients start to loose attention after only a few minutes. This limits the number of locations that can be tested and has led to developments in threshold algorithms, the use of prior data, and the focus upon test locations with high informational value. This presentation will summarise some of the research looking at measures of attention during clinical perimetry, the selection of test location, the development of new Bayesian methods and the use of prior data from previous tests and a knowledge of the relationship between test-retest variability and sensitivity.

[3S1C004] Automated static threshold perimetry using a remote eye-tracker

Pete R. Jones, Sarah Kalwarowsky, Gary S. Rubin and Marko Nardini
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Static Threshold Perimetry [STP] is a technique for mapping luminance-detection sensitivity across the visual field. Current STP methods require (i) an explicit, button-press response (precluding testing of infants) and (ii) expensive, specialised equipment. Here we present a new measure that addresses these problems by combining a cheap, commercially available eye-tracker (Tobii EyeX: $135), with an ordinary desktop computer. Luminance detection thresholds were measured monocularly in 18 healthy adults (additional data collection ongoing), using both a Humphrey Field Analyzer [HFA] and a new procedure based on remote eyetracking. The eye-tracker was used to present (Goldmann III) stimuli relative to the current point of fixation, and to assess whether the participant made an eye-movement towards the stimulus. Participants completed each test twice to assess test-retest reliability. The eyetracker was able to produce maps of luminance-sensitivity, which: (i) were correlated with those produced by the HFA; (ii) exhibited similar (though slightly lower) reliability; (iii) could distinguish between luminance sensitivity in central ($<10^{\circ}$) versus peripheral ($>10^{\circ}$) retinal locations; (iv) and could differentiate between the blind spot and surrounding locations. This work demonstrates that STP can be performed using remote eye-tracking and low-cost components. Such a test could be particularly effective for screening preverbal infants.

This work was supported by Fight for Sight, the NIHR Biomedical Research Centre at Moorfields Eye Hospital NHS Foundation Trust and UCL Institute of Ophthalmology, the Special Trustees of Moorfields Eye Hospital

[3S1C005] The Glasgow Caledonian University Face Test: A New Clinical Test of Face Discrimination

Andrew J Logan, Gael E Gordon and Gunter Loffler
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Introduction: Accurate interpretation of face information is critical for social functioning. Impairments of face perception are associated with a range of ocular, developmental and neurological conditions. The aim of this study was to develop a face test which is both clinically applicable and able to capture normal variability.
Methods: The new face test presents four synthetic faces in an "odd-one-out" task. The difference between the faces is controlled by an adaptive procedure which allows face sensitivity (i.e. the minimum difference between faces required for discrimination) to be measured. Results: A broad range of face discrimination sensitivity was established for a large group of healthy adults ($N = 52$; 29.7 ± 15.1 years). The test is rapid (3 min) and repeatable (Bland-Altman analysis and test-re-test r squared $= 0.795$). Older adults (72 ± 4.1 years) showed preserved face discrimination ability. A case report of a patient who reported a lifelong difficulty with face perception indicated that the test is highly sensitive to impairments of face perception (Z-score of -7; c.f. Z-score of -2 for existing face tests). Conclusions: The new face test offers a novel, sensitive and repeatable assessment of face discrimination ability. It overcomes limitations of existing tests such as restricted testing ranges and confounding factors (e.g. memory, familiarity).

Oral Presentations: Eye movements

[3T2A001] What can saccadic inhibition reveal about foveal and peripheral information processing within fixations?

Johannes Schulz and Sebastian Pannasch
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The abrupt onset of task-irrelevant distractors leads to saccadic inhibition. The magnitude and delay of the effect is related to the location and size of the distractor (Glaholt et al., 2012; Pannasch & Velichkovsky, 2009). It was hypothesized that the saccadic inhibition represents the time required for information processing of the distractor. To test this assumption, we presented distractors of different occlusion conditions. Distractors occluded either (1) the foveal region, (2) the periphery, (3) a small part of the periphery, (4) the foveal region and most of the periphery or (5) the whole image. The onset of saccadic inhibition was the same for all distractor conditions but for (4) it was earlier terminated and showed a smaller magnitude. Combining the effects of conditions (1) and (2) produced a similar inhibition distribution as in (5). Results implicate that in a single fixation, foveal (i.e., information extraction) and peripheral (i.e., saccade target selection) information processing can occur in parallel and independent of each other.
This research was funded by German Research Foundation (DFG) under Grant No. PA 1232/3-1.

[3T2A002] Transformation priming promotes stable and consistent perception in spite of unstable retinal input

Alexander Pastukhov, Solveiga Vivian-Griffiths and Jochen Braun
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If there is one thing constant about retinal input, it is that it constantly changes due to eye-movements, self-motion, illumination changes, object-motion, etc. All these changes must be correctly interpreted on the fly in order to keep visual perception stable and consistent. This poses an enormous challenge, as many transients are highly ambiguous in that they are consistent with many alternative physical transformations. We investigated how our visual system uses a recent perceptual experience to overcome this problem. We used three dynamical displays (structure-from-motion (SFM), shape-from-shading (SFS), and streaming-bouncing object collisions (SB)) with a transient ambiguous change that can produce two qualitatively different perceptual experiences: stable or reversed rotation in SFM, stable or inverted depth in SFS, streaming or bouncing in SB. For all displays, we observed reliable transformation priming, as the perceptual interpretation of a physical change in earlier trials tended to repeat in subsequent trials. Additional experiments demonstrated that the observed priming was specific to the perception of transient events and did not originate in priming of perceptual states, selective attention, or low level stimulus attributes. In summary, we demonstrate how experience-driven updates of prior knowledge about physical transformations build stable and consistent vision from unstable retinal input.

[3T2A003] The role of visual stability in representations of pre- and post-saccadic objects

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In the present study, we investigated how object information is integrated and updated across saccades. Specifically, we asked how visual stability (perceiving the target object as continuous across the saccade) influences the pre-saccadic representation of the object. Participants were presented with a colored target and instructed to memorize its color before executing a saccade to it. On some trials, the color was changed to a new value during the saccade. Participants reported either the pre- or the post-saccadic color. Stability was manipulated with target blanking paradigm. The data were fit with probabilistic mixture models. We found that when reporting the pre-saccadic color, incorrect reports of the post-saccadic color were more likely under conditions of visual stability versus instability, supporting an object-based model of transsaccadic updating and integration: under visual stability, pre- and post-saccadic features are mapped to the same object representation, leading to the overwriting of the pre-saccadic features by the post-saccadic features. If stability is disrupted, pre- and post-saccadic features are represented as different objects, leading to protection of the pre-saccadic features. In addition to overwriting errors, color reports were subtly shifted toward the non-reported color, regardless of the stability condition, suggesting some degree of color integration.

[3T2A004] How aware are we of our own eye movements?

Alasdair Clarke, Aoife Mahon, Alex Irvine and Amelia Hunt
University of Aberdeen, UK; University of Aberdeen, UK; University of Aberdeen, UK; University of Aberdeen, UK

People can identify their own fixations compared to those of someone else but only slightly above chance (Foulsham and Kingstone, 2013). This conclusion is based on fixations recorded during a scene memory task, so people may remember fixated objects as opposed to eye movements. In oculomotor capture (Theeuwes et al 1998), in contrast, it has been claimed that people are unaware of their own erroneous saccades towards distractors. This claim is based on general statements of remembered accuracy made after the experiment. Here we asked whether people could accurately report on their own eye movements using three different approaches: first, we asked participants after a visual search experiment to discriminate their own eye movements from those of someone else searching the same image. Second, we asked participants in an oculomotor capture experiment to report after each trial whether they looked directly at the target. Third, we replayed an animation of saccades after each trial in a double-step saccade experiment and asked participants if they were viewing their own or someone else's behaviour. The results across all three studies suggest that observers are sensitive to what they looked at, but have little knowledge about their own eyemovements per se.

[3T2A005] Substhreshold post-saccadic errors decelerate oculomotor learning

Martin Rolfs, Carlos R. Cassanello, Mark Harwood and Thérèse Collins
Humboldt University of Berlin, Germany; Humboldt University of Berlin, Germany; City College of New York, USA; Unviversité Paris Descartes, France

Saccadic eye movements remain accurate through a process called saccadic adaptation, compensating for errors experienced upon landing off intended targets. We have shown recently that saccades continuously track intrasaccadic steps (ISS) whose amplitudes rise and fall with a sinusoidal profile, varying forwards and backwards across trials at a slow, fixed frequency. Specifically, we found saccadic landing errors were modulated exactly at the ISS frequency, but lagging the ISS modulation by 20 trials on average (Cassanello et al., 2014). Here, we used this method to examine the speed and completeness of adaptation as a function of objective visibility of the ISS. Twenty observers completed adaptation trials with sinusoidal-ISS modulation (3×100 trials/cycle) in three ISS-amplitude conditions: either completely invisible (ISS amplitude at the observer's threshold for detecting the ISS, determined in a pretest), barely visible or clearly visible (one and two JNDs above threshold, respectively). Adaptation occurred in all three conditions and its completeness was independent of visibility ($\sim$10% of ISS amplitude). Conversely, visibility significantly decreased the oculomotor response lag (22, 16, 13 trials in the three visibilities). These results suggest that the oculomotor system tracks subthreshold ISS as properly as visible ones, by integrating errors over a larger number of saccades.
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[3T2A006] Predicting oculomotor strategies in reading with normal and damaged visual fields

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The distribution of fixation positions during reading shows that normally-sighted subjects typically read by successively placing their fovea next to the center of the words, in order to reduce the deleterious effects of the visual periphery such as reduced acuity or crowding. In this study, we present a Bayesian ideal observer of reading which is based on spatiotemporal characteristics of letter recognition across the visual field. Our approach to reading assumes that the optimal fixation is the one that optimizes the "Expected Information Gain" to identify the letters from the current word. At each fixation, Bayesian inference is used to combine prior knowledge with newly extracted information about letter identities. This is done by using letter recognition rates and letter confusion matrices across the visual field. Lexical inference is also used to update letter identity information at each fixation. The model predicts the 2D spatiotemporal pattern of saccades during reading, in contrast with theories that use 1D letter-slot approaches to model reading. This is critical to predict optimal reading strategies for readers who cannot extract visual information with their fovea, such as Age-related Macular Degenerescence patients. Model predictions for normal and damaged visual field are discussed.

Oral Presentations: Colour vision: appearance and constancy

[3T2B001] Extraretinal factors modulate color after effect

Takao Sato, Ryohei Nakayama and Anna Nakamura
University of Tokyo, Japan; University of Tokyo, Japan; University of Tokyo, Japan

The visual system uses several different coordinate systems, such as retinal, world, and body/head coordinates. In this study, we manipulated world and head coordinates while keeping the stimulus with regard to retina coordinate during adaptation, and measured the duration of Color after effect (CAE) to examine contributions of extraretinal factors. In the fixation condition, where observers fixate on stationary adaptor, the adaptor was stationary as regard to all coordinate systems, but in the other three conditions, pursuit, head-movement, and head-eye-movement conditions, the adaptor was stationary in retinal coordinate, but were moved in at least on of the other coordinate. The motion speed in all motions was 10 deg/sec and amplitude was 30 deg. The movements of eyes and head were monitored by eye-tracker and laser-pointer attached to observer's head. It was found that CAE lasted for about 80 sec for fixation condition, and the duration was reduced by approximately 30% for the other conditions, although the stimulus was stationary on the retina in all conditions. These results demonstrate that CAE, which is generally understood as a retinal phenomenon, is affected by extraretinal factors, i.e. the stationarity and movement in world and head-centered coordinates.

[3T2B002] Colour constancy without colour experience

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We used metacontrast masking to render coloured stimuli invisible. Even though the stimuli are invisible they nevertheless prime decisions about the colour of the masks that follow them, speeding the decision if the prime and mask match in colour. What constitutes 'matching'? Under a change in illumination a match could either mean that light reaching the eyes from the prime and mask has the same spectral composition or that the prime and mask have surfaces with similar reflectance properties. We show that decisions are speeded most when prime and mask match in reflectance properties. In a separate signal detection experiment we show that the primes are undetectable. This implies that a colour constancy process operates independently of colour experience. Control experiments rule out explanations in terms of expectation, local contrast or effects of retinal adaptation. This constancy-based priming does not depend upon visual attention and, in a conscious feature based attention experiment, we show that the constant surface representation is more effective than spectral composition in directing attention. We discuss the implications of these results for understanding the basis of colour experience.
The James S. McDonnell Foundation

[3T2B003] Unmasking the dichoptic mask: Binocularly matched features reduce dichoptic masking for both chromatic and luminance stimuli

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In dichoptic masking a suprathreshold mask contrast in one eye is found to elevate thresholds for detecting a target contrast in the other eye, and more so than if the mask and test are in the same or in both eyes. Recent studies have shown that binocularly matched luminance features reduce, or 'unmask' chromatic dichoptic masking (Wang & Kingdom, JOV, 2014). Here we explore the effect using a dichoptic disk surrounded by a binocular, i.e. matched in the two eyes ring of variable width. When the disk is chromatically defined both chromatic and luminance rings increasingly unmask dichoptic masking as the ring width increases from zero, the effect asymptoting at a ring width approximately a quarter of the disk diameter. The smallest unmasking effect is found for a chromatic ring surrounding a luminance disk. These results suggest that binocularly matched features have a general effect in reducing interocular suppression among unmatched features. We argue that our results are consistent with the "object-commonality hypothesis", whereby matched features in the two eyes promote the interpretation that features that are unmatched nevertheless arise from the same object, and as a result are relieved from the effects of interocular competition.
Canada Institute of Health Research grant #MOP123349 given to F.K.

[3T2B004] Does colour constancy exist? Yes and No

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The question whether colour constancy exists or not is a multilayered one. Researchers since Hering agree that the term „constancy "is not to be taken litteraly, but refers to an approximately constant colour perception of „things "(„angenäherte Farbkonstanz der Sehdinge", E. Hering). This is the semantic level. Secondly, there is a conceptual level, in that the question cannot be isolated to one level of processing, in particular not to the level of receptor adaptation. Instead, we have to include the cognitive level, where humans (and possibly also animals) use inferences from prior knowledge in order to interpret sensory data ("unbewußter Einfluß des Urteils", v. Helmholtz); in other words, colour constancy should be discussed at the level of object perception. This is highlightened by the recent observations concering the blue&black dress, which is seen by different individuals as being either blue/black (correct in terms of object recognition) or white/gold (incorrect). This shows (1) strong influences of cognitive processes and (2) the impact of different priors, whose origin is still a mystery. In this context I will show and discuss the results of colour matches of the blue&black dress made by subjects of different ethnical backgrounds and different levels of „colour experience".
Bernstein Centre for Computational Neuroscience FKZ01GQ1002 and Kerstan & Tistou Stiftung

[3T2B005] Colour constancy predicted by metameric mismatch volumes

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The present study investigated what determines the variation of colour constancy across colours. We examined the role of linguistic colour categories, and of the stability of the LMS signal across illumination changes. In particular, we tested the impact of metameric mismatch volumes, which describe the volumes of all theoretically possible LMS signals that may potentially result from a change in illumination if the reflectance is unknown. Observers were simultaneously presented two photorealistic images of the same scene rendered under different daylight illuminations. One of 12 coloured objects in one of the images was set to a random hue, and observers were asked to adjust it so that it matched the colour in the other image. Colour constancy did not peak at the category prototypes and was not correlated to "sensory singularities" (the dimensionality of the mapping of LMS signals). Instead, metameric mismatch volumes explained more than 50% of the variance even when controlling for performance in a control condition, in which illuminations did not vary across images. These results show that observers know, probably from experience, how uncertain different colour signals are when illumination changes. More generally, these results demonstrate the importance of metameric mismatching for colour constancy.
This research was supported by ERC Advanced Grant "FEEL", number 323674 to J. Kevin O'Regan.

[3T2B006] Changes in the lighting or reflectance of isolated glossy surfaces reveal a bias to associate particular colour directions with changes in lighting

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For a single matte surface, changes in surface reflectance and illumination are indistinguishable. Introducing a specular component to the reflectance properties of the surface allows separation of surface and illuminant colours (Lee & Smithson, ECVP, 2015; Smithson & Lee, ICVS 2015). We presented hyperspectrally raytraced movies showing isolated objects undergoing gradual changes in reflectance or illumination, and asked observers to classify the transition as a change in the colour of either the paint or the lighting. We used spectral functions interchangeably as reflectances and illuminants, allowing us to test observers' willingness to assign particular colour-transitions to either surface or illumination changes. Even low levels of specularity were sufficient to support discrimination of surface and illumination colour changes, but observers' response biases – quantified with a log likelihood ratio – depended on the chromaticity direction of the change. For spectral changes aligned to the daylight locus, the log likelihood ratio favoured lighting changes by 0.1 to 0.2 units, compared to spectral changes orthogonal to the daylight locus. By testing performance at different levels of specularity we estimated bias in relation to the reliability of cues in the movies. The bias was particularly marked at low specularities but persisted as specularity increased.
Welcome Trust Grant WT094595AIA (to Hannah E. Smithson)

Oral Presentations: Magnitude, time, and numerosity

[3T2C001] Central tendency effects in temporal interval reproduction in autism

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Central tendency, the tendency of judgements of quantities to gravitate towards their mean value, has been attributed to the use of 'prior knowledge' representations of a mean stimulus, which are integrated with noisy sensory estimates to improve precision. Based on this model, and a recent theoretical account positing attenuated prior knowledge in autistic perception (Pellicano & Burr, 2012), we predicted that children with autism should present reduced central tendency compared to typical children in temporal interval reproduction. We tested this prediction using a child-friendly, dual-task temporal interval reproduction/temporal discrimination paradigms which we administered to 23 children with autism, 23 age- and ability- matched typically developing children and 14 typical adults. Central tendency effects (assessed with a Bayesian computational model) reduced with age in typical development, while temporal discrimination improved. Children with autism performed far worse in temporal discrimination than matched controls, which predicts that they should show more central tendency than the controls. However, their

central tendency was far lower than predicted by their poorer temporal resolution. The results are consistent with the theoretical prediction that individuals with autism use prior knowledge to a lesser extent than controls to improve perceptual performance.
This work was generously supported by a grant from the UK's Medical Research Council awarded to E.P. and D.B. (MR/J013145/1) and also by the European Science Council (ERC advanced grant "STANIB"). Research at the Centre for Research in Autism and Education (CRAE) is also supported by The Clothworkers' Foundation and Pears Foundation.

[3T2C002] An illusion of numerosity explained

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Last year we reported that there seem to be more grey disks than white disks when 50 randomly-located white disks are intermingled with the same number of grey disks on a dark grey field. On a light grey field, there seem to be more dark grey than black disks. Thus lower-contrast disks paradoxically trump higher-contrast ones. (This was shown by comparison or matching to isolated disks, when the largest effect size was 36%, and now by differential numerosity power laws over the range from 20 to 80 disks.) When intermingled white and grey disks are segregated in depth, or by motion or shape, the illusion disappeared. Why? We assume salience improves grouping, and this increases clustering which is known to reduce perceived number. Segregated stimuli all group similarly, salient or not, but when stimuli are intermingled, only the stronger ones are grouped, on the principle that no more than one 'object' can occupy the same space-time volume; weaker stimuli remain disaggregated and therefore appear more numerous.
none

[3T2C003] Motion-induced compression of perceived numerosity

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In 2003 Walsh proposed an innovative theory, proposing that the perception of time, space and number share a common encoding system of magnitude. Much evidence supports this idea, including the fact that adaptation to fast translational motion produces a robust reduction of the perceived duration (Johnston et al., 2006; Burr et al., 2007); however, adaptation to flow motion of comparable speed does not (Fornaciai et al., 2014). Here we tested whether adaptation to visual motion also affects numerical estimates. Subjects were asked to discriminate the numerosity of two patches of dots within a numerosity range of 8–30, after adapting to a grating translating or rotating at 20 Hz or 5 Hz (in different sessions), positioned at one of the patches. Adaptation to fast translational motion yielded a significant reduction in the apparent numerosity of the adapted stimulus (up to 25%), while adaptation to slow motion had no effect on numerosity. Adaptation to complex rotational motion of either speed had no effect on numerosity. Control experiments show that none of these effects can be accounted for by trivial

masking aftereffects. Taken together these results clearly support Walsh's idea of a common, shared-mechanism for encoding space, time and number.
This study has been supported by the Italian Ministry of University and Research (FIRB 2013) and by European Community Project 'ECSPLAIN' (FP7 ERC Advanced grant).

[3T2C004] Perceived Duration, Task Difficulty and Performance: A General Metric

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Time perception has been shown to depend on the difficulty of and, indirectly, performance on a concurrent task. Here we offer the first design permitting the metrical quantification of this relationship and its generalization over any task and duration range. The time necessary to perform a variable length visuo-motor task was first assessed for each participant. The task consisted in clicking-off as fast as possible a variable number of discs displayed on a virtual circle around fixation. Participants were then required to perform this same task during either the necessary durations (520, 960 and 1760 ms) or during durations 1.8 times shorter or longer than necessary and to estimate the given durations via a comparison and reproduction technique. Task difficulty was quantified as the ratio between the given and necessary durations. Performance was quantified as the ratio between the numbers of clicked and displayed discs for each given duration. Perceived duration was also assessed in the absence of the visuo-motor task to serve as a reference baseline. The results show that difficulty per se (as defined) is not a factor in duration estimation but that the latter increases linearly with performance with a slope of about 260 ms.
Work supported by a grant ANR-12-BSH2-0005-01 to AG.

[3T2C005] Tempus Fugit: Competitive social interactions impair time perception

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Humans are capable of discriminating small intervals of time ranging from milliseconds to seconds. Despite our frequent engagement in social interactions, where sometimes time-keeping is essential, their effect over our perception of time's passage has hardly been studied. We assessed the effect of social interactions on time perception by asking participants to solve puzzles either by themselves (isolated condition) or in competition with a partner (competitive condition). In a control condition, they passively watched the partner solving the puzzle. They then reported whether each trial was longer or shorter than a standard interval. We fitted psychometric curves to these reports and found that, relative to the control, the psychometric curve was shifted rightwards only in the isolated condition. In contrast, the slope of the curve was substantially shallower for competitive interactions than for both non-social interactions (isolated or passive viewing). These findings indicate that time is felt to be consistently longer when performing a task by oneself, but temporal discrimination is strongly impaired during

competition. Further, these results could not be explained by general arousal or by factors such as number of visual or action-based events. We conclude that social interactions alter time perception in ways distinct from other factors.

[3T2C006] Individuation of objects and object parts rely on the same neuronal mechanism

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Humans can enumerate up to three-four objects very efficiently but their performance decreases sharply above four items. This ability is called subitizing and is evident for separate objects. Recently, a study showed the same subitizing effect when participants enumerated parts of a single object. Here we searched for the neural mechanisms underlying this new type of subitization. To this end, we measured a lateralized EEG response (N2pc) previously associated with individuation of multiple objects. In Experiment 1, participants were asked to enumerate the number of outdents of one of two solid half discs presented in each hemifield. In Experiment 2, a single circle with bilateral indents was presented and participants were asked to enumerate the number indents on one side of the circle. In both experiments, participants' error rate was low (less than 10%) when enumerating up to three parts but increased for larger numerosities. The N2pc amplitude increased as a function of the number of object parts, and reached an asymptote corresponding to the behavioral subitizing limit. These results replicate the ones previously reported for separate objects, and suggest that the same individuation mechanism operates when enumerating a small set of different objects or parts of a single object.

Oral Presentations: Face perception

[3T3A001] Face shape cues to health

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Observers perceive health from faces with some accuracy. Prior work shows that weight perceived from faces predicts illness frequency, suggesting that visual cues to weight contribute to perceptions of health. We investigated whether facial shape cues to body physique and composition account for weight perception and predict illness. 3D facial surfaces were scanned (3dMD) for 118 Caucasians (age 19–31, 68 female). Height, weight, body composition (Tanita SC-330) and self-reported antibiotic use were recorded. The face surfaces were subjected to: Procrustes alignment, delineation of 49 feature landmarks, resampling, cropping to discard hair and neck, and Principal Component Analysis (PCA). Vectors were derived from PCA coefficients to define how face shape relates to BMI (weight scaled for height, Holzleitner et al., 2014) and relative fat mass. Estimations of BMI and relative fat mass from face shape for each participant accounted for weight perception. Face shape estimations predicted antibiotic use and outperformed body measures (actual BMI and% body fat) in accounting for illness frequency. The results show that facial shape provides an index of health that is more accurate than body

measures routinely used in medicine. The study also contributes to understanding of the cues used in weight and health perception.

[3T3A002] The visual gamma response to faces reflects the presence of sensory evidence and not awareness of the stimulus

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It has been suggested that gamma (30–100 Hz) oscillations mediate awareness of visual stimuli, but experimental tests of this hypothesis have produced conflicting results (Aru et al., 2012; Fahrenfort et al., 2012; Fisch et al., 2009). We used phase scrambling to vary the perceptibility of face stimuli presented to 25 participants. MEG was used to measure the gamma response while individuals viewed three conditions in which faces were presented either above, below or at the perceptual threshold. In each of 400 trials (100 each for the sub- and supra-threshold conditions, and 200 for the threshold condition) participants indicated whether or not they perceived a face in the stimulus. Gamma-band activity during the task was localised to bilateral ventral occipito-temporal cortex. We found that gamma amplitude was significantly increased both for threshold relative to subthreshold stimuli and for suprathreshold relative to threshold stimuli. However, for the threshold condition we did not find a significant difference in gamma amplitude between trials in which the face was percieved vs those were it was not perceived. We conclude that the gamma response to faces is modulated by the amount of sensory evidence present in the stimulus and not perceptual awareness of the face itself.
The author's work is supported by the School of Psychology, Cardiff University and the Cardiff University Brain Imaging Centre

[3T3A003] An objective measure of facial identity adaptation with fast periodic visual stimulation

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The human brain is remarkably adept at extracting visual identity information from faces, although understanding this process remains challenging. Here, a novel measure of system-level discrimination between two individual facial identities is presented. This measure utilizes fast periodic visual stimulation (FPVS) and electroencephalogram (EEG) recording combined with an adaptation paradigm (as in Ales & Norcia, 2009). Adaptation to one facial identity is induced through repeated presentation of that identity over a 10 s baseline, flickering at a base rate of 6 images per second (6 Hz). Subsequently, this identity is alternated with its anti-face (e.g., Leopold et al., 2001), over 20 s at the same rate. During this alternation, a response exactly at half the base presentation rate (3 Hz), localized over the right occipito-temporal cortex, indicates that adaptation produced an asymmetry in the perception of the two facial identities. Importantly, this 3 Hz response is not observed in a control condition without the single-identity baseline. These results indicate that neural adaptation to one identity can produce a measurable, electrophysiological discrimination response between that identity and another, which could be

further investigated with different categories of face pairs in future studies to increase understanding of individual face representation.

[3T3A004] Caloric Vestibular Stimulation Modulates High Level Face Processing

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Understanding of the link between the vestibular organs and the visual system is becoming established (e.g. Della-Justina et al., 2015), yet few studies have explored the use of vestibular stimulation to modulate visual processing. Preliminary evidence that this can be achieved is seen in one clinical case study which reported improved face perception in an acquired prosopagnosic following vestibular stimulation (Wilkinson, Ko, Kilduff, McGlinchey, & Milberg, 2005), and in one study that demonstrated an enlarged N170 in healthy adults during vestibular stimulation (Wilkinson, Ferguson, & Worley, 2012). The present study tested the behavioural effects of caloric vestibular stimulation on a higher cognitive level of face recognition in sixty adults. Participants were required to identify the nationality of celebrities in four testing sessions following a counterbalanced ABAB design. Relative to no stimulation, caloric vestibular stimulation significantly increased accuracy scores which could not be accounted for by practise effects. This study constitutes the first attempt to improve healthy face recognition skills through vestibular stimulation and the findings have immediate real-world value in settings that require superior face recognition performance such as passport control and identity parades. The study also provides further evidence to the efficacy of vestibular stimulation in modulating cognitive processes.

[3T3A005] Self-representation of facial appearance

Robert Ward and Shubha Sreeenivas
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Here we explore people's understanding of their own facial appearance, and individual differences in these self-representations. There is increasing evidence that facial appearance is correlated with personality, and that observers are sensitive to this correlation: for example, trait neuroticism can be identified merely from controlled "passport" facial photos (Little & Perrett, 2006; Kramer & Ward, 2010; Jones et al., 2012). We used these statistical regularities in personality appearance to investigate self-representation. A controlled photograph of the participant was morphed using sex-appropriate averages of people high and low in neuroticism, to create a looping image sequence of the participant, in which the objective visual signal of neuroticism varied from high to low and back again. Participants were asked to select the image within this sequence which best matched their actual appearance. Participants did not choose accurately, but instead chose images which exaggerated the visual characteristics associated with their personality. These exaggerations were also selected as having more positive social traits. In this case, visual self-representations exaggerated differences from group norms. More generally, these results show how visual self-perception can be influenced by visual trait signals and non-visual social trait differences.

[3T3A006] How does image background colour influence facial identification?

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In the UK, identification lineups have a standard background, either grey for VIPER lineups, or green for PROMAT lineups. However, as lineup fillers and suspects are filmed under a variety of lighting conditions, there can be a large variation in the colours of the background on which lineup members are presented, potentially causing some faces to appear more salient than others. Using the 1-in-10 face recognition paradigm (Bruce et al., 1999), we investigated whether manipulating the background colour of faces influenced identification for target present (TP) and target absent (TA) arrays. The first experiment used faces that were the same race (SR) as the participants, and found the colour manipulation significantly increased accuracy for TP lineups. The second experiment investigated the relationship between this effect and the own race effect (ORE). The ORE predicts individuals are more likely to correctly identify SR as compared to OR faces from TP lineups, and falsely identify OR faces from TA lineups at a higher rate to SR faces (Brigham, Bennett, Meissner & Mitchell, 2007). Results are discussed in terms of the implications for the creation and use of lineups and the relationship between background colour variation and the own race effect (ORE).
International Centre for Comparative Criminological Research (ICCCR)

[3T3A007] The crucial role of facelike configuration in the development of visual expertise: objective electrophysiological evidence

Aliette Lochy, Laguesse Renaud, Friederike Gs Zimmermann, Verena Willenbockel, Bruno Rossion and Quoc C Vuong
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Whether learning to individuate novel objects leads to visual expertise (i.e., the automatic processing with a change in the level of visual representation) and the factors that mediate expertise acquisition remain unknown. Here we used a well-controlled set of novel objects that could appear facelike or non-facelike depending on the objects' orientation (Vuong et al., 2014). Two groups of 11 adults were trained for 14 sessions (~20 hrs) at individuating 26 objects. The groups differed only in whether participants were trained and tested with the facelike or non-facelike orientation. Pre and post training, we used fast oddball periodic visual stimulation to measure robust and objective electrophysiological discrimination responses at predefined frequencies (Liu-Shuang et al., 2014). Sequences of identical objects (unseen at training) were presented at 5.88 Hz for 60 sec. At regular intervals (1.18 Hz), a different "oddball" object was inserted into the sequence. After training, only the facelike groups showed a significant increase in the discrimination response at 1.18 Hz and harmonics (2.36 Hz, etc.) over lateral occipital sites.

These results indicate that a facelike configuration is essential to observe the effect of extensive training on the visual representations of novel objects in adulthood.
This research was supported by an Economic and Social Research Council grant (ES/J009075/1) to QCV and BR, and by an IAP grant from the BELSPO (IAPVII/33) to AL.

Oral Presentations: Attention: visual search

[3T3B001] The preview benefit in single feature and conjunction search: Constraints of visual marking

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Watson & Humphreys (1997) proposed that the preview benefit (pb) rests on visual marking, a mechanism which actively encodes distracter locations at preview and inhibits them at search. We also used a letter-color search task to study constraints of visual marking in conjunction search and near-efficient single feature search. Search performance was measured for fixed target and distracter features (block design), and for changing them randomly across trials (random design). In single feature search there was a full pb in both designs. In conjunction search a full pb was obtained only for the block design. Randomly changing target and distracter features disrupted the pb, but it was restored when the distracters were organized in coherent blocks. Apparently, the temporal segregation of old and new items is sufficient for visual marking in near-efficient single feature search, while, in conjunction search, it is not. When the new items add a new color conjunction search is initialized, and attentional resources are withdrawn from the marking mechanism. Visual marking can be restored by a second grouping principle that joins with temporal asynchrony. This principle can either be spatial or feature-based. For feature-based grouping repetition priming is necessary to establish joint grouping with temporal asynchrony.

[3T3B002] Simulated hemianopia: the effect of partial information loss on serial and parallel search

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Patients with hemianopia tend to start searching a visual display from their intact visual field, causing a larger proportion of the search array to fall within the damaged field. This is generally considered to be a sub-optimal strategy. However, what constitutes an efficient search strategy depends on where and what kind of information is present in both the damaged and intact field. We investigated the degree to which healthy participants adapt their search strategy to conditions of total and partial information loss, target position, and search difficulty. Participants showed a bias towards the sighted field that diminished with increasing information in the sighted field. The sighted-field bias also persisted across search difficulty, which we manipulated by altering the heterogeneity of the distractors. This result was surprising because during search for a pop-out target, participants should execute a large saccade into the blind field on trials where the target is not immediately detected in the sighted field. We conclude that observers are driven largely by

bottom-up information and do not switch their search strategy under circumstances when it would be beneficial to examine the area corresponding to the field deficit first.
Anna Nowakowska is supported by an ESRC doctoral studentship. A James S McDonnell scholar award to AR Hunt also provided financial support

[3T3B003] Serial vs parallel processes in Visual Search: model comparison to RT-distribution

Marius Usher, Rani Moran and Michael Zehetleitner
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Visual search is central to the investigation of selective visual attention. The classical theory postulates two processing stages: i)a parallel unlimited capacity stage, during which a salience map is generated, ii)a serial and capacity-limited identification stage during which attention is serially deployed between items. While this theory accounts for set-size effects over a continuum of task-difficulties, it has been suggested that parallel models can account for such effects equally well. Here we compared the serial Competitive Guided Search with a parallel model in their ability to account for RT-distribution and error rate data from a large visual search experiment (Wolfe et al., 2010; Vis. Res., 50,1304–11). In the parallel model each item is represented by a diffusion to two (target/distractor) boundaries. The process is self-terminating with respect to 'target present' responses and exhaustive with respect to 'target absent responses. Both limited and unlimited capacity variants of the parallel model were examined. The serial model turns out to be superior to the parallel model, even prior to penalizing the parallel model for its increased complexity (four extra parameters with strategic dependencies on set-size). We discuss the implications of the results and the need for future studies to resolve the debate.

[3T3B004] Attentional Guidance by Simultaneously Active Working Memory Representations: Evidence from Competition in Saccade Target Selection

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The content of working memory (WM) guides attention, but there is debate over whether this interaction is limited to a single WM representation or functional for multiple WM representations. To evaluate whether multiple WM representations guide attention simultaneously, we used a gaze-contingent search paradigm to directly manipulate selection history and examine the competition between multiple cue-matching saccade target objects. Participants first saw a cue composed of two colors (e.g., red and blue) followed by two pairs of colored objects presented sequentially. For each pair, participants selectively fixated an object that matched one of the cue colors. Critically, for the second pair, the cue color from the first pair was presented either with a new distractor color or with the second cued color. In the latter case, if two colors in memory interact with selection simultaneously, we expected substantial competition from the second cued color, even though the first cued color was used to guide attention in the previous pair. Indeed, saccades for the second pair were more frequently directed to the second cued color object than to a distractor color object. This competition between cue-

matching objects provides compelling evidence that both WM representations were interacting with and influencing attentional guidance.
This study was supported by a grant from NEI (R01EY017356) and by an NSF Graduate Research Fellowship to Valerie Beck.

[3T3B005] Choice Invaders: A new iPad task to explore fixed-interval target selection

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During visual foraging, the ability to switch target categories varies considerably between individuals (Kristjánsson, Jóhannesson & Thornton, 2014). Do such individual differences occur for target selection in the absence of search? In the current task, rows of four objects moved down the screen in waves, reminiscent of classic Space Invaders. Each row contained two targets and two distractors, their position shuffled independently, row-by-row. Participants ($N = 14$) moved a player icon via tilt control to physically collide with either target in a row. If a distractor object was selected, or if a row passed untouched, the trial was aborted. A trial finished after 30 successful rows. In the "feature" condition, targets and distractors were identified by unique colours. In the "conjunction" condition, by colour and shape. Our dependent measure was the proportion of rows in which the same target category was repeated. Overall, the tendency to repeat categories increased under conjunction conditions ($t = 3.1$, $p < 0.01$). However, approximately 25% of participants showed very similar patterns of target category selection/switching under the two conditions. This replicates our previous finding with visual foraging, and further suggests that limits on top-down control of attention may be more flexible than fixed.

[3T3B006] Very large memory sets in hybrid search: Can the log still save us?

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Hybrid search refers to the combination of visual search and memory search: searching through arrays of visually presented items for any of a set of targets held in memory. The reaction time (RT) by memory set size function seemed linear for set sizes up to 4 (Shiffrin & Schneider, 1977), but appears logarithmic when memory set size is increased to 16 (Wolfe, 2012). In many expert search domains, such as medical image interpretation, the memory set is very large, and overlearned compared to typical laboratory protocols. I utilized the Airport Scanner (Kedlin Co., www.airportscannergame.com) dataset (Mitroff and Biggs 2014) to study these issues. Airport Scanner is a commercial x-ray baggage search game. New targets (threats) are added as the game progresses. I analyzed 836,738 single-target trials (bags) from 65,822 experienced players. Memory set size (potential threats) ranged from 7 to 218 items. Expertise decreased RT. RT by memory set size functions were more logarithmic than linear, but more quadratic than logarithmic; these trends were more pronounced for less experienced players. Encoding and

retrieval strategies may change with both expertise and memory set size; models developed for small set sizes may not generalize to naturalistically large set sizes.
None

[3T3B007] Eye-of-origin guides attention away: Search disadvantage by ocular singletons

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Collinearity and eye-of-origin are recently discovered to guide attention: target search is impaired if it is overlapping with a collinear structure (Jingling and Tseng, 2013) but enhanced if the target is an ocular singleton (Zhaoping, 2008). Both are proposed to occur in V1, and we study their interaction here. In our 9X9 search display, all columns consisted of horizontal bars (non-collinear column, NCC), except one randomly-selected column contained orthogonal bars (collinear column, CC). One randomly-selected column was projected to one eye (ocular singleton column, OS) while the rest of the columns were presented to the other eye (NOS). We expect the best target search at NCC + OS, and the worst search performance at CC + NOS. The other combinations would depend on the relative strength of collinearity and ocular information in guiding attention. As expected, we observed collinear impairment, but surprisingly, we did not observe any search advantage to OS but impairment. Our subsequent experiments confirmed that OS search disadvantage also occurred when color-defined or luminance-defined columns were used instead of collinear columns. While our result agrees with earlier findings that eye-of-origin information guides attention, it highlights that our previous understanding of search advantage by ocular singleton targets might have been over-simplified.
This work was supported by HKGRF, HKU Seed Funding Programme (to CT), and NSC (to LJ).

Oral Presentations: Colour vision

[3T3C001] Dichoptic color gratings reveal a perceptual bias for binocular summation over binocular difference, which is stronger in central than peripheral vision

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When left and right eyes are presented with composite patterns A + B and A-B, respectively, ambiguity can ensue between percepts reflecting ocular summation (A) and opponency (B) channels in primary visual cortex (Li and Atick, 1994; May, Zhaoping, and Hibbard, 2012). When A and B are foveal gratings having different drift directions (Shadlen and Carney 1985) or different orientations (Zhaoping, 2013), subjects more frequently perceive the ocular sum, A. This perceptual bias is weaker or absent in the periphery (Zhaoping, 2013, 2014). Here, I generalize these findings to color. A and B are static, colored, horizontal gratings, with random spatial phases. Each grating exhibits spatial alternations between its own pair of colors: e.g., one

grating is red-green and the other is blue-yellow. Each monocular image, A + B or A-B, typically displays a collection of hues. Observers briefly saw the dichoptic stimulus (e.g., 0.2 second) and reported whether it appeared more like reference A or B in color. The bias for ocular summation may be associated with a perceptual prior acquired through visual experience; its enhanced strength in the fovea is likely general across different visual feature dimensions, with top-down feedback (to implement visual analysis by synthesis) favored in central vision (Zhaoping 2013).
The Gatsby Charitable Foundation

[3T3C002] Flicker antagonism and synergism caused by multiple cone responses

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Psychophysical measurements reveal clear evidence for antagonistic and synergistic interactions between visual responses generated by uniform fields of flickering light. Such light generates fast or slow responses with the slower responses' being delayed by tens of milliseconds and being of either the same or the opposite sign as the faster response. The interactions of fast and slow responses can be clearly seen in the delays between pairs of S-, M- or L-cone flicker stimuli measured using a flicker-photometric cancellation technique, which expose ubiquitous and often sizeable delays between the various responses. The interactions can alter the shape of temporal contrast sensitivities depending on the frequencies at which the responses constructively or destructively interfere. Overall, the results are consistent with interactions between fast "centre" responses and delayed, antagonistic "surround" responses through a network of recursive, inhibitory lateral interconnections in which one step through the network of discrete elements produces a delayed inhibitory signal, two steps, a more delayed but excitatory signal, and so on. The delays for a single step are typically greater than 25 milliseconds. We suppose that the interactions reflect the properties of a recursive network of lateral connections each acting across several cells, perhaps horizontal cells.
BBSRC

[3T3C003] Putting the S (cones) into Symmetry

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Previous studies have argued that symmetry perception makes use of neural mechanisms that are temporally sustained and pool information from relatively large receptive fields. The S-(L + M) cone-opponent mechanism fits this description. S-cones could thus contribute to symmetry by providing a large-scale integration window for co-localised luminance signals. We ran a series of psychophysical and event-related potential (ERP) experiments in order to assess the contribution of different cone-opponent mechanisms to symmetry perception, in isolation or in combination with luminance. Psychophysical findings indicate that at low, threshold contrasts, S-(L + M) only

stimuli produced the largest bias towards perceiving images as symmetrical, whilst luminance stimuli introduced a bias towards perceiving them as asymmetrical, with no bias for images that combined the two signal types. The ERP experiment was run at high, multiple-of-threshold contrasts. Sustained Posterior Negativity (SPN), a symmetry-selective component of the ERP, was observed in all conditions and showed the expected enhancement for symmetry. The SPN symmetry effect was significantly larger when a relatively large S-(L + M) signal was combined with a luminance signal. This was not observed for other tested colour and/or luminance stimuli. In conclusion, S-(L + M) signals can facilitate symmetry processing, probably through providing a low-resolution window for large-scale spatial integration.

[3T3C004] Testing measures of saturation

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Several different measures of saturation have been suggested in the literature. Most of these measures are not ordinally equivalent. Nevertheless, it is not known which of the measures fits human perception of saturation best. We selected three standard colors and ten comparison color directions from the 30 cd/m2 equiluminant plane in CIE 1931 xyY color space. In each trial, we presented two color patches for 750 ms against a gray background whose luminance was 10 cd/m2 in one experimental session and 45 cd/m2 in another. One patch always had the color of one of the standards, while the other patch's color was sampled with an adaptive algorithm from one of the comparison directions. Observers had to decide which of the patches is more saturated. For each of the ten comparison directions and each of the standards we computed the point subjective equality (PSE). These PSEs were compared to the predictions of different saturation measures defined in the CIECAM02, HSV, DKL, LAB, LUV, and CIE 1931 xyY color spaces. On average, the predictions of the measures defined in LAB and LUV space fit human perception of saturation best, while the measures defined in CIE xyY and HSV space performed worst.
This research was supported by DFG grant 879/9

[3T3C005] Pedestal masking of S cone tests: Effects of gain control and cone combination

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Masking and habituation experiments have demonstrated psychophysical asymmetries for detection of S cone increment (+S) and decrement (-S) stimuli (reviewed by Smithson, 2014). Wang, Richters, & Eskew (2014) found significantly more masking of +S tests than -S tests by the identical noise masks. In the present study, masking of +S and -S tests was measured using a 2afc pedestal procedure. The chromaticity of the pedestal mask was varied in a plane in cone contrast space in which the L and M cone contrasts were equal, and the ratio of S to L = M varied, keeping constant the resultant vector length of the pedestal. 'Purplish' pedestals (combinations of +S and – L = M) produced significantly more masking than 'yellowish' (combinations of -S and +L = M) ones. This was true for both +S (purplish) and -S (yellowish) tests. Consistent with the noise

masking results of Wang et al. (2014), and with some single-cell physiological findings, this masking pattern suggests there is more contrast gain control in S-On than S-Off pathways; the difference in masking depends on the (high contrast) pedestal polarity rather than the (relatively weak) test polarity. Models of cone combination in the two pathways, based upon the masking pattern, will be discusse.

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[3T3C006] Classification Images of chromatic edge detectors in human vision

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Edge detection is an important early stage of visual processing. Spatial changes in luminance are associated with object boundaries, but they may also indicate shadows. Changes in colour, however, are associated with object boundaries but not shadows, and so may be more reliable indicators of object boundaries. For this reason, one might expect to find colour edge detectors in the human visual system. We mapped the shapes of luminance and colour edge detectors using classification image methods (Beard & Ahumada 1998). The observer's task was to detect a luminance edge embedded in luminance noise, or an isoluminant (L-M or S-cone) edge embedded in isoluminant chromatic noise. In both cases, brown noise (with 1/f2 power spectrum) was used. Brown noise constrains the width of optimal edge detectors (McIlhagga, 2011). Chromatic edge and noise were smoothed to lessen chromatic aberration artifacts. The luminance condition was also smoothed, for comparison purposes. We found that the classification images for the luminance and chromatic conditions were very similar to one another. The chromatic edge detectors were analogous to those found in primate V1 (Johnson et al., 2008). These results suggest that chromatic channels contain edge detectors like those found in luminance channels.

Royal Society International Exchanges Scheme

[3T3C007] fMRI adaptation in the human LGN

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Adaptation effects in fMRI, in which prior exposure to contrast causes a reduction in the BOLD contrast response, are known to occur in human visual cortex. Here we investigate whether the human LGN shows fMRI adaptation and whether it is selective for red-green (RG) chromatic or achromatic (Ach) contrast. We localized the LGN in 12 subjects (Mullen et al., 2008). Test and adapting stimuli were RG or Ach high contrast sinewave counter-phasing rings (0.5cpd, 2 Hz). Adaptation and no-adaptation conditions were compared within a block design, with adaptation or no-adapt stimuli presented for 12 s, test stimuli for 18 s, and fixation-only for 9 s. Ach and RG adaptors were tested in separate runs. The LGN showed significant fMRI adaptation. The signal for the RG test stimulus was significantly reduced following both RG and Ach adaptation, whereas the signal for the Ach test showed little change following either adaptor. Assuming the RG test response is mediated by LGN P-cells, our results suggest that: 1. this pathway can show

significant adaptation and 2. it is sensitive to both RG and Ach contrast. Results differ profoundly from the lack of adaptation reported neurophysiologically for primate P-cells, indicating the two types of adaptation likely have different origins.
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Thursday August 27th

Posters

[4P1M001] The EEG correlates of stimulus-induced spatial attention shifts in healthy aging

Gemma Learmonth, Gregor Thut, Christopher Benwell and Monika Harvey
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Young adults typically display a processing advantage for the left side of space ("pseudoneglect") but older adults display either no strongly lateralised bias or a preference towards the right (Benwell et al., 2014; Schmitz & Peigneux, 2011). We have previously reported an additive rightward shift in the spatial attention vector with decreasing landmark task line length and increasing age (Benwell et al., 2014). However there is very little neuroimaging evidence to show how this change is represented at a neural level. We tested 20 young (18–25) and 20 older (60–80) adults on long vs short landmark lines whilst recording activity using EEG. The peak "line length effect" (long vs short lines) was localised to the right parieto-occipital cortex (PO4) 137 ms post-stimulus. Importantly, older adults showed additional involvement of left frontal regions (AF3: 386 ms & F7: 387 ms) for short lines only, which may represent the neural correlate of this rightward shift. These behavioural results align with the HAROLD model of aging (Cabeza, 2002) where brain activity becomes distributed across both hemispheres in older adults to support successful performance.
University of Glasgow College of Science & Engineering scholarship (GL) & Economic & Social Research Council (CB) [ES/I02395X/1].

[4P1M003] Visual attentional focusing in 8-month-old infants predicts their future language skills

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A multi-sensory dysfunction of attentional focusing might be responsible for language deficits typically observed in children with specific language impairment (SLI). Although previous evidence showed that children with SLI demonstrate a sluggish engagement of visual attention,

which accounted for a significant percentage of unique variance in their grammatical performance, a longitudinal-prospective is needed to demonstrate the causal link between visual attention deficit and language acquisition disorder. Here we investigated whether pre-language visual frontoparietal-attention functioning may contribute to explain future language emergence and development. Since 8-month-old infants can already rapidly adjust their attentional focus size, we longitudinally studied the relationship between the infants' time course of attentional focusing and the future language production skills measured at 31 months in 35 children. The present 2 year longitudinal study shows that pre-language rapid attentional focusing skills – assessed by attentional cue-size facilitation (i.e., the shorter pre-saccadic latency in the small than in the large cue condition) – explain a significant portion of variance of the future language acquisition. Our findings provide the first evidence that visual spatial attention in pre-language infants specifically predicts future language acquisition, suggesting new approaches for early identification and efficient prevention of SLI.

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[4P1M005] Selectivity of face perception to horizontal information over lifespan (from 6 to 74 year old)

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Face recognition in young human adults preferentially relies on the processing of horizontally-oriented visual information. We addressed whether the horizontal tuning of face perception is modulated by the extensive experience humans acquire with faces over the lifespan, or whether it reflects an invariably prewired processing bias for this visual category.

We tested 296 subjects aged from 6 to 74 years in a face matching task. Stimuli were upright and inverted faces filtered to preserve information in the horizontal or vertical orientation, or both (HV) ranges. The reliance on face-specific processing was inferred based on the face inversion effect (FIE). FIE size increased linearly until young adulthood in the horizontal but not the vertical orientation range of face information. These findings indicate that the protracted specialization of the face processing system relies on the extensive experience humans acquire at encoding the horizontal information conveyed by upright faces.

[4P1M007] Modeling the development of visual perception with computational vision

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Since childhood humans acquire increasingly complex visual skills supporting their social development. Triggered by a presumably innate capability of perceiving the presence of interacting agents, human perception evolves and focuses on the quality of the observed

motion. Hence, children learn to decode others' action goals, and also to categorize different classes of actions on the basis of motion features. The long-term goal of our work is to model the development of visual perception with computational tools, bridging computer vision, cognitive science, and robotics.

We start from the earliest stages of the human development and focus on the use of coarse motion models for discriminating between biological and non-biological dynamic events. In particular, we propose a model inspired by the Two-Thirds Power Law (Viviani&Stucchi, 1992) and discuss its empirical validity in the context of video analysis. We then proceed to the estimation of the similarity between actions, and, as an add-on, we infer classes of affine movements. The analysis includes an evaluation of the tolerance of our models to view-point changes. Our computational tools will be exploited to improve robotic interaction skills, and, in perspective, to drive further empirical research on human vision.

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[4P1M009] Texture amplitude provides only limited support for shape-from-shading in a visual search task and older adults are less able to utilize this cue

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Second-order texture amplitude cues can disambiguate the role of luminance cues helping observers to discriminate illumination/shading from reflectance changes. Older adults are less sensitive to such cues than younger adults and this insensitivity extends to shading-reflectance discriminations. We tested visual search performance in a task involving simulated shaded bumps on a textured surface. When luminance and texture amplitude varied in harmony the bumps appeared more rounded: bump. When the cues were antagonistic the bumps looked flatter/less realistic: patch. We also varied light source direction. There was a significant effect of age on search efficiency but no clear effect of lighting direction. However reaction times were always very slow (intercept = 1–2s) and significantly slower when finding patches among bumps compared to bumps in patches. Accuracy followed a similar pattern. Control searches for horizontal vs vertical lines and un-textured bumps among dips were efficient, with no effect of age, and had more typical reaction times. We think that it is necessary to scrutinize the whole display to extract the relatively weak second-order cue, but that attention is drawn more to bumps than patches. Older adults are further impeded by their insensitivity to the second-order cue.

[4P1M011] Form-motion suppressive interactions in normal and disabled readers – ECPV2015

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Detection of a low contrast static Gabor is strongly reduced by high contrast flankers whose spatial frequency (SF) is either equal or differed by ± 1 and ± 2 octaves to the target's SF (Petrov, Carandini, & McKee, 2005). Suppression of a 0.5 c/deg drifting target occurs, with transient stimulation, with flankers SF <2 octave but not ≥ 2 octave, suggesting that suppression occurs when both target and flankers stimulate the same (magnocellular) but not different systems (magnocellular and parvocellular). Based on the hypotheses of earlier development of parvocellular than magnocellular system, and of a magnocellular deficit in dyslexia, we compared the suppressive effect by flankers of SF ± 2 octave on the drifting target in adults and children either normo-reader or dyslexics. Children's contrast threshold for the drifting isolated target did not differ from that of adults. However, both children's groups had higher thresholds than adults when flankers SF was either lower or equal to that of the target. Moreover, only in dyslexics thresholds with $+2$ octave flankers are higher than with no flankers and higher than in adults. These results indicate stronger suppressive magnocellular lateral interactions in children than adults and, only in dyslexics, a motion-form stimulation imbalance.

[4P1M013] Developmental progression in the audio-visual binding of novel environmental features in children

Simon Davies, Lorna Bourke and Neil Harrison
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The reliable crossmodal binding of environmental features supports a range of cognitive activities. During development children learn the statistical and semantic associations between these features. The current study explored the role of binding during the critical period in a child's life when they start to formally learn the association between the sounds and symbols of the alphabet. This study assessed whether the ability to bind improves with age independently of longer-term exposure to the alphabet or other sound-symbol relationships. Reception (4 yrs+) and Year One (5 yrs+) age children undertook a change detection task which involved mapping the relationship between novel (random Garner-like matrices) shapes and novel (scrambled environmental) sounds. Two sound-symbol combinations were sequentially observed and then one combination was tested which could be a new or old combination of the original features. Signal detection analysis revealed no difference in bias between the age groups, whereas sensitivity to the correct binding significantly increased with age. We conclude that children's ability to learn associations is based not only on experience, but also on individual difference in the ability to bind environmental features.

[4P1M015] Eye movements during obstacle crossing in people with Parkinson's disease who fall: Influence of disease severity and visual contrast

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INTRODUCTION: Negotiating obstacles is a complex task for people with Parkinson's disease (PD) due to a plethora of motor symptoms which worsen with disease progression. Visual deficits

in PD impede safe obstacle negotiation and increase the risk of falls (van der Marck et al., 2014, Parkinsonism and Related Disorders). Increasing the saliency of obstacles may improve the interpretation and negotiation of complex environments. AIMS: To quantify the association between eye movements and disease severity in PD participants who have previously fallen (PD-fallers) whilst negotiating obstacles of varying contrast. METHODS: 18 PD-fallers were asked to walk over an obstacle (HxWxD,15x60x2cm) of low and high contrast. Eye movements (number of saccades and fixation duration) were obtained using a mobile eye-tracker (Dikablis, 25 Hz). Spearman correlations described the association between eye movements and disease severity (UPDRSIII). Adjusted significance was accepted at $p < .01$. RESULTS: UPDRSIII was negatively associated with the number of saccades irrespective of obstacle contrast ($rho = -.66, p = .003$) and positively associated with fixation duration when obstacle contrast was high ($rho = .69, p = .002$). DISCUSSION: Reduced visual exploration was associated with more severe PD motor symptoms. Improving obstacle saliency offers the potential for prolonging visual attention to task-relevant stimuli when motor deficits are high.
This study was supported by the VTIME project, which is an European Union 7th Framework Programme (FP7) under the Health theme (FP7 – 278169).

[4P1M017] Effect of mental practice on mental rotation after stroke: comparison between alphabet letters and hands

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Mental practice (MP) is a recent rehabilitation method from cognitive psychology. In typical MP, stroke patients control visual images of the body and hands to improve their motor function (e.g., hand movements). In this study, the effects of MP using hand images on mental rotation performance were investigated. Three groups (control, normal rehabilitation program, and normal rehabilitation with MP) were assigned. In the MP group, patients observed video-instructed MP on a tablet twice per week. The mental rotation task featured two visual stimuli: an F and a mirrored F, and right and left hands. These images were rotated 0, 90, 180, and 270 degrees. The average reaction times of the mental rotation task in pre intervention, after a month (post1), and after six months (post2) were compared. The results indicated that there were no significant difference for the F- shaped mental rotation in both normal and MP groups. However, in the MP group, the mental rotation performances of post 1 and 2 improved, though no improvement was found in the normal rehabilitation group. These results suggest that the effect of MP in stroke patients might be task specific based on cognitive function.
This study was funded by joint research funds at the Kansai University of Welfare Sciences.

[4P1M019] ERP evidence of reduced spatial selectivity in those with high levels of self-reported autistic traits

Stephanie Dunn, Megan Freeth and Elizabeth Milne
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A number of studies have shown that individual differences in visual cognition correlate with autistic traits in the general population. For example, individuals with high levels of autistic traits are more efficient visual searchers and have larger amplitude of an ERP component reflecting selective attention (N2pc) than individuals with lower levels of autistic traits. However, it is not clear whether this difference is associated with target detection, distractor suppression, or both. Therefore, we measured N2pc, PD (distractor suppression) and NT (target selection) amplitude alongside a self-report measure of autistic traits. Forty-five neurotypical students were recruited to take part. Participants had either high ($N = 22$, $AQ \geq 28$) or low ($N = 24$, $AQ \leq 11$) levels of autistic traits. We found a significantly larger N2pc in those with high levels of autistic traits. There was no difference in the amplitude of the NT, but PD amplitude was significantly reduced in the participants with high levels of autistic traits. These results suggest that the allocation of spatial attention differs in those with high levels of autistic traits compared to those with fewer autistic traits. Specifically, these data provide further evidence for reduced distractor suppression in those with high levels of autistic traits.

[4P1M021] Contour-integration deficits in intact visual field of hemianopia patients

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We investigated Gestalt perception in the intact visual field (VF) of hemianopia patients. Three patients and matched controls performed a Yes-No figure detection task. Gabor patches of one orientation, making up the outline of a square, were embedded in randomly oriented "background" Gabor patches. Continuity of the square outline was modified by changing the orientation of 4 to 12 out of 16 Gabor patches. In addition, background density (BD) varied from low to high. Figure detection in the intact visual field was impaired in a patient with a temporal-parietal lesion but not in a patient with an occipital lesion. Both patients had frequent false positives when only the background elements or fragmented squares were presented. 'Pathological completion' occurred more frequently (i) for higher BDs, (ii) when the fragment ends faced the blind VF, and (iii) for central compared to peripheral presentation. The patient with an optical tract lesion had almost normal figure detection at low BD but impaired performance at higher BDs; no 'pathological completion' was observed. Our findings indicate that crowding engenders contour integration deficits in the "intact" VF of hemianopia patients. We attribute the deficits to malfunction of the cortical stage of processing in the visual system.
GVP thanks BA Sabel for providing her with access to the contact details of hemianopia patients and the laboratory for testing them.

[4P1M023] Orientation discrimination is not altered in children with autism spectrum conditions

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Atypical sensory perception is common in both adults and children with autism spectrum conditions (ASC; Ben-Sasson et al., 2009). In addition, sensory discrimination thresholds, including somatosensory (Blakemore et al., 2006) and auditory (Bonnel et al., 2003) thresholds are reduced (enhanced) in individuals with ASC. In vision, adults with ASC have been found to have lower orientation discrimination thresholds (Dickinson et al., in prep). However, to the best of our knowledge, orientation discrimination has not been measured in children with ASC. As sensory symptoms are seen in both children and adults with ASC, we might expect to see a similar alteration in discrimination thresholds.

We tested 52 children with ASC (mean = 12.54 years, SD = 3.02) and 52 control participants (mean = 12.62 years, SD = 2.87). Participants were matched on age, sex, and non-verbal reasoning ability. Orientation discrimination thresholds were measured using an adaptive staircase procedure. We found no significant difference in orientation discrimination thresholds between children with ASC (M = 9.08, SD = 4.03) and control participants (M = 8.69, SD = 3.41; $t(102) = .52$, $p = .6$). Therefore whilst enhanced orientation discrimination may be present in adults (Dickinson et al., in prep), using a very similar task, we do not find the same enhanced performance in children with ASC.

[4P1M025] The effect of high resolution letters on legibility for persons with low vision

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Certain persons with low vision state that high-resolution displays are easily visible; although most of us can perceive the specifics of these detailed edges, some persons cannot. However, are high-resolution displays effective in helping persons who cannot perceive details? Ohnishi and Oda (2014) reported that a higher contrast in a fundamental frequency component for recognition (three cycles per letter (cpl); Solomon & Pelli, 1994) improved legibility in a high-resolution letter image. This study proposed to clarify the resolution's effect on legibility for persons with low vision. Gray-scale images of letters sized 1.106 to 2.740 degrees of arc were presented to five participants with low vision at seven smoothness levels (6, 8, 12, 16, 24, 32, and 48 blocks/letters). Contrast thresholds for recognition were determined using the staircase method for each smoothness level. The ANOVA showed a significant primary effect of smoothness, and showed tendencies similar to those in result for people with normal vision (Ohnishi & Oda, 2014). Although the participants were unable to resolve the fine edges, their contrast thresholds for smooth letter images were lower than those for grainy images. This indicates that letter images with higher resolution were legible and beneficial for persons with low vision.

[4P1M027] Individual variability in visual acuity improvement due to binocular fusion and accommodation training

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Visual acuity improvement as a result of fusion and accommodation training was analyzed in 118 patients aged 10–28 years. These patients constitute 4 different nosological groups: hypermetropic, myopic, and two strabismic – convergent with hypermetropia and divergent with myopia (groups H, M, CH, DM). The measurements were performed at the distances 0.3; 0.5; 1.0; 5.0 m before and after 10 sessions of functional treatment. In all groups, the effect of training was significant. A common feature of all the groups was dependence of the treatment effect on distance with a peak at 1 m. However, there were also distinctive differences between groups and between patients within each group evidently determined by the specifics of anomalies and by their power. Thus, in group DM, improvement was found in all patients and was of similar magnitude at all distances while, in several patients of group M, training had no effect at all or was revealed only at 1 m. This difference could be due to significant development of binocular accommodation in group DM during training whereas in group M this capability was already close to its possible peak before training.

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[4P1M029] The reduced visual orientation discrimination in children with autism spectrum disorders (ASD) is specific for cardinal axis

Olga Sysoeva, Elena Orekhova, Marina Tsetlin, Natalia Pushina, Maria Davletshina, Ilja Galuta and Tatiana Stroganova

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The better angular resolution along cardinal than oblique axis ('oblique effect') is a well known phenomenon in visual perception. GABA-ergic inhibitory circuits of visual cortex are of particular importance for orientation discrimination and its modulation by axis position. Individuals with ASD are characterised by deficits in the inhibitory circuitry, that may potentially affect their ability for visual orientation discrimination and magnitude of the 'oblique effect'. These perceptual features have not been investigated in children with ASD. In the current study we examined ability for line orientation discrimination in 15 high-functional boys with ASD (age 7–15 years) and 21 age- and IQ- matched neuro-typicals (NT) boys. The orientation discrimination threshold was measured separately for the vertical (90°) and oblique (45°) axes orientations using circular gratings (diameter 7°; spatial frequency 3 cycles/degree; contrast 100%; mean luminance 3.3 Lux). We found reduced oblique effect in boys with ASD that was driven by their decreased sensitivity to orientations along cardinal axis. No group difference in oblique orientation threshold was detected. The oblique and cardinal orientation thresholds were correlated in ASD but not NT samples. Our results suggest specific impairment of mechanisms determining the cortical orientation anisotropy in ASD children.

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[4P1M031] Inducing the preferred retinal locus of fixation

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Patients suffering from central vision loss can still acquire visual information using parafoveal vision. They fixate an object eccentrically at a preferred retinal locus of fixation (PRL). Depending on the properties of the vision loss, or the nature of the visual task, PRL positions differ in their efficiency in acquiring visual information. Patients do not always choose the most efficient PRL position.
The present study investigates whether a PRL can be induced at a specific position.
Central vision loss of 6 deg is simulated in 10 healthy subjects, and PRL training is performed in a set of visual tasks in four one-hour training sessions, separated by at least 24 hours. Performance is tested in a reading task along the training.
In five of those subjects (induced group), every time a target is placed in the right half of the visual field, the target is shifted to the left visual field, thus inducing a left visual field PRL position.
After training subjects of both groups developed a PRL. Furthermore, induced group subjects placed a target in the left visual field, as intended by the inducing procedure. Thus, this study demonstrates that PRLs can be induced at a specific position.

[4P1M033] Evidence for attenuated predictive signalling in schizophrenia

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Positive symptoms of schizophrenia such as delusions and hallucinations are thought to arise from an alteration in predictive coding mechanisms that underlie perceptual inference. Here, we aimed to empirically test the hypothesized link between schizophrenia and perceptual inference. 20 patients with schizophrenia and 27 healthy controls matched for age and gender took part in a functional magnetic resonance imaging (fMRI) experiment that assessed the influence of beliefs on perception of an ambiguous structure-from-motion stimulus. Schizophrenia patients compared to healthy controls reported perception of the ambiguous stimulus to be less biased by beliefs. This effect was paralleled by weaker belief-related activity in orbitofrontal cortex, a region that has been previously been involved in the generation and maintenance of beliefs. Our results indicate that in schizophrenia the influence of higher-level predictions such as beliefs in perceptual inference might be weakened. We suggest that attenuated predictive signaling during perceptual inference may provide the starting point for the formation of positive symptoms in schizophrenia.
This work was supported by the German Research Foundation (STE-1430/2-1 and STE-1430/7-1). Katharina Schmack is participant in the Charité Clinical Scientist Program funded by the Charité – Universitätsmedizin Berlin and the Berlin Institute of Health.

[4P1M035] Orientation discrimination is superior in individuals with autism spectrum conditions (ASC)

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Atypical perception, such hyper-sensitivity to some types of visual stimuli (Tavassoli et al., 2013), is commonly reported in individuals with autism spectrum conditions (ASC). In addition, several studies have found sensory discrimination to be altered in ASC. For instance, somatosensory discrimination (Blakemore et al., 2006) and pitch discrimination (Bonnel et al., 2003) have both been found to be enhanced in ASC. Here, we investigated whether orientation discrimination is also enhanced in ASC. We measured oblique orientation discrimination in 48 individuals with ASC, and 48 control participants matched on age, gender, and non-verbal reasoning ability. Orientation discrimination thresholds were significantly lower in adults with ASC ($M = 5.81$, $SD = 2.26$) than those without ($M = 6.88$, $SD = 2.37$; $t(94) = -2.267$, $p = .026$). This study demonstrates that oblique orientation discrimination is superior in individuals with ASC. Determining the cause of atypical perception in ASC may help cast light on the neural underpinnings of the condition. As neural inhibition is closely implicated in the tuning of orientation selective neurons, our future work will address whether neural inhibition may also be atypical in individuals with ASC.

[4P1M037] The effect of visual fatigue on clinical evaluation of vergence

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The number of complaints and visual fatigue increases after prolonged near work. It can be related to significant changes in coordinated work of accommodation and vergence system such as decreased accommodation and vergence range (Gur et al., 1994, Murata et al., 1996). The purpose of the study was to evaluate the effect of prolonged near work (computer and paper work > 4 hours a day) on the clinical measurements of vergence response. Associated heterophoria (vergence state as a result of accommodation and vergence interaction), negative and positive fusional vergence (vergence amplitude), and vergence facility (dynamics of vergence response) were tested in 15 students (20–22 y., 11 with emmetropia and 4 with corrected myopia) using specially designed computerized tests. Dichoptic images were presented to each eye using red-cyan filters. The measurements were performed on five working days (in the morning and at the evening). Analysing the whole sample group, we observed no statistically significant changes of heterophoria, positive fusional vergence, and vergence facility at the end of the working day. Only negative fusional vergence demonstrated statistically, but not clinically significant decrease of values at the end of the working day. The results indicate that vergence response is rather stable over the day.

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[4P1M039] Perceptual compensation of pursuit-induced retinal motion in infantile nystagmus

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Infantile nystagmus (IN) produces constant involuntary horizontal oscillations of the eyes. Individuals with IN are thought to compensate for this by comparing retinal estimates of the continual image motion with extra-retinal estimates of eye velocity. This is similar to how typical observers are able to interpret image motion during smooth pursuit, but whether individuals with IN are able to do so for these larger, more deliberate eye movements remains explored. We conducted a monocular velocity-nulling task on 11 adult IN participants and compared their performance with age-matched controls. Participants followed a pursuit target moving at 8°/s, during which time a random dot pattern was presented for 500 ± 50 ms. Dot velocity was adjusted to yield the Point-of-Subjective-Stationarity (PSS), which in typical observers is the point at which the dot pattern appears stationary. Preliminary findings show the PSS was small and positive for both groups, with a possible directional asymmetry in individuals with IN allied with their beat direction. Compensation for pursuit therefore appears similar and incomplete in both groups (the Filehne illusion), suggesting that the processing of pursuit-induced retinal motion is relatively normal in IN, despite the continual oscillation of the eyes.
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[4P1M041] Briefly presented visual search tasks reveal superior parallel processing in individuals with autism spectrum disorder

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The underlying mechanisms of the superior visual search skills in individuals with autism spectrum disorder (ASD) still remain controversial. The present study compared the performance of individuals with ASD and controls in briefly presented (160 ms) search tasks where the participants were asked to determine instantaneously the presence or absence of a pre-defined target among distractors. The short presentation method allows us to assess how quickly and accurately the participants process multiple stimuli simultaneously rather than focus on a stimulus serially. We found that overall the ASD group achieved faster reaction times regardless of set size with higher accuracy than the controls in a typical conjunction search task. The superior performance of those with ASD was consistent in a hard search where the target feature information was ineffective in prioritizing likely-target stimuli. The results indicate that the search superiority of individuals with ASD derives neither from differences in feature-based attention nor from serial search processes. Unlike conventional models of visual search, in which only basic visual features such as color and orientation are processed at a parallel processing stage, individuals with ASD presumably distinguish a target on the basis of more complex visual information at this stage.

[4P1M043] Color Vision Deficiency Test using Multi-primary Image Projector

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This study develops a simple and effective color vision deficiency test using a multi-primary image projector. The multi-primary projection system is mainly configured with a light source component and an image projection component. The programmable light source can reproduce any spectral curve. Spatial images are then generated using a digital mirror device (DMD) chip that quickly controls the intensity of the light source spectra in 2D image plane. Consequently the multi-primary image projector can reproduce 2D spatial image with arbitrary spectral power distributions. As with the test with an anomaloscope, our system generates circle stimuli. The upper side of the circle is the mixture of 545 nm green light and 665 nm red light. The bottom side is 590 nm monochromatic yellow light. By using the multi-primary image projector, we simultaneously presented fifteen different circles which consist of various mixture ratios of the upper side stimuli and various intensity levels of the bottom side stimuli. Then we tested color vision deficiencies by finding distinguishable colored circles. Through experiments using color vision deficiency simulation glasses, we confirmed that our system could realize the simple and effective test for color vision deficiencies.

[4P1M045] Optimal parameters of the treatment procedures for rehabilitation and development of binocular functions in different cases

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To increase the efficiency of functional treatment aimed at rehabilitation and development of binocular functions, one should choose the parameters of the procedures taking into account individual characteristics of the patient. We tried to find optimal treatment conditions for the two groups of patients who had concomitant strabismus – convergent with hypermetropia (group CH, N = 31) and divergent with myopia (group DM, N = 23) – and underwent surgical operation just before our study. The main purpose of the treatment was to achieve fusion and formation of a clear and stable binocular single image. The improvement of binocular functions was assessed quantitatively by measuring the ratios of monocular and binocular visual acuity values and accommodation ranges at four distances. Among other findings, it was revealed that, at the beginning of treatment, to obtain noticeable progress, one should use specific binocular optical correction differing from the monocular one and depending on the anamnesis. Thus, at the distance 0.5 m, in group DM, the required differences between optimal binocular and monocular optical correction varied from 0 to −4.5 D; in group CH, corresponding differences varied from 0 to + 3.5 D, however, in the majority of cases, they were in the range from + 2.0 to + 2.5 D.
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[4P1M047] Central and peripheral vision loss differentially affects contextual cueing in visual search

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Visual search for targets in repeated displays is more efficient than search for the same targets in random distractor layouts. Previous work has shown that this contextual cueing is severely impaired under central vision loss. Here, we investigated whether vision loss, simulated with gaze-contingent displays, prevents the incidental learning of contextual cues or the expression of learning, that is, the guidance of search by learned target-distractor configurations. Visual search with a central scotoma reduced contextual cueing both with respect to search times and gaze parameters. However, when the scotoma was subsequently removed, contextual cueing was observed in a comparable magnitude as for non-impaired controls. This indicated that search with a central scotoma did not prevent incidental context learning, but interfered with search guidance by learned contexts. In contrast to central vision loss, peripheral vision loss was expected to prevent spatial configuration learning itself, because the restricted search window did not allow the integration of invariant local configurations with the global display layout. This expectation was confirmed in that visual search with a simulated peripheral scotoma eliminated contextual cueing not only in the initial learning phase with scotoma, but also in the subsequent test phase without scotoma.
This work was supported by the Deutsche Forschungsgemeinschaft (PO548/14-1).

[4P1M049] Contrast detection differences between dichromats and trichromats

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Dichromacy is a form of congenital retinal lesion: protanopes and deuteranopes lack a precortical (L-M) opponent channel but the consequences for cortical development are unclear. One possibility is that the number of neurons in primary visual cortex is unchanged relative to trichromats so that more V1 neurons are available to process achromatic signals. If this is the case, we might expect that dichromats have improved achromatic visual processing compared to trichromatic controls. The nature of this improvement would depend on the details of the reallocation across spatial and temporal frequency channels and contrast sensitivities. Here, we used a spatial 4AFC task, to measure achromatic contrast discrimination thresholds for trichromatic and dichromatic observers, across a range of pedestal contrasts. We find evidence of lower thresholds in dichromats for high contrast pedestals ($p < .04$). Thresholds for low pedestal contrasts are unchanged between groups. These findings are discussed in the context of signal detection theory and the population-level encoding of contrast. We hypothesise that reallocation of neuronal resources does occur in dichromats and that the effects of this plasticity are most pronounced in the relatively sparse populations of neurons sensitive to high contrasts. Plans for further neuroimaging and behavioural experiments are described.

[4P1M051] Measuring visual field distortions in amblyopia

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Abnormal visual experience early in life alters the functional architecture of visual cortex and results in marked deficits in monocular visual acuity and binocular function – collectively referred to as amblyopia. Recently, we have shown there are also distortions in the visual field representation of amblyopic individuals (Hussain et al., 2015). Here, we attempt to map the associated changes in early visual cortex of subjects with amblyopia, using high-resolution magnetic resonance imaging (MRI) at 7 T. To measure visual field representations functionally, we used anatomical and functional MRI (GE-EPI, 1.5 mm isotropic voxels, TR = 2 s, TE = 25 ms) and standard retinotopic mapping stimuli in healthy and amblyopic participants. Stimuli were presented to each eye, monocularly. Outside the scanner, we also assessed fixation stability in each participant. We used the population receptive field (pRF) method to estimate polar angle, eccentricity maps, and pRF sizes (Dumoulin et al., 2008). Our results reveal systematic differences in the maps of normal and amblyopic subjects. We relate these changes to behavioural maps measured using a dichoptic positional matching technique, and individual anatomy.
The Leverhulme Trust

[4P1M053] Differences between deaf and hearing adults in visual projections from eye to brain

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Previous research has suggested that differences in retinal nerve fibre layer (RNFL) thickness can predict peripheral visual sensitivity in hearing and early deaf adults (Codina et al., 2011). As the size of early visual structures is correlated within individuals (Andrews et al., 1997), we hypothesised that RNFL differences should lead to downstream structural differences in the visual pathways. Participants included congenitally, profoundly deaf adults and age-matched hearing controls, all without visual deficits. Retinal layer thickness was measured using spectral-domain optical coherence tomography (SD-OCT). Optic nerve, chiasm and tract widths were measured using structural MRI. The visual field representation within primary visual cortex (V1) was measured using functional MRI retinotopic mapping. Retinal layers projecting from the macula were thicker in hearing participants while peripheral projections were thicker in deaf participants. The optic nerve, chiasm and tract were wider in hearing participants, reflecting the predominance of central fibres comprising these structures. Finally, the area and volume of the representation of the central visual field in V1 were relatively larger in hearing compared to deaf participants. Differences in the distribution of neural processing across the visual field between deaf and hearing individuals provide compelling evidence that congenital hearing loss influences early visual structures.

[4P1M055] Do strabismics perceive monocular stereopsis?

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A prerequisite for binocular stereopsis is the correct alignment of the two eyes and normal binocular fusion. Individuals with misalignment of the eyes (strabismus) are, most often, unable to obtain binocular stereopsis. Recently, we established that an impression of stereopsis can be obtained under monocular-aperture viewing of pictures. Though monocular stereopsis is weaker than binocular stereopsis, it shares the same phenomenological characteristics. This suggests that stereopsis ("seeing in 3D") is not simply a byproduct of binocular vision but a more basic visual phenomenon linked to the derivation of the visual scale (Vishwanath, 2014). We report on a study aimed to determine if individuals with infantile constant strabismus can obtain the impression of monocular stereopsis. We tested individuals with various manifestations of strabismus, along with a control stereonormal group. Subjects compared viewing a pictorial image with two eyes or one eye through an aperture, and answered questions directed at understanding their depth impressions in both pictures and real scenes. Stereonormal observers confirmed our previous findings on monocular stereopsis. Interestingly, some observers with constant infantile strabismus reported depth impressions consistent with monocular stereopsis, though there was significant variability in the overall reports depending on the history and current manifestation of strabismus.
British Academy / Leverhulme

[4P1M057] Lateralization of visual functions

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Lateralization of different visual functions have mostly been studied in isolation from one another. It remains unclear whether lateralization for one visual function relates to lateralization of another. Moreover, for a number of visual functions, lateralization was found by some researchers, but could not be replicated by others. Also in our lab, we were able to replicate lateralization of some visual functions (face perception and global/local perception), but did not find convincing results in favor of lateralization of other functions (categorical perception of colors (or 'lateralized Whorf effect'), categorical and coordinate spatial relation processing), or only marginally so (spatial frequency perception). We hypothesize that, while some individuals can be strongly lateralized for a certain visual function, this is not necessarily the case for all people. Because statistics are generally done on group level, the participant group needs to be composed such that enough (strongly) lateralized participants are included, in order to find a significant lateralization effect. To circumvent this random element of group composition, we study lateralization of a number of visual functions on an individual level. This also enables us to examine correlations between lateralization quotients for these functions.

[4P1M059] Combining body ownership illusions and time delay adaptation in virtual reality environments

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The promise of virtual reality is that it is possible to explore perception under extraordinary and impossible circumstances – some such circumstances may induce unusual percepts. Recently, body ownership/presence illusions have been studied using avatars in virtual reality environments; a hallmark of illusory presence is a strong physiological reaction to the avatar's harm. A special manipulation that can be introduced to VR is time delay adaptation. Adapting to 250 msec time delays in flight simulators, then snapping it back suddenly, induces an extraordinary causality violation aftereffect: the pilot believes the aircraft maneuvered before the pilot moved the controls (Cunningham et al., Psychological Science, 2001). It should be possible to combine these causality violation aftereffects with presence illusions to create a premonition-of-death-of-the-avatar illusion. Operating an avatar running in a maze induced a strong body ownership illusion. A pursuing drone shoots the avatar in the back and the operator experiences the shots through a tactile vest. A time delay between the movements of the operator and the avatar is gradually increased and adapted to. Unfortunately, using time-delay adaptation interferes with the presence illusion; additional multisensory feedback is being programed to compensate for the time delay adaptation's effects and restore the presence illusion.
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[4P1M061] Comparing the role of concavities and convexities in haptics and in vision

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In vision it is generally easier to detect mirror-reflectional symmetry than translational symmetry. However, by altering figure-ground factors it is possible to make translation easier to detect than reflection. This finding has been interpreted as revealing the role of concavities and convexities in visual shape perception and part decomposition (Baylis & Driver, 1995). However, vision is not the only modality that we use to perceive shape. Our sense of active touch (haptics) also allows us to efficiently extract shape information, identify objects and detect symmetry. Haptics, though, acquires information in a slower and more serial manner than vision. Since vision and touch differ in how information is acquired, even if the same task and stimuli are used the final percept may be different. Here, we investigated how the assignment of contour as a concavity or a convexity influenced the detection of reflectional and translational symmetry across vision and touch. Our results suggest that concavities and convexities play different roles in symmetry perception as a result of differences in how information is extracted across the two modalities.

[4P1M063] Deficits in visual and auditory Gestalt perception after stroke

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When perceiving the environment humans group single elements into Gestalts using so-called Gestalt principles which can be applied to visual as well as to auditory stimuli. In this study we investigated the relationship between visual and auditory Gestalt perception and categorization, additionally exploring the influence of both attention and working memory. Experiments were conducted with patients suffering unilateral middle cerebral artery (MCA) or temporal posterior cerebral artery (PCA) stroke and with healthy control subjects. They performed the Montreal Battery of Evaluation of Amusia (auditory Gestalt), a Gabor shape comparison (visual Gestalt), four categorization subtests (pictures, sounds, written words, spoken words), the D2 concentration endurance test and a memory task. The results showed strong correlations between a) visual and auditory Gestalt perception tests, b) music- and speech-related material and c) Gestalt perception and categorization skills for healthy subjects. For patients we found only minor correlations but significantly worse performance for attention, working memory and visual Gestalt perception. We propose that a network is responsible for building visual and auditory Gestalts and which is closely connected to higher processing areas, modulated by attention. In the injured brain the network seems to be weakened due to decreased attention and working memory capacities.

[4P1M065] Saccades towards targets of different somatosensory modalities

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Saccades to somatosensory targets have longer latencies, and are less accurate and precise than saccades to visual targets. But how do different somatosensory target modalities influence the planning and control of saccades? Participants fixated a start location and initiated a saccade as fast as possible in response to a touch of either the index or the middle fingertip of the left hand. In a static block, the hand remained at a target location in space for the entire block and the touch was applied at a fixed time after trial onset. In a moving block, the hand was first actively moved to the same target location and the touch was then applied immediately. Thus, in the moving block additional kinesthetic information about the target location was available. We found shorter latencies and faster saccades in the moving compared to the static block, but no differences in accuracy and precision of saccadic endpoints. The shorter latencies in the moving block were not due to the moment of the touch being predictable as was confirmed in a second experiment where the touch occurred unpredictably after trial onset. These findings suggest that kinesthetic information enhances saccade planning, but not control, towards tactile targets.
This work was supported by the German Research Foundation (DFG) projects TRR 135 and Fi 1567/4-2

[4P1M067] Time contraction during delayed visual feedback of hand action

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Congruent visual feedback increases perceived duration of hand action (Press et al., 2014). Action-outcome congruence is fundamental to sense of agency (the feeling that I am causing an action) and contributes to time distortion (Haggard et al., 2002). We therefore hypothesized that sense of agency over visual feedback of the moving hand would increase perceived duration of action. Participants moved their hand to imitate models of hand poses. To manipulate sense of agency, we provided video feedback (3000 ms duration) of their hand movement, with spatio-temporal biases (spatial: upright or inverted; temporal: 50 – 1500 ms delays). Participants then judged whether the video was of short or long duration in comparison with videos presented in previous trials (including practice trials). They also reported whether they felt in control of the hand movement in the video. Delayed videos were judged as "short" and "no agency" more frequently than synchronous videos (50-ms delay). Our results showed subjective time contraction caused by delayed visual feedback of hand action, suggesting that sense of agency modulates time perception during action.
Grant-in-Aid for JSPS Fellows (13J00943) supported this work.

[4P1M069] Investigating Sound Content in Early Visual Cortex

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V1 neurons receive non-feedforward input from lateral and top-down connections (Muckli & Petro, 2013). Top-down inputs to V1 originate from both visual and non-visual areas, such as auditory cortices. Auditory input to early visual cortex has been shown to contain category-specific information related to complex natural sounds (Vetter, Smith, Muckli, 2014). However, this categorical auditory information in early visual cortex was examined in the absence of visual input (i.e. subjects were blindfolded). Therefore the representation of categorical auditory information in visual cortex during concurrent visual stimulation remains unknown. Using functional brain imaging and multivoxel pattern analysis, we investigated if auditory information can be discriminated in V1 during an eyes-open fixation paradigm, while subjects were independently stimulated with complex aural and visual scenes. We also investigated similarities between auditory and visual stimuli in V1, to compare categorically-matched top-down auditory input with feedforward visual input. Lastly, we compared top-down auditory input to V1 with top-down visual input, by presenting visual scene stimuli with the lower-right quadrant occluded. We suggest that top-down expectations are shared between modalities and contain abstract categorical information. Such cross-modal information could facilitate spatial temporal expectations or more generally facilitate the brain's inference about the external world (Mumford, 1991).
European Research Council

[4P1M071] "Feeling by seeing": Eliciting haptic sensing by a non-attentive visual method: Psychophysical haptic – visual transformation functions

Michael Wagner and Tomer Elbaum
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We investigate a sensory-substitution phenomenon, whereby unattended peripheral dynamic visual-stimuli elicit haptic sensation. Remotely operated systems such as surgical robots lack haptic feedback essential for operation, which limit their regular use. Participants were requested to maintain various stylus pressures while tracking routes on a pressure-sensing tablet or on a virtual surface above the tablet. Routes, feedback and stylus location was displayed on a wide-screen. Level of stylus pressure varied the route-trace color, and served as an "attended" feedback. A remote pulsating ellipse reflecting stylus pressure served as peripheral feedback ("unattended"). Following acquisition trials, performance was examined for different feedback conditions (color, peripheral, none). Results indicated better performance for unattended-peripheral feedback trials, compared to no-feedback trials. In study one, color and frequency feedback parameters were coupled to stylus pressure using a linear transformation function. Well-established psychophysical principles indicate that logarithmic transformation functions adapted to specific sensory modalities, elicit optimal perceptual responses.
In study two, color and frequency feedback parameters were therefore coupled to stylus pressure using a logarithmic transformation function. Comparison of the two studies indicate significantly higher performance levels when using the logarithmic function (compared to the linear function), but faster learning, when using the linear function.

[4P1M073] Superior sensitivity for horizontal but not vertical audio localization in sighted children

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Audio localization is a complex spatial ability that matures during development. Compared to visual stimuli, localization of audio stimuli is more complex, since the auditory system lacks a straightforward correspondence between external spatial locations and sensory receptive fields (Ahveninena et al., 2014). Here we study how the static audio localization is influenced by the presentation plane (horizontal and vertical) and by the response requested (verbal or motor) during development. The setup consisted of 16 aligned loudspeakers (4*4 cm each) covered by tactile sensors that could be positioned in the horizontal and in the vertical plane. We asked forty-five blindfolded children aged between 6 and 10 years to complete two audio tasks in which they had to indicate the position of a sound presented in the horizontal and the vertical plane with a verbal (i.e. saying the correspondent number) or motor (i.e. touching the box) response. We found that irrespective of the method employed (verbal or motor), all children were consistently more precise in the audio localization on the horizontal axis ($P < 0.01$). These results suggest that humans have superior sensitivity for the audio localization in the horizontal plane already at young age.
This study was partially supported by the European ABBI project (FP7-ICT 611452).

[4P1M075] The development of audio-visual integration processes in short-term memory for information used in literacy

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Although it is acknowledged that orthographic processing is important, learning the basic association (e.g. binding) between a shape (grapheme) and its sound is critical in the early stages of literacy development. This study reports an experiment measuring the accuracy with which children could discern between which of two previously heard and seen events (individual items and item strings) were associated with one another. A sample of 87 children (Reception and Year 1) representing low and high ability in literacy skills participated. The task involved a series of trials in which the child saw and heard two events sequentially (memory stage), with each of the two events consisting of a novel sound(s) and a novel shape(s) presented together. On the same trials, the original binding was maintained, and on different trials, a new binding was formed from one of the event sounds (or string) and one of the event shapes (or string). Not unexpectedly, the results clearly demonstrate that the younger age group of children have substantially more difficulty with the binding task. Further analyses suggest that the ability to bind is crucial to transitions in the development of writing skills in young children.

[4P1M077] Depth echolocation task in novices sighted people

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Some blind people have developed a unique technique, called echolocation, to orient themselves in unknown environments. Specifically, by self-generating a clicking noise with the tongue, echolocation allows blind people to perceive some characteristics of objects, such as material, shape, size and how they vary with the distance, ultimately gaining knowledge about the external environment. It is not clear to date whether also sighted individuals can develop such technique. Here, we tested the ability of novices sighted participants to perform an echolocation task, where the position of an object in depth had to be estimated. The participants repeated the task three times in three different sessions. The first was a training session, where the participants received a feedback about their performance. In the next two sessions no feedback was given. Participants were able to properly achieve the task already by the first session after the training with a high level of correct responses. More interestingly, an improvement in precision and accuracy was observed in the second and in the third session, suggesting that echolocation can be progressively learnt by sighted individuals.

[4P1M079] A role of cutaneous inputs in self-motion perception (2): Does the wind decide the direction of perceived self-motion?

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Perceived self-motion has been mainly investigated in vision. But, Murata et al. (2014) reported the wind for cutaneous sensation with vibration for vestibule also occurred perceived self-motion. They referred to as "cutaneous vection". The authors of this study have compared perceived self-motion on cutaneous vection with actual body transfer. In this study, we prepared two conditions that were the wind direction (front or behind from the participant) and the transfer direction (forward, backward or vibration alone). We used two bladeless fans for cutaneous stimulus to the participant face and a DC motor for vibration to the participant body. The floor of the participant could move to and fro. Onset latency, accumulative duration and rating of subjective strength were measured. The participant was also asked to point to the perceived direction. When the direction of wind was consistent with the direction of transfer, latency was significantly shorter, and the value of rating was significantly higher than other conditions. When the vibration alone with wind was presented, the perceived direction depended on the wind direction. When the wind from the front and behind simultaneously blew the participant, perceived direction was ambiguous. The wind direction contributed to decide the perceived direction.

[4P1M081] Cross-modal insights into the controversies of conceptual knowledge representation and temporal pole asymmetry

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How is conceptual knowledge represented? Do the temporal poles form a bilateral unified representational system for conceptual knowledge, or is there left/right specialization? To address this hotly debated issue and its generalization to non-visual modalities, we developed a novel cross-modal approach. Methods: FMRI was conducted in a Siemens 3 T scanner with a custom tablet system for the presentation of tactile information. The conceptual information was presented tactilely through Braille text, and its retrieval from memory was expressed through two non-visual modes – Braille writing and blind-drawing. Blind subjects read Braille paragraphs describing objects, faces, scenes and navigation sequences; then expressed their comprehension of each by i) non-visual (Braille) writing-from-memory, and ii) non-visual drawing-from-memory (20 s/task). Results/Conclusions: Comprehension of the Braille text concepts expressed through Braille writing-from-memory produced strong left-lateralized response at the temporal pole, while their expression through drawing-from-memory produced a right-lateralized response in the mid-anterior temporal lobe. In both cases, the corresponding regions in the opposite hemispheres were strongly suppressed. This first Braille writing and Braille-derived drawing study thus reveals a distinctive form of counterposed hemispheric specializations in the anterior temporal lobe. Furthermore, it extends the issue of conceptual knowledge representation beyond the visual modality for both encoding and retrieval.
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[4P1M083] Does the sense of agency occur when tactile feedback is substituted for proprioceptive feedback?

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When people view their left hand in a mirror positioned along the midsagittal plane while moving both hands synchronously, the hand in the mirror visually captures the unseen right hand's position. This is called mirror illusion. The illusion evokes the sense of agency; that is, the participant's sense of controlling their own body. In Gallagher's model (2000), this sense occurs when sensory feedback predicted by the forward model of body movement matches actual sensory feedback. Since this model does not address multimodality, it is unclear whether the sense of agency occurs when information is incongruent between multimodal sensory feedback, particularly vision, proprioception, and tactile sensation. To answer this question, a 2×2 factorial design experiment was performed using the mirror illusion (the unseen hand's movement: voluntary or relaxed; vibration on the unseen hand: applied or not). Questionnaires' result showed that sense of agency was present in the relaxed vibrating condition, as well as in both voluntary conditions, indicating that the sense of agency may occur when visual and tactile feedback are supplied without proprioceptive feedback. This suggests possible feedback types that may evoke the sense of agency, and that the sense of agency's criteria may depend on feedback context.
Supported by COI

[4P1M085] Hearing through your eyes: the Visually-Evoked Auditory Response

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In some people, visual stimulation evokes auditory sensations. How prevalent is this, and can it affect performance of visual and auditory tasks?
We measured auditory versus visual 'Morse code' sequence matching in 40 randomly-sampled adults. When asked whether they had heard faint sounds accompanying the flash stimuli, 16% responded 'Yes'. These same participants performed significantly better than 'No' respondents on visual sequence matching, as if their concurrent auditory sensations benefited visual performance (Saenz & Koch, 2008). But in a separate test, we found that any such benefit for visual sequencing was balanced by a cost for detecting faint auditory signals in the context of irrelevant visual stimulation, regardless of reported awareness. Thus even when subliminal, visually-evoked auditory sensations may affect detection of real sounds. The high prevalence of subjective reports of 'hearing' visual flashes greatly exceeds the estimated prevalence of other typical synaesthesias (e.g. 2–4%; Simner et al., 2006). Our objective results suggest that subliminal visually-evoked auditory sensations may affect an even larger population. Such prevalence might be explained by the greater natural correlation between visual and auditory stimuli, compared to other more arbitrary associations typical of synaesthesia.
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[4P1M087] Audiovisual synchrony improves temporal order judgment performance only in complex dynamic visual environments

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Visual temporal order judgments can be profoundly degraded by the mere presence of additional visual events at remote spatio-temporal locations. In this study we investigate whether this Remote Temporal Camouflage (RTC) effect can be modulated by the presence of auditory events paired with visual target events. In the first experiment visual temporal order judgment performance was compared under static or irregularly timed dynamic visual distractor conditions, without or in combination with a pair of broadband tones either synchronised with each target event (Synchronised condition) or preceding the first and succeeding the second by 75 ms (Ventriloquism condition). In the case of static distractor environments visual temporal acuity benefits were observed only in the Ventriloquism condition. Whilst thresholds were significantly elevated in the dynamic visual context, the presence of both tone conditions significantly improved visual performance. In our second experiment we examined the effect of distractor regularity under analogous sound-related conditions. We find that the visual performance benefits afforded by synchronous target tones do not occur when the distractor events occur at regular intervals. These results suggest that audio-visual correspondences improve visual temporal order judgments only to the extent that they facilitate visual temporal segmentation.
Australian Research Council

[4P1M089] Evaluating Multimodal Warning Displays for Drivers with Autism

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Providing consistent sensory information across multiple modalities can frequently improve performance, however, evidence exists that individuals with autism exhibit limited performance in multisensory integration. We designed two driving simulation experiments to test the effectiveness of multimodal audio (A), tactile (T) and visual (V) warning signals designed with different levels of urgency. In both experiments, warning signals had 7 modality levels (A, T, V, AT, AV, TV, ATV) and 3 levels of urgency (High, Medium, Low) for a total of 21 possible stimulus combinations. Experiment 1 measured perceived urgency and perceived annoyance of the warnings while Experiment 2 measured recognition time and accuracy of identifying the level of urgency. A total of 20 adult males participated, 10 in the ASD group and 10 age-matched individuals in the typically developed (TD) group. Results from Experiment 1 showed no group difference in perceived urgency, though the ASD group revealed lower ratings in perceived annoyance. Results of Experiment 2 showed that the ASD group responded more accurately than the TD group, they also demonstrated quicker recognition times than the TD group for warnings containing vision and were quickest for the Vision-only condition
Freescale

[4P1M091] The effect of perceived reality of the visual scene in cross-modal interaction

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Using a head-mounted display with head orientation tracking, observers can experience a visual scene recorded by a panoramic camera as a real ongoing world in some controlled situation (e.g. Suzuki et al., 2012). In this study, the participants' subjective reality was manipulated using this procedure and the effect of visual scene on cross-modal interaction was investigated. One group was explained that the visual scene was live and displayed via the attached camera. The other group was explained that it was a recorded video. If the participants noticed that the visual display is not real, those participants were categorized as a different group. Participants put their hand at the position corresponding to the dummy hand displayed in a HMD and their hand was stroked with a paintbrush synchronously to the visual display. The participants judged the orientation of the haptic stimulation which was incongruent to the visual display. The shift of the perceived haptic orientation influenced by visual stimuli was much larger in the group who perceived the video as reality than the group who didn't. The result indicates that the amount of the cross-modal effect of visual perception on haptic perception depends on the subjective reality of the visual scene.

[4P1M093] Location of a visual object is processed in multiple frames of reference: An ERP study

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The location of an object in space is relative: We can say that a ball is in front us if we reference the location to ourselves(egocentric), or we can say that the ball is next to the window if we reference it to the room(allocentric). These two distinct frames of frame of reference are thought to work in parallel but so far studies have not shown how the encoding of object location unfolds over time in different frames of reference. For this purpose we designed an ERP experiment where 38 participants were placed in an immersive virtual cross maze and event-related brain potentials(ERPs) were measured. They had to collect reward objects by turning left or right from a starting point. The starting point was either the South or the North alley. This way we were able to contrast the egocentric and allocentric coding of reward object location in ERPs. Coding of object location was observable in the amplitudes of the P1–N1 complex. We found that allocentric coding started slightly earlier (85–110 msec) than egocentric coding (100–140 msec). These results show that indeed the two frames of reference activate almost at the same time and at early stages of object processing.

[4P1M095] Spatial attention to graphemes in grapheme-color synesthesia

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Grapheme-color synesthesia is a rare perceptual phenomenon in which an individual's perception of letters or numbers is associated with sensations of color. Using EEG alpha oscillations (9–11 Hz) and a spatial priming task, we investigated whether color-inducing graphemes attract attention in synesthetes. The participants were shown real-colored or achromatic color-inducing graphemes in either the left or the right visual field and performed an orientation judgment on a Gabor patch that was subsequently presented at the same or the opposite location. Achromatic non-color-inducing graphemes were shown as a baseline condition. Responses to both real-colored graphemes and color-inducing graphemes were faster than those in the baseline task. Color-inducing graphemes, but not real-colored graphemes, induced an asymmetric pattern of alpha activity, with a relative power decrease in left posterior areas and a corresponding increase over right posterior sites. This asymmetry did not depend on the presentation location of the grapheme. We discuss the alpha power modulations in the context of spatial shifts of attention.
This work is supported by the Deutsche Forschungsgemeinschaft (DFG), VO 1998/1-1.

[4P1M097] The Role of Stereoscopic Depth Cues in Place Recognition

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The recognition of places can be based on a variety of cues, such as landmark configuration or raw snapshot information (Gillner, Weiß, Mallot, 2008). Here we address the question if place recognition is also possible with pure depth information. To test this we designed a virtual environment that is presented as a dynamic pattern of random dots with limited lifetime. A mirror stereoscope was used to ensure that participants could perceive a 3D impression from stereoscopic and motion parallax cues. Presenting a stimulus in this way, all other cues but depth information were excluded. Participants did a 'return-to-cued-location' task in two conditions (rich, textured environment vs. depth only, random dot). Results show, that place recognition based on depth information is possible, but subjects' performance improved when more cues were available. A pre-test for participants' stereo vision (no motion parallax) showed no correlation in performance with the main experiment. In a second study we therefore tested participants in a monocular condition with motion parallax as the only available depth cue. The results indicate that place recognition is still possible but performance is markedly reduced as compared to the stereo condition. Motion parallax seems to play only a minor role.
This work was supported by the Bernstein Center for Computational Neuroscience, Tübingen (BMBF; FKZ: 01GQ1002)

[4P1M099] Effect of Luminance Contrast on Perceived Depth from Disparity

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According to the disparity energy model (Fleet et al., 1996, Vision Res.), the disparity energy depends on both binocular disparity and luminance contrast of the stimulus. To test this prediction, we used rectangular random dot stereograms to investigate the effect of luminance contrast on perceived depth from disparity. The disparity between the left and the right patterns modulated horizontally in cosine wave (1 or 3 cy/deg) to create the percept of a corrugated surface. The maximum test disparity ranged from 0 to 20 arc min while the luminance contrast ranged from 5% to 80%. The observer adjusted the length of a horizontal line to match the perceived depth difference in the test. At each contrast, perceived depth increased with disparity up to $\sim$10 arc min and then decreased with further increases in disparity. Both the maximum perceived depth and the slope of perceived depth change increased with luminance contrast. Our results show that luminance contrast profoundly affects perceived depth from binocular disparity. The data also suggest a soft threshold, such that perceived depth drops to zero below about 10% contrast and is independent of contrast above about 30% contrast. These effects are not compatible with a simple disparity energy concept.
MOST(Taiwan) 102-2420-H-002-018-MY3

[4P1M101] Shading Beats Binocular Disparity in Depth from Luminance Gradients

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We investigated how perceived depth can be determined by a shading and disparity cues. The target, designed to simulate a uniform corrugated surface under diffuse illumination, had a sinusoidal luminance modulation (1.8 cy/deg, contrast 20%–80%) modulated either in-phase or in opposite phase with a sinusoidal disparity of the same corrugation frequency, with disparity amplitudes ranging from 0'–20'. The observers' task was to adjust the binocular disparity of a comparison random-dot stereogram to match the perceived depth of the target. The perceived target depth increased with luminance contrast and was specific to luminance phase but was largely unaffected by the disparity modulation of the target. These results suggest that human observers can use the diffuse illumination assumption to perceive depth from luminance gradients alone without making an assumption of light direction. Remarkably, the observers gave a much greater perceived depth weighting to the luminance shading than to the disparity modulation of the targets, which cannot be explained by a Bayesian cue-combination model weighted in proportion to the variance of the measurements for each cue alone. Instead, they suggest that the visual system uses disjunctive mechanisms to process these two types of information rather than combining them according to their likelihood ratios.
MOST (Taiwan) 102-2420-H-002 -018 -MY3

[4P1M103] The Effect of Observation Distance on Space Configuration of Targets for Gaze Perception

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Gaze perception causes overestimation of amplitude underestimation of depth distance (Mori & Watanabe, 2014). We investigated what kind of influence observation distance has on space configuration of targets for gaze perception. Participants observed still images of life-size human faces displayed on the monitor from a distance of 1 m or 4 m, judged the gaze point from the still images, and put markers of the judged gaze points on the floor. Configuration of targets (gaze points) is defined as the amplitude and direct distance from the origin, which is the monitor. As a result of having estimated the linear regression equation between the physical configuration and the perceptual configuration based on amplitude and direct distance, it was shown that there was a higher tendency of overestimation of the amplitude, and underestimation of the direct distance when observation is made from a shorter distance. As a result of having estimated the magnification ratio of coordinate value with affine transformation, observation made from a shorter distance there was a tendency of underestimation of the depth distance, while lateral distance was not influenced by the observation distance. Those results suggest that observation distance affects depth of space configuration of targets for gaze perception.

[4P1M105] Asymmetric effects of stereoscopic depth on simultaneous lightness contrast

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As perception of lightness is modulated by relatively high level of stimulus configurations, it is surprising that stereoscopic depth of the test patches does not have strong effects on simultaneous lightness contrast (Gibbs & Lawson, 1974; Menshikova, 2013). Here we report results that demonstrate a partial but substantial effect of the depth configuration. A classical configuration of two grey patches on adjacent black and white surroundings was shown on a computer screen stereoscopically by using LCD shutter goggles (nVidia 3D Vision). The lightness of the patch on the black background was manipulated, and the point of subjective equality was measured by the method of constant stimuli. The lightness contrast was substantially enhanced when the patch on the black was behind the background, irrespective of the depth of the patch on the white. There was no such effect when the patch was in front of the black background. It was suggested that the patch appeared to be located in a dark room under the crucial condition. The reason for the marked asymmetry is not clear, but the results demonstrate a particular case where stereoscopic depth works as a configuration cue in simultaneous lightness contrast.
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[4P1M107] Framing can enhance the perceived depth of a picture

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We examined the effect of framing on a picture's apparent depth. Sixteen observers rated the apparent depth of 60 pictures with a frame placed 13.0 cm in front of a display, while another 16 participants evaluated the same set of pictures without a frame. The pictures were rated on a 0–4 scale, with 4 indicating the greatest depth. The 32 observers were then presented the same picture with and without a frame, placed side-by-side, and they judged which of the two had greater depth for all 60 pictures. Observers performed depth ratings both before and after depth judgment. Before depth judgment, mean scores for the 15 higher-rated pictures with frames were higher than those for the same pictures without frames, but mean scores for the 45 lower-rated pictures with frames were almost the same as those for the same pictures without frames. After depth judgment, 82% of the pictures were scored higher when they were presented with frames. Moreover, the mean proportion of observers that chose framed pictures as having more depth was 75%. These results indicate that framing a picture enhances its perceived depth, suggesting that framing makes distance cues less reliable and pictorial depth cues more effective.
This study was partially supported by JSPS Grant-in-Aid for Scientific Research (23330215).

[4P1M109] A preference for stereopsis in deep layers of human primary visual cortex

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Recovering depth from binocular disparity requires multiple computations which are most likely implemented across early and higher visual areas. How these areas interact to support perception remains largely unknown. Here we used 7 T functional magnetic resonance imaging at sub-millimeter resolution to examine laminar responses to stereoscopic stimuli in V1. To disentangle perceptual experience from disparity processing, we presented random dot stereograms in correlated and anti-correlated form while observers ($N = 4$) performed a Vernier detection task. We measured blood-oxygenation level dependent (BOLD) responses using a gradient and spin-echo sequence with 0.8 mm3 resolution, and found increased BOLD signal for correlated versus anti-correlated stereograms in deep, not superficial, layers of V1. Control experiments ruled out bias in BOLD responses across cortical layers. By examining multivariate patterns in V1 we also found that voxels in deep layers are weighted most strongly when a classifier learns to discriminate activity patterns evoked by correlated vs anti-correlated stereograms. These results indicate a preference for disparities that support perception in the deep layers of V1. This is compatible with a role for recurrent circuits in stereopsis, either via local connections within V1 or feedback connections from higher visual areas, where neural signals are closely related to perception.

[4P1M111] The perceptual integrability of 3D shape

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3D shapes often strike us as unitary. This is also assumed in a well-known experimental paradigm: the attitude gauge figure task. Here, observers match the attitude of a virtual probe with the local attitude of a pictorial surface. To perform global analysis on the perceived 3D shape (like affine correlations) the local attitudes are integrated to a continuous 3D surface. This procedure requires an assumption that the surface is perceptually integrable. In this study we investigated this assumption. We rendered two shapes (a Gaussian surface and a torso) using five different material models: matte, mirror, glass, glossy and velvet. Three observers performed the attitude gauge figure task. Sampling was 229 and 249 points for the two stimuli, respectively, and number of repetitions was 3. We quantified the integrability by taking closed line integrals along the vertices. For a physical surface, these line integrals vanish to zero. Overall, we found that matte and glossy surfaces result in the most 'stable', integrable percepts. Glass and mirror surfaces caused more 'cracks' in the perceived surface, i.e. were less integrable. However, this was only found for the abstract Gaussian shape. For the torso, we did not find any difference between materials.

[4P1M113] Simple reaction times to stimuli in virtual 3D space

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Reaction times (RTs) to simple visual stimuli depend on several stimulus properties. Recently, there was converging evidence that larger stimulus size evokes faster simple RTs. This effect seemingly depends on the stimulus' perceived size rather than on physical stimulus properties. This effect typically is investigated using visual size illusions. In contrast, the present investigation was conducted using stereo head mounted displays. In that way, a circular reference plane consisting of 12 spheres was rendered. An additional target sphere was presented in the plane's center, either in the same depth plane or displaced (near, far). In two conditions the target sphere was modulated such that either physical or perceived size was constant across depth planes. Constant perceived size was expected to evoke constant RTs across space, while in the constant physical size condition decreasing RTs were expected along with increasing depth (and perceived size). However, the results show an opposite pattern: In both conditions RTs increased from near to far target position. This finding is at odds with recent investigations on simple RTs and perceived size. Apparently, the relative stimulus position in space as well as the physical stimulus size exert influence on simple RTs.

[4P1M115] The distribution of visual marking in 3-D space: Evidence for a depth sensitive mechanism

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In visual search, old distractors presented one second ahead of a new target containing set of items may be effectively ignored. This "preview benefit" has been argued to involve a "visual marking" mechanism that inhibits the locations of old distractors. The current study investigated the three-dimensional distribution of visual marking. Participants searched for and identified a target letter amongst distractors (always presented at 0 disparity). Subsequently, participants localised a square probe. Critically, the probe could appear at the same zero disparity depth, in front, or behind the letters. In the preview condition half of the items appeared first for one second, and the probe could surround an old or new distractor, or appeared in empty space. In the full-set condition, all the items appeared at the same time and the probe either surrounded a distractor or appeared in empty space. In the preview condition probe localisation was significantly slower for probes appearing on old compared to new distractors or empty space, but only when the probes appeared at the same depth as the distractor. No effects were observed in the full-set condition. The results are consistent with a depth sensitive visual marking mechanism that inhibits specific locations in three-dimensional space.

[4P1M117] Binocular summation, binocular fusion and the transition to diplopia

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The visual system combines spatial signals from the two eyes to achieve single vision. But if binocular disparity is too large, this perceptual fusion gives way to diplopia. We studied and modelled the processes underlying fusion and the transition to diplopia. The likely basis for fusion is linear summation of inputs onto binocular cortical cells. Previous studies of perceived position, contrast matching and contrast discrimination imply the computation of a dynamically weighted sum, where the weights vary with relative contrast. For gratings, perceived contrast was almost constant across all disparities, and this can be modelled by allowing the ocular weights to increase with disparity (Zhou, Georgeson & Hess, 2014). However, when a single Gaussian-blurred edge was shown to each eye perceived blur was invariant with disparity (Georgeson & Wallis, ECVP 2012) – not consistent with linear summation (which predicts that perceived blur increases with disparity). This blur constancy is consistent with a multiplicative form of combination (the contrast-weighted geometric mean) but that is hard to reconcile with the evidence favouring linear combination. We describe a 2-stage spatial filtering model with linear binocular combination and suggest that nonlinear output transduction (eg. 'half-squaring') at each stage may account for the blur constancy.
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[4P1M119] A population response model of spatial crowding over time

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Visual crowding, the inability to identify an object when it is surrounded by clutter, places a fundamental limit on object recognition in peripheral vision. Crowding is thought to arise because the features of a target and nearby flankers are represented within common receptive

fields in early visual cortex and thus cannot be individuated. However, recent work from our lab and others has challenged this view by revealing temporal dependencies of crowding. For example, if a brief onset asynchrony is introduced such that a target is presented 50 ms after the onset of flankers, the deleterious effect of crowding is greatly reduced. These data have been taken as evidence for a role of top-down processing in crowding. Here we present a new computational model of crowding of orientation signals that can account for these observations in a feed-forward framework. We model the responses of populations of orientation-selective visual neurons and predict the perceptual reports made by observers in a difficult crowding task. By incorporating the neurophysiological finding that orientation tuning changes over time, our model simulates the temporal dependence of crowding phenomena. Our model thus explains recent crowding data without invoking top-down processes.

[4P1M121] The relation between inter-object distance and contributions of eye- and image-based grouping during rivalry

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Binocular rivalry occurs when the information presented to the two eyes is inconsistent. Instead of fusing into a single stable image, perception alternates between multiple interpretations over time. Integration across space is also disrupted: although perception during rivalry can be affected by image content, visual information presented to the same eye tends to be integrated into a dominant percept most of the time. This suggests that integration across space during rivalry occurs mostly at an early monocular level of processing.
The question remains whether integration across space during rivalry that is based on image-content occurs at a later stage of processing than eye-based integration. We investigate the relation between eye- and image-based grouping and inter-object distance (IOD). Since later visual areas have increasingly larger receptive fields, image-based grouping should continue to facilitate dominance duration at larger IODs compared to eye-based grouping. However, if both types of grouping show the same relation with IOD, this would suggest that both image-based and eye-based models of rivalry occur at the same level of processing. Results will indicate whether multiple levels of processing are required to explain the spatial-temporal dynamic of binocular rivalry.

[4P1M123] Boundary extension effect is larger in tilt shift photographs

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In boundary extension (BE) experiments, people report remembering the content, which was originally beyond the edges of a studied view (Intraub & Richardson, 1989). Close-up views are known to yield larger BE errors compared to wide-angle views. We tested the hypothesis that larger BE is not caused by field of view, but by perceived distance. As people move in an

environment, their view of proximal space changes more profoundly (compared to distant objects); therefore, the extrapolation of visual input is more useful in the proximal space.
To manipulate perceived scene depth we used tilt shifted photographs, because they have the same layout, evoke same semantic references, but make the impression of toy-like scenery.
We presented participants ($N = 25$) with brief study view, followed by mask and asked them to adjust the test scene zoom level to match the study view. The protocol consisted of 12 distant scenes, 12 tilt shift versions of different distant scenes and 12 fillers. We found that irrespective of the initial study view zoom level ($+/-10\%$), the responses for tilt shift scenes were biased by 2–3% towards more zoom-out view. The observed pattern is consistent with the hypothesis about larger boundary extension found in proximal scenes.
The work was supported by Czech Science Foundation (GA13-23940S).

[4P1M125] Distance Perception in Immersive Environments – The Role of Photorealism

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Immersive environments (IE) are being increasingly used in order to perform psychophysical experiments. The versatility in terms of stimuli presentation and control and the less time-consuming procedures are their greatest strengths. However, to ensure that IE results can be generalized to real world scenarios we must first provide evidence that performance in IE is quantitatively indistinguishable from performance in real-world.
Our goal was to perceptually validate distance perception for CAVE-like IEs. Participants performed a Frontal Matching Distance Task (Durgin & Li, 2011) in three different conditions: real-world scenario (RWS); photorealistic IE (IEPH) and non-photorealistic IE (IENPH). Underestimation of distance was found across all the conditions, with a significant difference between the three conditions (Wilks' $\text{Lambda} = .38$, $F(2,134) = 110.8$, $p < .01$, significant pairwise differences with $p < .01$). We found a mean error of 2.3 meters for the RWS, 5 meters for the IEPH, and of 6 meters for the IENPH in a pooled data set of 5 participants. Results indicate that while having a photorealistic IE with perspective and stereoscopic depth cues might not be enough to elicit a real-world performance in distance judgment tasks, nevertheless this type of environment minimizes the discrepancy between simulation and real-world when compared with non-photorealistic IEs.
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[4P1M127] Can substitution explain crowding? A study of error distribution in letter crowding

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Introduction. Visual crowding refers to the impaired recognition of a flanked target, and was explained as flankers substituting the target. Crowding would alter the error distribution according to this substitution hypothesis, Here we measured letter confusion matrices (LCMs) and compared the dispersion of errors in uncrowded and crowded letter recognition. Methods. Thirty-three (Experiment 1) and 28 (Experiment 2) observers performed a 10-AFC letter identification task at 8° eccentricity in right visual field. Stimuli were 10 Sloan letters subtending 5° (Experiment 1) or 1° (Experiment 2). Two horizontal flankers were presented at 1° (Experiment 1) or 1.5° (Experiment 2) center-to-center distance in crowded conditions. Flankers were phase-intact letters in Experiment 1 and phase-perturbed letters in Experiment 2. Accuracy was maintained at $\sim$30% by adjusting target contrast. Results. Error trials were tabulated in LCMs. Joint entropy, a measure of error dispersion, was significantly higher in crowded conditions (Experiment 1 $= 6.17 \pm .025$ (Mean $\pm$ SE); Experiment 2 $= 6.23 \pm .026$) than in uncrowded conditions (Experiment 1 $= 5.25 \pm .052$; Experiment 2 $= 5.06 \pm .059$). Conclusion. Substitution could not explain the higher dispersion of error distribution in crowding with phase-perturbed flankers. Phase-perturbed flankers could have altered error distribution through compulsory averaging of low-level visual signals.

[4P1M129] Invisible Aftereffects: is awareness necessary?

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One of the most intriguing questions is how awareness influences the processing of visual information. Conscious access to the properties of physical stimulation is considered to be a crucial factor in determining perception. However, their exact relationship remains elusive. One way to address this issue is to control whether perceptual aftereffects are fully developed once awareness is abolished during adaptation. Here, we manipulate the visibility of the adapting stimuli using crowding to investigate how diminution of awareness acts upon the magnitude of the dynamic motion aftereffect (MAE). Random dots displays, moving at various levels of coherence served as target, flanking, and adapting stimuli. To examine the interaction of perceptual and physical attributes of stimulation with perception, we tested MAE under full, high and low visibility adaptation conditions under crowding and no crowding. Psychometric measurements were based upon the observers' performance on a directional motion discrimination task. Our results showed that crowding severely impaired motion discrimination ability and reduced MAE to a lesser extent (full adaptation condition). Physically identical and perceptually similar stimuli produced unequal in strength MAE (high visibility condition). In addition, MAE still persists even with invisible adaptors, indicating that both perceptual and physical factors influence perception.
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[4P1M131] The neural origins of visual crowding as revealed by event-related potentials and high-frequency oscillatory dynamics

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Visual crowding is the difficulty in identifying a target in the presence of nearby flankers. Most neurophysiological studies of crowding employed functional neuroimaging, but because of its low temporal resolution, no definitive answer can be given to the question: is crowding arising at the earliest (e.g., V1-V2) or at later stages of visual processing (e.g. V4)? Here, we used a classic crowding paradigm in combination with electroencephalography (EEG). We manipulated the critical space between peripheral target and flankers, while ensuring a proper control of basic stimulus characteristics. Analyses were focused on event-related potentials (ERPs) and oscillatory activity in the beta (15–30 Hz) and gamma (30–80 Hz) bands. We found that the first sign of a crowding-induced modulation of EEG activity was a suppression of the N1 component ($\sim$240 ms post-stimulus), in agreement with a recent study by Chicherov et al. (2014). Oscillatory analysis revealed an early stimulus-evoked gamma enhancement ($\sim$100–200 ms) that, however, was not influenced by the amount of crowding. Contrarily, a subsequent reduction in the beta band ($\sim$250–500 ms) was observed for strong relative to mid crowding condition, and correlated with individual behavioral performance. Collectively, these findings show that crowding emerges at higher levels of the visual processing hierarchy.

[4P1M133] Object substitution masking, stimulus noise, and perceptual fidelity

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In Object Substitution Masking (OSM) a mask surrounding, simultaneously onsetting with, and trailing a target leads to a reduction in target perceptibility (Di Lollo et al., 2000). It has been questioned whether this process is due to target substitution or the addition of noise to the percept (Pödor, 2012). Two experiments examined this issue using an adjustment task in which a test Landolt C is presented and participants rotate it to match the target Landolt C shown during the trial (typical OSM paradigms use 2–4 alternative forced choice); the dependent measure was the angle of error. In Experiment 1 the effect of a trailing OSM mask (80 ms–320 ms) is compared against that of adding stimulus noise of varying densities (25%–75%) to the target location. Both manipulations (OSM, stimulus noise) produced a similar change in the distribution of errors compared against a baseline (0 ms trailing mask, 0%-noise). The pattern is consistent with both mask manipulations reducing the fidelity of the target percept. In Experiment 2 the OSM and stimulus noise manipulations were varied factorially. Here the two manipulations had combinatorial effects on the error distribution. Implications are discussed regarding the mechanisms of OSM and the consequences of OSM for target perception.

[4P1M135] Peripheral vision effects central task performance under visual fatigue

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Visual load and difficult visual conditions can reduce performance (Richter, 2014). Nevertheless, open space offices are becoming more popular as well as GPS navigation while driving. What is more, we use our peripheral vision all the time, though a lot of tests are made to examine central vision and few of them involve periphery. For this reason, we investigated the role of peripheral vision on central task performance due to visual fatigue. The central task was performed at 60 cm. It was a computer-based visual search task consisting of a matrix (19.7 deg horizontally and vertically) of black Landolt squares in size of 1.1 deg each. This task was demonstrated on white background, with 5%, and 15% noise in periphery.Each participant had to memorize the target and find all the ones looking alike by clicking on them with a computer mouse. In addition, we measured near point of convergence, positive and negative relative accommodation and phorias at near. From the results, peripheral visual noise decreases central task performance under visual fatigue. Visual search task with 15% visual noise in periphery differs significantly between the performance with and without visual fatigue ($p < 0.05$, One-Way Anova).
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[4P1M137] Discrimination of blur in peripherally-viewed natural scenes

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All optical systems display some degree of blur. Although this may ultimately limit spatial resolution, blur also provides important signals for ocular accommodation, depth perception and motion perception. Predicting blur detection and discrimination of natural scenes, however, has been problematic and led to rather complex and varied models. Here we ask whether a recent blur discrimination model (Watson & Ahumada, 2011), operating on visible contrast energy differences between simple stimuli, can also capture performance with natural scene stimuli. We measured human blur discrimination performance using natural scene stimuli presented at three different eccentricities (0, 11, 22.5°) and blurred by seven different Gaussian kernels of varied scale (reference blurs). Images blurred by reference and test amounts were presented in a two interval forced choice method of constant stimuli task requiring participants to indicate the sharper image. Threshold vs Reference (TvR) functions were similarly shaped to those of previous studies using simple stimuli. Blur detection thresholds (no reference blur) increased with eccentricity. However, in contrast to previous work with edge stimuli, blur discrimination thresholds for different eccentricities converged at higher reference blurs. Modelling suggests that eccentricity-based differences in the contrast sensitivity function shape TvR functions for natural scenes.

[4P2M002] The relationship between orienting and zooming of spatial attention in autism spectrum disorder

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Autism spectrum disorder (ASD) has been consistently associated with different types of dysfunctions in spatial attention. Previous studies demonstrated impairments in rapid orienting, in disengaging or in zooming-out of the attentional focus, independently. However, a more ecological examination of the deployment of visual attention should involve both orienting and zooming mechanisms. In the present study, we examined the relationship between orienting and zooming in children affected by ASD (n = 22) and typically developing (TD) (n = 22) peers. To this aim, we modified a classical spatial cuing paradigm, presenting two small or large cues at opposite sides of the visual hemifield. Subsequently, one of these cues was briefly flashed varying the cue-target delay in order to measure the time course of the attentional orienting. Results demonstrate that only for trials in which attention had initially to be zoomed-out, the ASD group manifested a sluggish attentional orienting toward the cued location. This evidence was supported also by a correlation between the individual rapid orienting ability in the large cue condition and clinical scores of autistic symptomatology. In conclusion, impairment in rapid orienting that affects individuals with ASD may reflect a primary difficulty in zooming-out the attentional focus size.
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[4P2M004] The effect of age on confidence and accuracy in eye-witness judgements

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Groups of younger (under 40) and older (over 40) adults viewed a film of a staged incident involving two protagonists and were subsequently presented with separate video line-ups for each target. One line-up was target present (TP) and the other target absent (TA). Participants reported their confidence that each line-up member had been seen in the film. Consistent with previous findings that older participants make more false identifications than younger participants (Memon et al 2003), the older group produced higher confidence ratings to foils in the TA condition than did the younger. In the TP condition most participants gave the highest confidence rating to the target, however older participants gave significantly higher ratings to foils seen before the target than did the younger. There was no difference between the groups in confidence ratings to foils seen after the target. After identifying the target older eyewitnesses expressed much less confidence in the foils actually being the target. The results suggest that older eyewitnesses may have different expectations or be more susceptible to social pressure to make a positive identification.

[4P2M006] Visual-spatial-motor integration in a cross-section of primary-aged children: implications for assessing risk of dyslexia

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Dyslexia is a common condition characterized by difficulties with reading and writing despite adequate intelligence, education and motivation. Many individuals with dyslexia also have problems integrating visual information over space and time, and /or motor control: however, whether sensory and motor deficits underlie phonological difficulties in dyslexia, or merely co-exist with them, remains a topic of debate. We used a novel, computer-based "dot-to-dot" (DtD) task to explore visual-motor integration in 253 children (aged 4 – 10 yrs, m = 5.69; 114 females) from three primary schools in Edinburgh, UK, and its relationship with phonological and cognitive skills known to be compromised in dyslexia. We found that: (1) DtD accuracy was significantly correlated with Phonological Awareness, Rapid Automatized Naming (RAN) and Digit Span (arguably the best predictors of dyslexia); (2) DtD accuracy was the single most predictive variable of phonological awareness out of all the measures (accounting for 41% of the variance), more than RAN and Digit Span; (3) children deemed at "high" risk of dyslexia according to existing screening tools (e.g. LUCID-Rapid) performed significantly less accurately than those deemed at "low" risk. Follow-up testing of the youngest, pre-reading children will indicate whether or not poor visual-motor integration performance predicts later reading problems.
Supported by Edinburgh Napier University

[4P2M008] The Oblique Effect is Not Altered By Aging

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Neurophysiological studies in monkeys have found that aging significantly degrades the orientation selectivity of visual cortical neurons (Schmolesky et al., 2000; Yu et al., 2006). However, psychophysical studies of human observers have found that aging has very small effects on orientation perception. Specifically, orientation discrimination thresholds and the orientation-selectivity of pattern masking are very similar in older and younger adults (Betts et al., 2007; Delahunt et al., 2008; Govenlock et al., 2009). However, those psychophysical studies used horizontal and vertical gratings, not oblique gratings. Our perception of oblique contours differs in many respects from our perception of horizontal and vertical contours (Appelle, 1972), and the cortical mechanisms that encode oblique and cardinal orientations appear to differ (e.g., Edden et al., 2009). Hence, it is possible that age-related changes in orientation coding may be greater for oblique contours. To test this hypothesis, we measured orientation discrimination thresholds in 20 younger (20–28 years) and 20 older (70–79 years) adults with high contrast (80%) vertical and oblique 3 cy/deg sine wave gratings. Mean discrimination thresholds for both vertical and oblique gratings, and the magnitude of the oblique effect, did not differ between age groups. Thus, aging appears to not alter the oblique effect.
National Sciences and Engineering Research Council of Canada, Canada Research Chairs Program, and Canadian Institutes of Health Research to A.B.S and P.J.B, and Vanier Canada Graduate Scholarship to A.M.B.

[4P2M010] Spatiotemporal Visual Processing in school-age children and adults

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We compared performance in children and adults on detecting low contrast stimuli with spatiotemporal properties suitable to activate the dorsal stream at early level in order to assess the developmental timing of magnocellular over parvocellular component of the visual system. The spatial frequency of Gabor patches used as stimuli was either 0.5 or 4 cycles/deg. Gabors could be presented static, flickering (10 Hz, 20 Hz, 30 Hz) or drifting (5–6 deg/sec). Contrast thresholds were estimated using a two interval forced choice task that according to a psychophysical adaptive procedure tracked 79% of the participant's psychometric function. Results show reduced sensitivity in children for low spatial frequency static Gabors in respect to adults. In children, sensitivity for flickering Gabors is also reduced, selectively for the lowest spatial frequency and decreases as the temporal frequency is increased from 10 to 20 Hz. Finally, with drifting Gabors, we find, only for children, higher contrast thresholds at short than long durations.
Altogether, these results confirm the suggestion of a protracted development in visual processes dependent on the dorsal stream at early level, which is sensitive to very low spatial frequency, medium-high drifting speed and that is characterized by an high temporal modulation cut-off.

[4P2M012] Contour Interpolation: Normal development and the effect of early visual deprivation

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We studied the development of contour interpolation by testing 6-year-olds, 9-year-olds, and adults on the interpolation of subjective and occluded contours across variations in size and support ratio (the ratio of physically present to interpolated contour length). Interpolation improved significantly with age and both types of contour were affected equally by spatial constraints during early childhood. However, while interpolation of occluded contours became more precise and less dependent on support ratio by adulthood, interpolation of subjective contours improved less and became even more tied to support ratio. To examine the role of early visual experience, we tested adults who been treated for bilateral congenital cataracts and adults who had suffered the additional disadvantage of uneven competition between the eyes because the cataracts were unilateral. Only the unilaterally deprived patients later showed deficits in contour interpolation. Together, these findings indicate that perceptual interpolation improves significantly with age and that early bilateral deprivation does not prevent the normal construction and/or preservation of the neural architecture underlying interpolation. In contrast, early unilateral deprivation for as little as the first 2–3 months of life is sufficient to compromise the architecture mediating contour interpolation.

[4P2M014] Saccadic adaptation in aging

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Saccades – rapid eye movements that bring objects of interest onto the fovea – are recalibrated such that if the target is shifted in mid-flight, amplitude adapts to compensate for the shift. This phenomenon is known as saccadic adaptation. In the present study we investigated the characteristics of saccadic adaptation in elderly people. Twenty-four healthy elderly subjects (aged 60–75 years) and twenty young controls (aged 18–32 years) participated in our experiments. We measured saccadic adaptation and saccadic suppression of displacement concurrently.
Results showed longer latency and lower accuracy in the elderly, but no difference in trial by trial adaptation or perceptual performance between the two groups. This suggests that plasticity mechanisms survive despite general saccadic modifications with age.
Work was supported by Shota Rustaveli National Science Foundation (Tbilisi, Georgia) State grant (PG/90/7-272/13)

[4P2M016] Characterising individual differences with Bayesian Models: an example using autistic traits and motion perception

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Bayesian models describe how perceptual experience arises from the optimal combination of noisy sensory information and prior knowledge about the world. Here we probed whether individual differences in perceptual experience are best explained by differences in prior or sensory sensitivity. Priors cannot be assessed directly, but Pelicano & Burr (2011) suggested that individuals with Autism Spectrum Disorders may have flatter prior distributions, so we used this as a potential proxy. Trait measures were collected alongside psychophysical assessment of the perceived slowing of moving stimuli pursued by eye (Aubert-Fleischl phenomenon, AFP), because AFP can be modelled using Bayesian principles (Freeman et al 2010). Autistic traits were negatively correlated with AFP, and this relationship was strengthened after controlling for variance associated with motion thresholds during pursuit and fixation. The correlation between threshold differences and AFP was also significant after controlling for variance in autistic traits. Finally, thresholds and autistic traits did not correlate. Taken together, these results suggest that individual differences in both thresholds and prior distributions contribute separately to differences in perceptual experience. This supports Pelicano & Burr's hypothesis, but also suggests that differences in sensory sensitivity could sometimes mask the relationship between priors and perceptual experience and vice versa.

[4P2M018] Stimulating the Aberrant Brain: Predisposition to Anomalous Visual Distortions Reflects increased Cortical Hyperexcitability in those prone to Hallucinations: Evidence from a tDCS Brain Stimulation Study

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Clinical and neurological research has suggested that increased predisposition to anomalous perceptual experience can result from increases in cortical hyperexcitability. However, such studies are often based on subjective questionnaire measures alone. The present study examined the role of cortical hyperexcitability in healthy individuals predisposed to anomalous hallucinatory visual experiences by manipulating the level of excitability in the visual cortex via transcranial direct current stimulation (tDCS).
Sixty participants completed questionnaire measures indexing their predispositions to anomalous perceptions. They also took part in a computer based pattern-glare task (view irritable gratings) across three separate tDCS sessions (sham/anodal/cathodal) applied over the visual cortex. Participants reported the number of phantom visual and somatic distortions experienced during the viewing these highly irritable gratings.
Those predisposed to anomalous experiences, reported more visual distortions as a result of viewing the grating stimuli even under sham conditions. In addition, these individuals responded more strongly to excitatory stimulation of the visual cortex (reporting more visual distortions as a result of such stimulation), yet more weakly to inhibitory stimulation of the same brain regions. Collectively, these findings are consistent with a hyperexcitable cortex being associated with proneness to report more visual distortions and hallucinations even in non-clinical samples.
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[4P2M020] Ultra-rapid categorization of meaningful real-life scenes in people with and without ASD

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The Reverse Hierarchy Theory (RHT) by Hochstein and Ahissar (2002) assumes that ultra-rapid categorization of visual information (paradigm developed by Thorpe and colleagues, 1996) involves the extraction of the global gist of an image. People with Autism Spectrum Disorder (ASD) are generally outperformed by the typically developing population in tasks that require such global information processing. We tested a group of high-functioning adults with and without ASD on an explorative test battery of different ultra-rapid categorization tasks. As already reported in a previous study (Vanmarcke & Wagemans, 2015) gender differences (women better than men) were clearly present on all different categorization tasks (except for the motor baseline task). But, in contrast to our expectations, people with ASD only performed worse when the stimuli

required the categorization of scenes depicting social interactions. These results argue against a general deficit in ultra-rapid gist perception of visual information in people with ASD. Instead of supporting the Weak Central Coherence (WCC) hypothesis (Frith & Happé, 1994; Happé & Frith, 2006), arguing for a slower, more effortful extraction of global meaning in people with ASD, this finding suggests a more specific problem with the fast processing of social relations.

[4P2M022] Visual search in migraine

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Migraine is a visual disorder, showing differences in visual performance across a range of tasks between attacks. Lack of inhibition has been suggested as a possible reason for these differences. Specifically, migraine groups are more susceptible to the effects of external noise compared to healthy volunteers (e.g. Tibber et al., 2014). Although visual search should depend on inhibitory processing, migraine groups have not shown a deficit on this task (e.g. Wray et al., 1995, Palmer and Chronicle, 1998; Conlon and Humphreys, 2001), possibly as pop-out visual search tasks may not have sufficient noise to cause difficulties for migraine groups. Using a conjunction feature search task based on Zhaoping and May (2007), the effect of adding task-irrelevant noise to the stimulus on performance between migraine and control groups was explored.

[4P2M024] Dual focus contact lenses produce inaccurate steady state accommodation responses in emmetropic subjects

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The progression of myopia may be inhibited by manipulating peripheral retinal blur using dual focus contact lenses (DF). Previous studies have shown deficiencies in the accommodation response in myopic subjects although the effect of DF upon the accommodation response has not been examined in detail. The aim of this study is to assess the accuracy of steady-state accommodation responses with DF lenses. Ten emmetropic subjects (mean age 22.3 ± 2.0 years) were fitted with a concentric DF with plano power in the central 3 mm and $+2.50$D in the peripheral zone. The accommodation response was measured continuously with a specially modified infrared autorefractor (SRW-5000, Shin-Nippon) at stimulus levels of 0D, 2D and 4D, while subjects viewed a high contrast Maltese cross target with and without the DF. The steady state accommodation response showed significant variability in the DF condition for the 0D ($p < 0.01$) stimulus level. Frequency spectrum analysis revealed this was due to significantly larger low frequency drift in the accommodation response with the DF. The use of dual focus contact lenses causes inaccuracy in the steady-state accommodation response in emmetropic subjects. It is important that future work examines the accommodation response in myopic subjects when wearing these contact lenses.

[4P2M026] Investigating visual integration in Autism Spectrum Disorders using collinear facilitation with temporal masking

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Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by impaired social interaction. Altered perceptual experiences are also common, possibly due to reduced integration of local information into a global percept. To explore this claim we investigated visual integration in adults with ASD using a collinear facilitation (CF) task. In CF, a faint Gabor target is easier to detect when flanked by high contrast, co-aligned Gabors compared to a no flanker condition. CF is mediated by propagation of excitatory signals from flanker to target cells along horizontal connections in V1 as well as feedback from higher visual areas. To investigate whether horizontal or feedback signals are altered in ASD we manipulated the timing of the flankers relative to the target so that the flankers could either occur before, simultaneously or following the target. CF in the latter condition is more reliant on feedback than the other timing conditions. Both ASD and controls ($n = 24$) showed significant CF for all three timings, which was maximal when flankers and target occurred simultaneously. There were no differences between the two participant groups. These results suggest that for these CF conditions, horizontal and feedback contributions are similar for ASD and control participants.

[4P2M028] The dissociation of different measures of cortical inhibition in the visual system, and their use for non-invasive monitoring of epilepsy susceptibility

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Epilepsy is believed to arise in many cases from deficits in cortical inhibitory mechanisms. Recently, it has been suggested that the psychophysical phenomenon known as surround suppression may reflect cortical inhibition. This raises the possibility that visual psychophysics could offer a non-invasive way of assessing disease state in epilepsy. One theory suggests that the timing of seizures may reflect fluctuations in the quality of cortical inhibition. We recruited 153 healthy volunteer controls and 50 patients with clinically confirmed epilepsy. Two different stimulus paradigms (motion direction discrimination (Tadin et al., 2003) and contrast detection task (Serrano-Pedraza et al., 2012)) were used to derive surround suppression indices. Motion direction discrimination showed a highly significant reduction with increasing age in both groups, but not for the contrast detection task. The two measures of surround suppression were not correlated across populations. Surround suppression indices derived from the motion direction discrimination, but not the contrast detection task, show a significant difference between controls and patients with frequent seizures. Patients with higher frequency of seizures showed higher indices of cortical inhibition. This suggests that the motion discrimination version of surround suppression does indeed capture some aspect of the pathology in epilepsy.
This work is supported by a PhD studentship awarded to Partow Yazdani from Epilepsy Action.

[4P2M030] Exogenous Spatial Attention in Adults with ADHD is Intact

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ADHD is a disorder characterized by maladaptive hyperactive, inattentive, and impulsive behavior. We explored whether exogenous (transient) attention improves orientation discrimination in ADHD and whether it differentially affects processing at locations across the visual field. We tested 14 adults with ADHD and 14 controls (age- and gender-matched) binocularly on a 2-AFC orientation discrimination task. Four tilted Gabor patches appeared briefly along the vertical and horizontal meridians. To manipulate attention, participants were presented with either a valid-cue or a neutral-cue (one or four peripheral precues). Participants reported the orientation of the Gabor indicated by a response cue. Performance was significantly higher and faster for the valid- than the neutral-cue condition for both groups. The magnitude of the attentional benefit did not differ between the two groups. Moreover, both groups exhibited canonical performance fields–better performance along the horizontal than vertical meridian and at the lower than upper vertical meridian–and similar effects of attention at all locations. These results illustrate that exogenous attention remains functionally intact in adults with ADHD.

[4P2M032] Spatial-frequency tuning of the steady-state pattern-onset visual evoked potential: The topography of the "notch"

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Steady-state checkerboard-onset visual evoked potentials are a popular tool for objective testing of visual acuity. Their amplitude-versus-checksize tuning exhibits a so-called "notch" in many subjects, i.e. a reduced amplitude at intermediate check sizes despite the pattern being easily visible. Explanations include superposition of responses from separate cortical sources, resulting in a spatially variable cancellation of the scalp potential. We tested the assumption that some combinations of reference and active electrode should avoid the notch, or a notch at one location might be counterpoised by an increased response at a different location ('anti-notch'). We recorded steady-state VEPs to 7 check sizes with a multi-channel EEG system, computed all pairwise bipolar derivations, and performed frequency-space response extraction. Sizeable notches occurred in 11 out of 41 subjects. Anti-notches were mostly outside the occipital half of the scalp, were small and did not cluster spatially, or check-sizes of notch and anti-notch did not match. Anti-notches thus neither individually nor collectively can serve as a compensation of the notches. Re-referencing, or selecting specific bipolar derivations, does not provide a solution to the notch problem. Assuming the validity of the superposition hypothesis, the results favor global surface cancellation caused by very local combination of cortical sources.
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[4P2M034] Attachment style dimensions are associated with neural activation during projective activity

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Numerous studies show the existence of a neural circuit, frontal and parietal-temporal, involved in the projection, remembering the past and understand the intention of others (Theory of Mind). A recent study, using the tables of the Rorschach, shows the existence of a fronto-parietal neural circuit during the attribution of meaning to these stimuli. However, numerous studies show that the styles of attachment may occur in selective biases toward certain types of emotional information environment. The hypothesis of present study is that the neural correlate in response to stimuli not-structured is modulated by the scores of the attachment dimensions. Electroencephalography activity of 27 subjects was recorded with a 256-HydroCelGeodesicSensor-Net during visual task consists of structured and not-structured figures. Subsequently, the subjects were administered Attachment Style Questionnaire (ASQ). During the presentation of the not-structured figures score of the "Relationships as secondary" was negatively associated with the activation of the limbic areas and the "Need for approval" was negatively correlated with the activation of the prefrontal cortex and limbic areas, no association was found during the presentation of the structured figures The findings demonstrate as attachment style can modulate brain activation during the projective activity in the Rorschach test.
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[4P2M036] What crowding tells about schizophrenia

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Visual paradigms are versatile tools to investigate the pathophysiology of schizophrenia. Contextual modulation refers to a class of paradigms where a target is flanked by neighboring elements, which either deteriorate or facilitate target perception. It is often proposed that contextual modulation is weakened in schizophrenia, i.e., facilitating contexts are less facilitating and deteriorating contexts are less deteriorating compared to controls. However, results are mixed. In addition, facilitating and deteriorating effects are usually determined in different paradigms, making comparisons difficult. Here, we used a recently established crowding paradigm in which both facilitation and deterioration effects can be determined all together. We found a main effect of group, i.e., patients performed worse in all conditions compared to controls. However, when we discounted for this main effect, facilitation and deterioration were well

comparable to controls. Our results indicate that contextual modulation can be intact in schizophrenia patients.

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[4P2M038] What is the underlying nature of the perceptual deficit in adult poor readers?

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It has been suggested that an impairment of the dorsal stream leads to a selective deficit in perceiving global motion, relative to global form, in poor readers (Braddick et al., 2003). However the underlying nature of the perceptual deficit is unclear. It may reflect a difficulty with motion detection, temporal processing, or the integration of local information both across space and over time. To resolve this issue we administered four, diagnostic, motion and form tasks to a large ($N = 150$), undifferentiated sample of adult readers to characterise their perceptual abilities. A composite reading score was used to identify groups of relatively good and poor readers (the upper and lower thirds of our sample, respectively). Results showed that poor readers' coherence thresholds were significantly higher than those of good readers on a random-dot global motion task, but not a static global form task nor a spatially one-dimensional global motion task. Crucially, poor readers were significantly worse than good readers on a temporally-defined global form task, requiring integration across two spatial dimensions and over time. Thus the perceptual deficit in poor readers may be indicative of a difficulty combining local visual information across multiple dimensions, rather than a motion or temporal processing impairment.

[4P2M040] The relationship between visual functions and reading performance in children with reading difficulties

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Learning to read is a milestone during primary school and the foundation for lifelong learning as well as participation in society (OECD, 2010). From a visual perspective reading is a very complex task und it requires the effortless and rapid processing of fine visual details (Hyvärinen, 2013; Trauzettel-Klosinski, 2002). This study aims to explore how children with reading difficulties (3rd – to 5th grade) face reading demands and to assess their visual preconditions for reading. The focus is to examine whether they show specific strategies, which relate to their distinct visual conditions and the properties of the presented reading task. The collection of data covers three dimensions combining quantitative and qualitative measures: vision, reading and strategy use. The analysis of data focuses on exploring intrapersonal as well as interpersonal differences in reading with regard to the assessed visual functions and the specific reading texts. The collected data shows that the visual preconditions of children have to be taken into account when reading difficulties occur.

Vision is commonly taken for granted and the influence of visual functioning on reading is underestimated.

[4P2M042] Changes in amplitude of accommodation for school-age children during the day

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School-aged children spend a lot of time doing near work. Long hours of reading could influence some visual functions, for example, accommodation system and can lead to aesthenopia and fatigue. Other studies showed that reading distance is shorter for younger than older children (Wang, Bao et al., 2013). It means that younger children accommodate more than older children when reading. Taking in account these data we could expect that during the day amplitude of accommodation is reduced more for younger than older children. We wanted to test this hypothesis. Amplitude of accommodation was measured for 7- 15 years old children using subjective push-up technique. For measurements RAF Near Point Rule – a road with movable target – was used. Measurements were done before and after lessons. Distance visual acuity also was measured in both sessions. Results showed that visual acuity does not change significantly during the day. However amplitude of accommodation reduced during the day, in average by 0.8D. Changes were larger for younger than older children. We can conclude that most of children have significant visual fatigue during the day and it is important to control that they take regular visual breaks to rest their eyes.
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[4P2M044] A Mixed-Method Analysis Assessing the Effects of Wearing organic light emitting diode (OLED) sleep mask on Sleep and Psychological Wellbeing

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Organic light emitting diode (OLED) sleep masks are of potential use for slowing the progress of diabetic retinopathy (Czanner et al., 2015) but little is known about their effect on sleep quality and psychological wellbeing. The purpose of this study was to use mixed-methods, using sleep diaries and standardised questionnaires (CESD, GHQ, PSQI) to examine these effects. We ask two questions. 1. What are the similarities and differences between data collected in diaries on sleep quality and quantity, with questionnaire data on sleep, and with automatically recorded mask wearing hours? 2. Does mask wear influence psychological wellbeing and sleep quality recorded in the diaries? We find broad similarities between diary, self-report and mask data. Our preliminary

analysis shows: 1. Mask use was not associated with changes in wellbeing as assessed with questionnaires. 2. The sleep diary showed that mask comfort rather than light was the most important factor in sleep quality. 3. Sleep quality, as recorded in the diaries is affected by mask use in a small number of participants. Our study demonstrates the value of combining sleep diaries with objective and self-report measures of wellbeing, sleep quality and mask usage in evaluating sleep mask acceptability by complementing sleep questionnaires.

Small Business Research Initiative, Health Enterprise East, NHS Midlands and East on behalf of the Technology Strategy Board, United Kingdom

[4P2M046] The Iterative Amsler Grid (IAG): A procedure to measure image distortions in Age-Related Macular Degeneration (AMD)

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Age-related macular degeneration is a major cause of severe visual dysfunction in the elderly. Early detection of the symptoms can be crucial for intervention. One manifestation of the AMD is metamorphopsia – a condition where straight lines are perceived as curvy and wavy. Assessment is usually made with a printed Amsler grid of straight horizontal and vertical lines, where perceptual irregularities indicate a macula problem. In order to quantify the location and severity of distortions, we recently developed a computer-based iterative procedure, where line segments at different grid locations were presented in isolation to be interactively adjusted until they are perceived as straight. The feasibility of the procedure was tested on control participants, who could reliably correct deformations simulating metamorphopsia, while maintaining central fixation. Fixation stability was a challenge, however, for AMD patients with foveal damage, leading to difficulties in completing the task with isolated test fields. In order to facilitate fixation, we developed a new variant of the IAG procedure, where a low-contrast grid – continuously updated to reflect the subjective corrections in each iteration step – is displayed behind the test field to serve a reference, and present some initial data collected with this revised method.

[4P2M048] Neurodegeneration of the optic radiations and corpus callosum in Normal-Tension Glaucoma

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Purpose: There is debate about whether glaucoma is exclusively an eye disease or also a brain disease. To further examine this issue, we used Diffusion Tensor Imaging (DTI) to study white matter integrity in a Japanese glaucoma population. This population has a significantly higher incidence of normal-tension glaucoma, in which optic nerve damage occurs in the absence of the elevated eye pressure that characterizes the most common form of glaucoma.

Methods: We performed DTI in 23 participants with normal-tension glaucoma and 31 age-matched healthy controls. We used voxel-wise tract-based spatial statistics (TBSS) to compare fractional anisotropy (FA) of the white matter of the brain between patients and control group. Results: FA was significantly lower in glaucoma patients: a cluster in the right occipital lobe ($p < 0.05$; FWE-corrected). This cluster may comprise fibers of both the optic radiation (OR) and the forceps major. Additional explorative analysis confirmed involvement of the forceps major, the left and right OR's and the corpus callosum ($p < 0.09$; FWE-corrected). Conclusions: Glaucoma in this specific population is associated with white matter abnormalities in the OR as well as the forceps major. In particular the latter finding suggests cortical neurodegeneration in glaucoma that is hard to reconcile with retinal neurodegeneration.

[4P2M050] Visual performance linked to cortical magnification differences in deaf and hearing adults

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Loss of one sensory modality can result in enhancement of the remaining senses. For example, congenitally deaf adults perform better than hearing adults in many peripheral visual tasks (Pavani & Bottari, 2012). Previous studies have linked visual performance with cortical magnification differences within primary visual cortex (V1) (Duncan & Boynton, 2003; Schwarzkopf & Rees, 2013). We hypothesised that eccentricity-dependent neural differences might also be evident in deaf adults. Participants included fifteen congenitally, profoundly deaf adults and fifteen age-matched hearing controls, all without visual deficits. Cortical magnification functions in V1 were measured in each individual using wide-field fMRI retinotopic mapping ($\pm 72^{\circ}$) to capture the far periphery. Visual performance was compared in the same participants using a 2AFC random dot motion detection task at varying eccentricities. Cortical magnification functions in V1 were shallower in deaf participants, representing relatively greater neural territory devoted to peripheral processing than in hearing participants. Deaf individuals were also more sensitive to motion in the periphery than hearing participants. Differences in the distribution of neural processing across the visual field in V1 may underpin behavioural differences in deaf and hearing adults. These findings provide evidence of plasticity in visual cortex following early profound hearing loss.

[4P2M052] Is adding a new class of cones to the retina sufficient to cure colour blindness?

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New genetic methods have made it possible to substitute cone pigments in the retinas of adult non-human primates. Doing so influences the animals' visual abilities, but so far no studies have unambiguously demonstrated that experimental animals can make new –higher dimensional– colour distinctions. Simply put, it has been shown that animals that underwent gene treatment

can now – in addition to finding a red ball – also find a green ball (on a greyish background). However, it has not been shown that the animals can distinguish a red ball from a green one. For most people, that ability would be the primary reason for wanting to undergo a treatment for colour blindness in the first place, for instance because their colour blindness prevents them from pursuing a specific career. It is important to point out such possible limitations, to avoid unwarranted expectations in both clinicians and patients. To explain the origin of our concerns, we simulate how replacing the pigment of some cones is expected to influence the behavioural tests used so far. The simulations show that these tests do not provide conclusive evidence that the animals acquired the ability to make new higher dimensional chromatic distinctions.

[4P2M054] Perception of Affect from Audiovisual Stimuli in Individuals with Subclinical Autistic-like Traits and Anxiety

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Despite growing evidence of the presence of anxiety in ASD, it remains unclear how this comorbidity modulates the perception of affect. To address this we studied the recognition of affect from face-voice stimuli in individuals with subclinical autistic traits and comorbid anxiety. Auditory (A) stimuli were selected from Montreal Affective Voices. Visual (V) stimuli with duration of around 3 s were extracted from the BP4D Spontaneous Facial Expression database. Audio-visual (AV) stimuli were constructed by combining auditory and visual information. The BP4D face database is new and has not previously been paired with the Montreal Affective Voices. Participants were entered into the study based on their scores on the AQ for autistic traits and the STAI for anxiety. From this a 2 by 2 grouping of high and low autistic traits and high and low anxiety was formed, with low anxiety and low autistic traits as baseline. We examined the ability of participants to identify 7 different affects (neutral, happiness, sadness, fear, anger, surprise and disgust) from A, V and AV stimuli. Data collection is ongoing and preliminary results for the baseline group shows recognition rates of 87%, 57% and 84% respectively for the A, V and AV stimuli.

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[4P2M056] Noise reveals abnormal global integration of motion and form in strabismic amblyopia

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Abnormal motion and form processing along the dorsal or ventral pathway has been reported in amblyopia. In the current study, we attempted to characterise visual processings in both pathways in amblyopia concurrently using equivalent stimuli in the presence of noise. Six anisometropes, six strabismics, and 12 visually normal observers monocularly discriminated the global direction of random dot kinematogram (motion) and orientation of Glass pattern (form) where individual direction or orientation of local elements were drawn from normal distributions with a range of variances that served as noise. Direction/orientation discrimination threshold without noise

was measured first, followed by threshold variance measured at the multiples of the direction/orientation threshold. Overall, the form thresholds were higher than motion thresholds for all observers regardless of the noise levels. The thresholds were modelled to separate the effect of local and global processing in the respective pathways. The analyses showed that anisometropic performance for both form and motion were identical to normal ($p > .5$). Strabismic performance for both form and motion were poorer than the normal eyes ($p < .01$). Nested model testing suggested the poorer performance of the strabismic eyes were due to the deficits in global integration, reflected in the lower efficiency parameter.

[4P2M058] Characterization of an adaptive optics SLO based retinal display for cellular level visual psychophysics

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Adaptive optics scanning laser ophthalmoscopy (AOSLO) can image single photoreceptors in vivo. Due to its scanning nature, visual stimuli can be encoded into the imaging beam with high-speed acousto-optic modulation, thereby creating an acutely focused visual display directly on the retina. Modulation accuracy for benchmark stimuli in a multi-wavelength AOSLO (imaging: 840 nm; stimulation: 543 nm light) was measured using a high-speed Si analog photodetector sampled at 1.25 – 5 Gigahertz. The smallest full contrast stimuli presentable were on the order of 3 pixels across in raster scanning coordinates. Optical modelling confirms that this size would place almost all light within the dimensions of a single cone inner segment diameter. Maximum light intensity contrast for extended stimuli achieved in our setup was $\sim$0.99 (Michelson, or about 355:1), a level limited by the extinction ratio of the acousto-optic device used for optical switching. Residual light leak ($\sim$4.3 cd/m2 at 543 nm, $\sim$4100 rhodopsin isomerizations per second) through these switches likely saturates any rod photoreceptor contribution. Therefore, AOSLO-based microstimulation has enough spatial resolution to drive individual cone photoreceptors in the living eye, allowing investigators to probe the relationship between retinal structure and visual function on single cell level.
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[4P2M060] Auditively induced Kuleshov Effect. On multisensory integration in movie perception

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Almost a hundred years ago, the Russian filmmaker Lev Kuleshov conducted his now famous editing experiment in which an audience was presented with film scenes alternating between a neutral face and several objects/people. It is said that the audience interpreted the unchanged facial expression differently depending on the object. For instance, the face appeared to look sad when juxtaposed with a coffin but hungry when presented next to a soup bowl. This interaction effect

has been replicated and dubbed "Kuleshov effect". In this study we explored the role of sound on the evaluation of facial expression in a movie. Thirty participants watched different clips of faces that were intercut with neutral scenes. The neutral scenes either featured happy music, sad music, or no music at all. This was crossed with the facial expressions of happy, sad, or neutral. We found that while sad music did only have a weak effect on the evaluation of the facial expression, happy music lead participants to judge the face as significantly more happy. We conclude that music can be used as an additional cue to evaluate movie scenes and give meaning to ambiguous situations.

[4P2M062] Visual and haptic detection of mirror-reflected contours and repeated contours within one object versus across two objects

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For vision, detecting mirror-reflectional symmetry across two contours is usually easier if both belong to the same object rather than to two different objects whereas the opposite occurs for repetition (Koning & Wagemans, 2009). We investigated whether the same interaction is found when novel, planar shapes are explored by active touch (haptics). We varied modality (haptics or vision), regularity (mirror-reflection or repetition), objects (one or two) and axis orientation (vertical or horizontal). For both modalities, performance was better overall for mirror-reflection than for repetition. For vision we replicated the interaction between type of regularity and number of objects for both stereoscopic and monocular presentation. In contrast, for haptics there was a one object advantage for repetition as well as for mirror-reflection. Thus the perception of regularity appears to differ across vision and haptics depending on whether the regularity is found within a single object or across different objects. Other modality-specific factors were also important, such as whether the visual stimuli were shown from top-down versus angled views, and whether one versus two hands were used to feel the haptic stimuli. These findings demonstrate the powerful influence of how we acquire information and explore stimuli on our perception of regularity.

[4P2M064] Separate neural representations of visual and haptic object size

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The brain must interpret sensory input from diverse receptor systems to produce explicit estimates of object properties. Consider estimating size from vision and haptics: signals at the retinas, and stretch receptors in the hand, must both be transformed into reportable size estimates. We tested for commonalities and distinctions in the neural representations supporting this. Using fMRI, we measured brain activity during size judgements, while participants either felt objects with the left or right hand, or viewed the same sizes on a screen. Stimulus discriminability was controlled with psychophysical pilot data. Separate MVPA searchlight analyses for vision and haptics identified brain regions meeting three criteria: 1) different sizes produced reliably different patterns of activity; 2) more similar sizes produced

more similar patterns of activity; 3) these criteria held across hands and hemifields. Haptic and visual tasks engaged separate but adjacent frontoparietal regions. Specifically, right parietal cortex represented haptic size irrespective of the hand used, while visual size was more strongly represented in left parietal cortex. These findings reveal object size representations that are abstract (generalised across hand and hemifield), yet specific to each modality. These regions may hold mid-level object representations that mediate between peripheral signals and fully abstract size coding.

[4P2M066] Bimodal perceptual integration facilitates representation in working memory

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Cue integration incorporating multiple sensory modalities is a common process when perceiving natural (multimodal) stimuli. While the perceptual facilitation of multimodal stimuli is thought to result from combining the unimodal cues, the integrative mechanism of multimodal attention and the built-up of a memory representation remain unclear.
The aim of the current study was to investigate the supporting effect of bimodal (visual-auditive) stimulation on the representation in a working memory stage. To assess memory operations quantitatively, we tested participants in a 2-back task with five repetitions (blocks) per modality using a complete within subject design (3 modalities $\times$ 5 blocks). In the unimodal conditions, unfamiliar visual patterns (containing six randomly distributed black dots) and auditive stimuli (chords recorded from a piano and a guitar) were presented in a sequence and participants had to compare each stimulus with the second last one to indicate if they were identical or not. In the bimodal task, both kinds of unimodal stimuli were presented simultaneously. Comparing d-prime values, we found significant improvement (compared to both unimodal conditions) of working memory processing when bimodal stimuli were presented. Further, data show an improvement of task performance over time in each condition.

[4P2M068] The development of the perception of visuotactile simultaneity

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We measured the typical developmental trajectory of the visuotactile simultaneity window by testing adults and four age groups of children (7, 9, 11, and 13 years of age). We presented a visual flash on a LCD screen and a tactile tap to the right index finger separated by various SOAs; participants reported whether the two stimuli were simultaneous or not. Compared to adults, 7- and 9-year-olds made more simultaneous responses when the tap led the flash by 300 ms or more and when the tap lagged the flash by 200 ms or more, and they made fewer simultaneous responses at the 0 ms SOA. The point of subjective simultaneity occurred on the tactile-leading side, as in adults, by 7 years of age. However, the window of visuotactile simultaneity became

progressively narrower from 7 to 11 years of age, at which point it was adult-like. Together, the results demonstrate that the adult-like precision of perceiving visuotactile simultaneity develops after 9 years of age. This developmental pattern is similar to that found for the perception of audiovisual simultaneity (Chen, Shore, Lewis, & Maurer, 2015) except that adult-like performance is reached by age 11 rather than 9 years of age.
This study is supported by James S. McDonnell Foundation and NSERC to DM

[4P2M070] Unfaithful mirror: A new procedure to decrease the sense of ownership and agency of one's own face

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Previous studies have demonstrated that one's own body representation is based on integration of sensory inputs. Illusions emerge from the manipulation of these inputs, such as the Rubber Hand Illusion (Botvinick & Cohen, 1998) and the Enfacement illusion (Sforza et al., 2010). The synchronization between different stimulations (tactile, visual and proprioceptive) is particularly important for these two illusions. The present study introduces a new paradigm verifying if an asynchronous stimulation between sight, touch and proprioception could induce a decrease of the sense of ownership (SoO) and agency (SoA) in relation to one's own face. In this study we compared different types of inconsistency between modalities. Additionally we collected measures of depersonalisation, locus of control, hallucination-proneness and delusional beliefs. Results ($N = 60$) suggest that the SoO and SoA over one's own face is decreased when visual feedback is presented with a delay of a few seconds. Secondly results suggest that an inconsistency between proprioception and sight induces a stronger decrease of the sense of ownership than the inconsistency between touch and sight. Thirdly, contrarily to expectancies, participants high on a depersonalisation continuum seem to have a stronger sense of ownership of their face independently of type of feedback.

[4P2M072] Simulation Fidelity Affects Perceived Comfort

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The effects of change in the qualities of sounds upon comfort are well known, however the effect of fidelity within a simulated environment upon sound comfort is less well documented. This study provides an insight into the effects of fidelity on sound comfort, employing two types of fidelity Audio-Functional and Environmental. Participants carried out a tracking task as described in Meyer, Wong, Timson, Perfect, and White (2012), and filled out a questionnaire to assess presence and comfort. The first hypothesis stated both presence and comfort increase in higher fidelity settings. The second hypothesis put forward that performance in the tracking task would also be affected by the level of fidelity experienced by the participant. An increased level of fidelity did indeed have a positive effect upon presence and comfort ratings both in Audio-Functional and Environmental fidelity. An effect of fidelity was also found on performance with Environmental but not with

Audio-Functional Fidelity. This would indicate that comfort is significantly affected by the fidelity of the setting in which audio stimuli are presented. These results have implications for research testing audio comfort furthering the concept that there is more to assess than only the qualities of the audio in question.
TSB

[4P2M074] Multimodal effects of color and aroma on predicted palatability of semisolid and liquid milk beverages

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We have revealed the effect of color and aroma on "predicted palatability" quantitatively before drinking tea. To reveal the effect of jellies and milk beverages, we used four types of liquids (milk beverages) and four types of semisolids (jellies made of the milk beverages) present on the market as visual stimuli: milk, strawberry milk, green tea soy-milk and coffee with milk. As Olfactory stimuli, we used four types of flavor samples as olfactory stimuli: vanilla, strawberry, green powdered tea and chocolate. These stimuli were evaluated by twenty participants in their twenties. Each visual stimulus was in a plastic-wrapped glass, and each olfactory stimulus was soaked into absorbent cotton in a brown bottle. In the visual evaluation experiment, participants observed one milk or jelly without any olfactory stimulus. In the olfactory evaluation experiment, they smelled a flavor sample without any visual stimulus. Finally, they observed one of the milks or jellies while smelling an olfactory sample in the visual-olfactory evaluation experiment. Evaluated items were "predicted sweetness, sourness, bitterness, umami taste, saltiness", and "predicted palatability". The results show that the weighting factor of color on evaluating "predicted palatability" of milk beverages was smaller than on evaluating "predicted palatability" of jellies.

[4P2M076] Luminance signals interfere with echolocation in sighted people

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Echolocation is the ability to perceive the environment by making sonar emissions and listening to returning echoes. For people, it has been suggested that echolocation may not only draw on auditory processing, but also recruitment of 'visual' cortex (Arnott, Thaler, Milne, Kish, & Goodale, 2013; Thaler, Arnott, & Goodale, 2011). The recruitment of 'visual' cortex for echolocation may be driven by neuroplastic changes associated with vision loss and/or by an individuals' ability to recruit 'visual' cortex for processing of non-retinal input (Thaler, Wilson, & Gee, 2014). Here we used an interference paradigm to further explore the role of 'visual' cortex in echolocation. Specifically, if echolocation relies on co-opting 'visual' cortex, we expect retinal visual signals to interfere with echolocation. Twelve sighted echo-naive participants used mouth-click based echolocation to discriminate sizes of objects. Participants wore black-out goggles fitted with LEDs. The goggles blacked out vision of the environment at all times, but LEDs when

switched on also provided luminance input. Participants' echolocation accuracy scores were significantly reduced in conditions where luminance input had been provided, as compared to conditions where it had not been provided. This result is consistent with the idea that echolocation may draw on recruitment of 'visual' cortex.

[4P2M078] Distinct mechanisms of audio-visual asynchrony adaptation operate over different timescales

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To maintain a coherent percept of the external environment, the brain combines information encoded by different sensory systems. This process however, is complicated by temporal uncertainties, due to different delays in sensory pathways. One way in which the brain appears to compensate for these uncertainties is through temporal recalibration. Both prolonged and rapid adaptation to a regular inter-modal delay alters the point at which subsequently presented stimuli are perceived to be simultaneous. However, it remains unknown how the magnitude and duration of this aftereffect changes with adapting duration. Here, we adapted subjects to a fixed temporal delay (150 ms) between pairs of brief co-localised auditory and visual stimuli (1–512 pairs). Subjects' estimates of perceived asynchrony on subsequent test trials revealed that both the magnitude and duration of induced biases increased with adapting duration. Using an 'adapt-deadapt' procedure, we also investigated whether asynchrony adaptation reflects a single mechanism, or multiple mechanisms operating over different timescales. The perceptual aftereffects of asynchrony adaptation to 512 stimulus pairs were initially cancelled by 32 pairs of deadaptation to an equal but opposite asynchrony, but subsequently reappeared with further testing. Our results suggest that adaptation to asynchronous auditory-visual stimuli involves multiple, distinct mechanisms operating over different timescales.

[4P2M080] A role of cutaneous inputs in self-motion perception (1): Is perceived self-motion equal to an actual motion?

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We recently confirmed that self-motion perception could be elicited by cutaneous stimulation accompanied by vestibular inputs (Murata et al., 2014). The present study further investigated functional characteristics of such cutaneous induced self-motion, particularly with a focus on the influence of actual transfer movement that stimulates the vestibular system. The experimental conditions were: two wind conditions [with or without] serving as a cutaneous stimulation applied to participants' face and two transfer conditions [with (i.e., floor was made to move front) or

without (i.e., vibration alone)] serving as a vestibular stimulation applied to participants' body. A pedestal fan and a DC motor were used for stimulating each system. In experiment 1, participants were asked to press a response button when they perceived self-motion. Onset latency and the accumulated duration of self-motion were measured for each trial. The self-motion was observed in all conditions, with stronger effect for "with" conditions compared to "without" conditions. In experiment 2, participants were asked to point to the perceived direction where they were transferred. The perceived direction was consistent with actual body transfer, coupled with the wind, while it was variable in the "without" transfer. An important role of cutaneous inputs for eliciting forward self-motion was highlighted.

[4P2M082] Auditory Working Memory Modulates Unconscious Visual Processing

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The modulation effects of working memory (WM) on attention and selection have mainly been investigated within visual modality. It remains unknown whether similar WM effects can occur across different sensory modalities. Here we probed this issue by introducing auditory stimuli to a modified delayed match-to-sample paradigm. Participants first held a sound of an animal (dog or bird) in WM and then detected an image of an animal that was rendered temporally invisible by utilizing the continuous flash suppression method. We showed that the animal images matched the sound held in WM emerged from suppression into awareness significantly faster than those did not match. This effect could not be explained by cross-modal priming, as passively listening to these sounds failed to affect the unconscious visual processing. Moreover, the modulation effect was not found when the visual words ("dog" or "bird") rather than the sounds were held in WM, indicating that the observed cross-modal effect might not be mediated by the semantic associations between the auditory and the visual stimuli. Our findings together suggest that the top-down modulation of WM on information processing can operate across different modalities (i.e., vision and audition) independent of semantic association and conscious awareness.

[4P2M084] Difference of impressions on kimono fabrics by LCD view, actual view, and tactile feels

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Electronic commerce using web services has extended in the recent years. This includes sales in the textile industry. Since the commercial value of textile highly depends on its tactile feels, the expression of tactile feels on web sites is an important problem for this industry. This research investigates the difference of human impressions on kimono fabrics in the cases of viewing the digital images of the fabrics on a liquid crystal display, viewing the actual fabrics on a table, and touching the fabrics using their hands. Sixteen Japanese respondents, consisting of seven men and nine women, carried out an experiment for six different kimono fabrics. The respondents were

requested to answer the degree of their impressions on heaviness, thickness, gorgeousness, fineness, for the three cases of viewing or touching. The results show the tendency that viewing some fabrics on an LCD yields significantly heavier and thicker impressions than the other two cases of viewing or touching the same fabrics. It suggests that the material feels of textiles are not sufficiently transmitted via web services and it should be compensated by some method in the electronic commerce of textile.
This work is partially financially supported by JSPS KAKENHI Grant No. 15K00706.

[4P2M086] Hearing through your eyes: modulation of the visually-evoked auditory response by transcranial electrical stimulation

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Evidence is emerging that some people can 'hear' visual events as sounds (Saenz & Koch, 2006). This ability may benefit performance of tasks such as judging whether pairs of 'Morse-code' sequences of flashes match or differ. Here we investigated the neurophysiological basis of this auditory-recoding ability. Twenty participants, including musicians and synaesthetes, received 10 Hz Transcranial Alternating Current stimulation (or sham stimulation) over Occipital versus Temporal scalp sites, while performing a sequence matching task for Visual versus Auditory pairs. On average, occipital stimulation impaired Visual but benefited Auditory performance, relative to sham. Temporal stimulation had the opposite effect, albeit weaker. The above effect of Occipital stimulation was largest in individuals whose performance was most consistent with auditory recoding of flashes (i.e. better Visual relative to Auditory sequencing). Our results suggest, counterintuitively, that the ability to recode flashes as sounds may depend more on occipital than temporal cortex. This is consistent with evidence that occipital stimulation may evoke non-visual phosphenes, such as tongue sensations (Kupers, 2006). This framework tentatively explains why here, occipital stimulation removes the benefit for encoding of visual sequences, but also benefits unimodal auditory sequencing by disrupting competing inputs from extra-auditory areas.
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[4P2M088] Motivation modulates haptic softness exploration

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Haptic softness perception requires active movement control. Stereotypically, softness is judged by repeatedly indenting an objects surface. In an exploration without any constrains, participants freely control the number of indentations and the executed forces. We investigated the influence of motivation and task difficulty on these two parameters. Participants performed a 2AFC discrimination task for stimulus pairs, taken from two softness categories and with one of two difficulties. Half of the participants explored all stimulus pairs from one softness category in one block, allowing expectations on softness category, while the second half of participants explored all stimulus pairs in a random order. We manipulated the participants' motivation by associating a monetary value to each correct response for half of the experiment. In the other half,

performance was unrelated to the payment. We found higher exploratory forces in the high-motivation condition. The number of indentations was influenced by task difficulty and not by motivation. Furthermore, motivational effects were modulated by the existence of softness expectations. Taken together, these results indicate the existence of motivational effects on movement control in haptic softness exploration. Consequently, as executed movements influence the sensory intake, top-down signals affect how we gather bottom-up sensory information.

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[4P2M090] Putting visual reference frames in conflict to study the horizontal effect: a visual anisotropy

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When viewing natural stimuli, people more easily perceive oblique orientations in contrast to horizontal orientations, with vertical in-between, known as "the horizontal effect". Here we investigate if this process changes with head tilt, when the anisotropy in natural scenes changes with respect to retinal coordinates. We used a matched contrast paradigm in which participants changed the scalar of the oriented bandwidth of the test stimulus to match their perception of the bandwidth strength in the reference stimulus. Both test and reference stimuli were noise images constructed by combining random phase spectra with a 0.2–17cpd amplitude spectrum with slope −1, mirroring that in natural scenes. The 45° orientation bandwidth was centered on 0°, 45°, 90°, or 135° for the test stimulus and on 112.5° for the reference stimulus. Participants were seated upright with a head tilt of 45° to the right. Our results show that the horizontal effect can follow either retinocentric or geocentric coordinates with head tilt, depending on the subject. This suggests that the anisotropy of gain control in the horizontal effect is not 'hard-wired' in early visual orientation encoding, but rather is a plastic mechanism that is influenced by subjects' perceptual response to head tilt.

University of Louisville GSC Research Fund Grant

[4P2M092] An fMRI study investigating the contribution of visual features to an intersubject correlation (ISC) of brain activity during observation of a String Quartet

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This study used fMRI to explore the brain response of 18 novice observers during audiovisual presentation of a string quartet with free viewing of the stimulus. The string quartet was presented visually as a group of four stick figures of the upper body, observed from a static viewpoint. The quartet 'Quartetto di Cremona' performed a 114 second segment of the allegro of String Quartet, No 14 in D minor by Schubert. These data were initially analysed using inter-subject correlation

(ISC), which showed ISC across observers in auditory, visual and visual motion regions (BA37). The ISC in visual motion regions was unexpected due to the free viewing of observers but could be explained if the physical motion of every musician was correlated to brain activity in the visual motion region. To explore this, we regressed bow velocities of individual musicians and the average of all four bows against brain activity and results confirmed that each musician individually as well as the average correlated with the visual motion region. Finally, it was found that loudness, a feature known to covary with speed on stringed instruments also correlated with the visual motion region, raising the possibility of multisensory contributions to this visual activity.

[4P2M094] Changing depth cue reliance by playing videogames

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We tested the cue reliance of regular videogame players (VGP, N = 21) and those who do not play (NVGP, N = 13). We used stimuli where stereo, texture and outline cues sometimes conflicted (Buckley & Frisby, 1993) and found VGPs relied more on stereo cues in cue-conflict stimuli than NVGP. This finding seems counterintuitive, as videogames are rich in monocular not binocular depth cues. We then took a group of NVGP (N = 14) and measured their cue reliance before and after playing videogames, one game was rich in monocular cues (QUAKE) the other was not (TETRIS). Games were played on a monitor at the same distance as the cue reliance test. We found that 30 minutes of playing either game changed the cue reliance in the direction of VGPs. The cue content of the games appeared unimportant and we suggest the changes are simply due to adaptations to the display distance. We discuss our findings in context of Shah et al (2003) who found stereo cue reliance similar to our VGP group in laparoscopic surgeons and Rosser et al (2012) who found improved performance on a laparoscopic surgery trainer if preceded by 6 minutes of videogame play.

[4P2M096] Ocular Accommodation and Depth Position in Depth-Fused 3D Visual Perception

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Stereoscopic image perception is due to physiological factors of depth perception, such as binocular parallax, convergence, accommodation and motion parallax. For a natural 3D display, we have found depth-fused 3D (DFD) visual perception (Suyama et al., 2004). In DFD perception, two images that differ only in luminance and are displayed at the front and rear planes are perceived as a single image at one depth. We perceive a continuous depth change when the luminance ratio between the two images is continuously changed according to the 3D image depth. We perceive 3D images between the two planes. It is known that DFD images are

fatigueless (Ishigure et al., 2004) and cause motion parallax (Takada et al., 2007). However, the accommodation has not been clarified. In this study, we examined the accommodation mechanism and verified that it is used during viewing of DFD images. We measured accommodation in subjects who gazed at DFD images.
As a result, it is suggested that the changes in luminance were perceived such that the DFD image approached and moved the accommodation focus. This trend was seen in the young and middle aged subjects. In the future, we will develop a natural telecommunication system using DFD perception.

[4P2M098] Luminance prevailed over disparity in depth discrimination

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To understand how the visual system combines monocular and binocular cues in depth perception, we investigated the effect of luminance gradient (monocular cue) on disparity (binocular cue) discrimination. The stimuli, designed to simulate a uniform corrugated surface under diffuse illumination, had a sinusoidal luminance modulation (0.26 or 1.8 cy/deg, contrast 20%–80%) modulated either in-phase or in opposite phase with a sinusoidal disparity of the same corrugation frequency. The disparity amplitudes ranged from 0'–20'. We used a two-alternative forced-choice paradigm, in which two stimuli with different disparities were presented simultaneously in each trial. The participants were to choose the one with greater depth contrast. Depth discrimination threshold was measured at 75% accuracy with a dynamic staircase algorithm (Kontsevich & Tyler, 1999). In the no luminance cue condition, which used a random dot stereogram rather than a sinusoid grating, thresholds increased monotonically with disparity. When luminance gradient was introduced, thresholds were greater than the no-luminance condition and stayed the same across all disparity levels. This result suggests either that the presence of the luminance cue inhibited the disparity mechanism or that the observers used a combination of luminance and disparity for depth discrimination with the luminance cue in the dominating role.
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[4P2M100] Differential sensitivity to surface curvature polarity in 3D objects is not modulated by stereo disparity

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It has previously been shown that observers are more sensitive to detecting changes in concave relative to convex curvature in the bounding contour of 2D shapes. Here we examined two related issues: (1) Whether this differential sensitivity to curvature polarity extends to the surfaces of three-dimensional (3D) objects, and (2) whether the detection of surface curvature polarity is modulated by stereo disparity. We created 3D rendered 'asteroid like' stimuli, keeping the silhouette constant but modifying part of the object surface by either introducing, removing,

extending or reducing a new concave or convex region. In two separate experiments, we asked participants to discriminate between two sequentially presented 3D shapes under either mono or stereo viewing conditions. The results showed that, analogous to curvature detection in 2D bounding contour, participants are significantly better at discriminating between objects if changes occur in a concave region compared to a convex one. We also found observers to be significantly more accurate at detecting changes when curved regions were introduced or removed in comparison to when these were extended or reduced in magnitude. Surprisingly, we found no viewing condition effect. These findings provide further evidence of the functional status of concave regions in 3D shape representation.

[4P2M102] The effects of 2-D and 3-D configuration on stereoscopic depth magnitude percepts

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The perception of closure in a stereoscopic figure degrades suprathreshold depth estimates; this disruption can be eliminated by manipulating grouping cues that contribute to the percept of a closed figure. Here, we systematically evaluate the impact of specific 2-D contextual properties including connectedness, collinearity, and proximity to understand their role in this phenomenon. Concurrently, we assessed their interaction with a new stereoscopic grouping principle 'good stereoscopic continuation'. We used closed rectangular stimuli and systematically varied 2-D and 3-D contextual cues. In all conditions, observers estimated the amount of depth between the vertical edges of the rectangle viewed in a stereoscope. Our results show that the dramatic effects of closure on perceived depth do not require that the lines are physically connected, but critically depend on the degree of collinearity and location of the horizontal connector. Both collinearity and corners (L-junctions) are necessary to create the percept of a closed object, and reduce depth estimates. Importantly, these effects critically depend on the presence of good stereoscopic continuation (a 3-D grouping cue). Taken together, our results highlight the often-neglected role of stereoscopic depth in the perception of object form.
NSERC grant to Wilcox; Trillium Foundation Grant to Deas

[4P2M104] Fusional demand and stereoacuity

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Fine stereopsis is dependent on a number of factors, including the requirement that both eyes share a common visual direction, controlled using motor fusion. Varying the level of fusional demand may affect stereoacuity; we aimed to investigate this by adjusting visual alignment using a clinically used mirror stereoscope (synoptophore). A synoptophore was modified by adding LCD monitors in order to assess dynamic and static stereopsis under zero and controlled fusional stress. A 4-spatial AFC adaptive procedure was used to measure thresholds for foveally presented stimuli (1 s duration). Stereoacuity was defined by fitting a psychometric function (Weibull) to the data, using the 72.41% correct response as threshold. Fourteen Subjects (aged 18–28) out of 40

assessed were able to provide a reliable result in each condition tested and included in analysis. Mean (SD) in arc seconds for Static and Dynamic in the unstressed conditions were: 99(56) and 37(19), and in the stressed conditions, 80(21) and 31(21). Our main finding was fusional stress did not affect stereoacuity level ($p = 0.154$ (2-Way ANOVA)), and dynamic cues lead to better thresholds than static cues ($p < 0.001$). There was no significant interaction ($p = 0.44$).
If an individual's eye alignment is well controlled, it is unlikely to affect stereoacuity levels.
This work was supported by the Economic and Social Research Council grant number ES/J500094/1

[4P2M106] Reformulating Motion Parallax as a source of 3-D information

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Reverspectives provide compelling evidence that perspective information can overrule disparities in the perception of 3-D structure (Rogers and Gyani, 2010) but the role of motion parallax in Reverspectives is unclear. The similarity of motion parallax and binocular stereopsis as sources of 3-D information suggests that the parallax created by Reverspectives is similarly overruled by perspective (Papathomas, 2007) but this assumes that objects remain stationary during side-to-side head movements. Using 'virtual' Reverspectives, where we can independently manipulate both disparities and parallax motions, we found that the visual system makes no such 'stationarity' assumption. However, parallax motions are not merely subordinated by perspective information. Rather, they increase both the amount and vividness of the perceived depth, compared to static viewing. Moreover, when the perspective information is weak and stationary observers perceive the 3-D structure specified by the disparities, the depth switches as soon as the observer begins to move and observers perceive the 3-D structure specified by the weak perspective. These results suggest that motion parallax is not just a powerful source of information about 3-D structure but is better understood as a variant of the KDE rather than a strict analogue of binocular stereopsis.

[4P2M108] Closed loop accommodation response to step changes in disparity vergence upon stereoscopic displays

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Stereoscopic displays present unnatural stimulus demands for accommodation and vergence. The aim of the present study was to measure the closed loop accommodation response to step changes in disparity vergence on a stereoscopic display.
Ten young adult subjects (mean age: 21.3 ± 2.4 years) with normal visual function participated. The stereoscopic display (Zalman ZM215W) presented a high contrast Maltese cross target at 40 cm with disparity vergence demands of 6Δ of convergence or divergence presented in a random order at 10 s intervals. Vergence responses were measured continuously using an infrared limbal reflection eyetracker (Skalar IRIS 6500 Simulink) while accommodation responses were recorded continuously and simultaneously with a specially modified infrared, open field autorefractor (Shin-Nippon SRW-5000).

A small (mean $\pm$ sd 0.49 ± 0.17D) but significant ($p < 0.01$) step response of accommodation was noted for both convergent and divergent disparity stimuli. During the subsequent 10 s fixation period, the accommodation response drifted back to the original level in both conditions. Disparity vergence responses induce changes in phasic accommodation in the absence of any accommodation stimulus. When the vergence response is maintained, the accommodation system returns to the response level required for the display position. Stereoscopic displays produce paradoxical responses in the accommodation system through the vergence accommodation crosslink.

[4P2M110] The contribution of motion to shape-from-specularities

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To infer the 3D shape of an object, the visual system often relies on 2D retinal input. For ideal specular surfaces, the retinal image is a deformation of the surrounding environment. Since many configurations of shape and environment can potentially generate the same retinal image, 3D specular shape estimation is ambiguous. A relative motion between object, observer and environment produces dynamic information on the retina, called specular flow. From a computational point of view, this specular flow may diminish perceptual ambiguities. For this research, two novel, smooth shapes were rendered with two different environment maps (a forest and a city) and under two motion conditions (static and dynamic). In the dynamic condition, the surface and the observer were kept relatively static, but the surrounding environment map was rotated at sinusoidal speed around the vertical axis, generating 'flowing' reflections on the surface. Eight observers performed the gauge figure task (attitude probe) with these stimuli. The analysis of variance indicated that both inter-observer correlations and correlations with the 3D input model were higher for the static presentation than for the dynamic one. Results imply that specular flow, despite offering a computational advantage, is not beneficially used by the human visual system.

[4P2M112] The impact of active shutter glasses viewing upon horizontal motor fusion amplitudes

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Much of the literature evaluating the impact of viewing stereoscopic displays upon binocular functions has focused upon passive methods of presentation (Emoto et al., 2004, Fortuin et al., 2011, Wee et al., 2012). The aim for this study was to evaluate any change in fusional amplitudes under dichoptic viewing conditions through active shutter glasses (ASG), compared to free space and to conditions of reduced luminance without active shutter alternation. 15 visually normal participants (mean age 22.56 ± 1.16 years) had their horizontal motor fusion break and recovery amplitudes measured at 75 cm, while viewing a superimposed white H (right eye) and E (left eye)

letters in free space, through ASG, and through 5% LTF spectacles. Base in (BI) fusional break/recovery amplitudes were reduced when wearing ASG or 5% LTF spectacles (median decrease = 4Δ, p = 0.005 for active shutter glasses, p = 0.006 for 5% LTF spectacles). Amplitudes did not significantly vary between the ASG and 5% LTF spectacles viewing conditions. Increasing esophoria is associated with poorer BI fusional amplitudes (rho = −0.663, p = 0.007). Esophoric individuals may therefore be likely to have visual discomfort in association with stereoscopic viewing via this medium.
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[4P2M114] The contributions of various aspects of motion parallax when judging distances while standing still

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Even when standing still, moving one's arm to indicate the position of an object causes head movements that provide cues about the distance to the object. Three cues can be identified: the eye-movements needed to fixate the object, the orientation of the object with respect to the line-of-sight, and the object's position in the retinal image with respect to the background. These cues might be particularly useful in the absence of binocular vision. Is this so for any of them? Participants indicated the position of a virtual target that was either presented binocularly or monocularly. The position and size of the target changed across trials, with pairs of trials in which the same target was presented at the same location, except that one or more of the three above-mentioned cues indicated that the target was either 10 cm nearer or further away. Results indicate that presenting the three cues together explain about 11% of the judged distance under monocular conditions but only 2% under binocular conditions, although participants did not move their heads more in monocular conditions. For monocular targets, when the three cues were presented in isolation their combined effects were much smaller than when they were presented together.
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[4P2M116] The Dimpled Horopter Explained by the Strategy of Binocular Fixation

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The deviation of the empirical Retinal Corresponding Points (RCP) from the geometrical ones has the perceptual role of easing the solution of the stereoscopic matching problem, improving binocular vision (Howard & Rogers, 2002; Schreiber et al., 2008). From this perspective, the

actual perceived disparities are likely to play an important role in the development of these correspondences. Exploiting a purposely designed database of binocular fixations (disparity patterns and stereo-images), we obtained the Mean Disparity Pattern (MDP) experienced by a fixating observer in the near space. The MDP was exploited as a plausible RCP pattern to derive the 3D Empirical Horopter (EH). Uniform distributed fixations result in flat, tilted top away EH, according to experimental deviations. To analyze more natural fixation distributions, we obtained binocular saliency maps by eye movement recordings of three subjects during free exploration of the stereoimages. The EH derived from a "saliency-weighted" MDP preserves similar characteristics in the peripheral field of view, but exhibits a dimpling in its central part, in agreement with experimental observations (Fogt & Jones, 1998). The obtained result points out a possible influence of the fixation strategy on the RCP development, strengthening the local shift versus the flattening hypothesis (Hillis & Banks, 2001).

[4P2M118] A computational model for stereopsis and its relevance to binocular rivalry

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We present a global computational model for stereopsis, which derives from our earlier idea (Geier, 1998). One fundamental constraint is introduced to substitute for all the numerous constrains employed by conventional approaches (ordering, smoothness, etc.). A 3D object is searched directly that corresponds best to the texture of both the left and right images. This is similar to Gregory's (1970) object hypothesis: the visual system hypothesises such possible 3D objects and selects the best-fitting one. This correspondence is measured by surface constraint: if the two retinal images of a given stereo-pair are projected to the surface of the original 3D object, then the projected images will perfectly overlap on the regions of the object's surface. The computational goal is to find the 3D surface that provides the best satisfaction of surface constraint. Surface constraint provides an exact criterion for testing the solution of stereopsis: if and only if the true 3D surface is found, then the correlation between the two images projected on the surface is 100%. Therefore, no other constraints are necessary. If no such corresponding 3D surface is found, binocular rivalry occurs, which, in the present theoretical framework, is merely a side-effect of not finding the correct object-hypothesis.

[4P2M120] The effect of viewing angle on visual crowding

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The ability to recognise objects is strongly influenced by the presence of neighbouring objects (flankers), a phenomenon known as visual crowding. Changes to the viewing angle of a crowded configuration can alter the relationship between the target and flankers in several ways; the relative disparity, perceived size and spatial separation between the target and flanker stimuli are all modified. Individually, these changes have previously been shown to differentially influence the degree of visual crowding. Here we investigate the combined effect of these factors by changing the orientation of the object surface. Visual acuity was measured using Tumbling E optotypes

presented in isolation (isolated acuity-IA) or in a row of five (crowded acuity-CA). Isolated and crowded acuity were measured over a range of viewing angles (−60 to 60 deg) at fixation and 3 deg below fixation. Our results show that while isolated acuity, crowded acuity and the spatial extent of crowding increased with viewing angle, crowding ratios (CA/IA) were relatively invariant to the orientation of the object surface. The retinal image transformations that accompany changes in the orientation of the object surface provide a good account of our results.
This is a summary of independent research funded by the National Institute for Health Research (NIHR)'s Postdoctoral Fellowship Programme. The views expressed are those of the author(s) and not necessarily those of the NHS, the NIHR or the Department of Health

[4P2M122] James Jurin (1684–1750): A pioneer of crowding research?

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James Jurin wrote an extended essay on distinct and indistinct vision in 1738. In it he distinguished between 'perfect', 'distinct' and 'indistinct vision' as perceptual categories and his meticulous descriptions and analyses of perceptual phenomena contained observations which are akin to crowding. Remaining with the concepts of his day, however, he failed to recognize crowding as separate from spatial resolution. We present quotations from Jurin's essay and place them in the context of the contemporary concerns with visual resolution and crowding.

[4P2M124] Investigating scene feedback to foveal and peripheral V1 using fMRI

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Object and scene information can be recovered from non-stimulated foveal and peripheral V1 cortex, respectively (Williams et al., 2008; Smith & Muckli, 2010). These findings demonstrate feedback to V1. Scene feedback to foveal rather than peripheral cortex remains unexplored. In an fMRI experiment, we presented three scenes, with either the central or lower-right portion occluded by a mask, or both. This prevented scene-specific feed-forward stimulation of foveal, peripheral, or both cortical regions respectively. Therefore, we could examine feedback to these regions. Using SVM classifiers, we decoded scene information in non-stimulated foveal and peripheral regions, either with one or both portions occluded.
We replicated scene decoding in non-stimulated peripheral V1. We could also decode scenes in non-stimulated foveal cortex. In both regions, decoding was possible with the double occluder. Further, the presence of the foveal occluder could be classified in occluded peripheral V1. Nonetheless, double and single occluder patterns remained generalizable, as training the classifier in peripheral V1 with a single occluder enabled successful scene decoding with a double occluder.
We suggest that both foveal cortex and peripheral V1 receive scene feedback, and that feedback to peripheral V1 is influenced by, but is not critically dependent upon, processing in foveal cortex.

[4P2M126] Eigen-Adaptation and Distributed Representation of 2-D Phase, Energy, Scale and Orientation in Spatial Vision

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Distributed representations (DR) of cortical channels are pervasive in models of spatio-temporal vision. A central idea that underpins current innovations of DR stems from the extension of 1-D phase into 2-D images. Neurophysiological evidence, however, provides tenuous support for a quadrature representation in the visual cortex, since even phase visual units are associated with broader orientation tuning than odd phase visual units (J.Neurophys.,88,455–463, 2002). We demonstrate that the application of the steering theorems to a 2-D definition of phase afforded by the Riesz Transform (IEEE Trans. Sig. Proc., 49, 3136–3144), to include a Scale Transform, allows one to smoothly interpolate across 2-D phase and pass from circularly symmetric to orientation tuned visual units, and from more narrowly tuned odd symmetric units to even ones. Steering across 2-D phase and scale can be orthogonalized via a linearizing transformation. Using the tilt-after effect as an example, we argue that effects of visual adaptation can be better explained by via an orthogonal rather than channel specific representation of visual units. This is because of the ability to explicitly account for isotropic and cross-orientation adaptation effect from the orthogonal representation from which both direct and indirect tilt after-effects can be explained.

[4P2M128] The role of crowding in Object Substitution Masking

Sarah Camp and Michael Pilling
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Object Substitution Masking (OSM) is a phenomenon wherein a surrounding mask (typically four dots) that onsets with a target but lingers after its offset can significantly reduce target perceptibility. OSM was originally claimed to be effective only when the target was not the focus of attention, i.e. when presented in large set-size displays (Di Lollo et al., 2000). The increased number of distractors was argued to influence time taken for focal attention to reach the target. More recent evidence however found OSM to be independent of set-size once constrained performance in the smallest set-size condition was accounted for (Argyropoulos et al., 2013; Filmer et al., 2014a). We recently replicated the set-size effect in OSM; importantly though this effect was found to be an artefact of crowding at larger set-sizes (Camp & Pilling, ECVP 2014). Here we further explore this crowding effect. In four experiments we show that crowding interacts with OSM irrespective of set size; and scales with eccentricity as is characteristic of crowding. The pattern of the crowding interaction with OSM shows parallels with the phenomenon of "supercrowding" (Vickery et al., 2009). The findings are discussed in terms of the position of OSM within the hierarchy of object processing.

[4P2M130] Both character size and spacing affect readability of Japanese

Koichi Oda, Madoka Ohnishi, Terumi Otsukuni and Aoi Takahashi
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Purpose: To investigate the effects of character size and spacing in reading Japanese texts by manipulating aspect ratio and spacing of characters. Methods: Twenty five participants read aloud 30-letter long easy-to-read Japanese sentences printed with a variety of fonts as quickly and precisely as possible. Stimulus fonts were based on the IWATA UD Gothic and its width-to-bounding box ratio was varied from 64% to 100% as well as the edge-to-edge character spacing being varied from 0% to 20%. Reading speed was measured for a range of print sizes and three readability indexes, ie, maximum reading speed(MRS), critical print size(CPS), reading acuity(RA) were calculated and compared among different font settings.
Results and Discussion: All three indexes were largely affected by character spacing and weakly by the aspect ratio. In large, character spacing influenced RA and CPS positively, but MRS negatively. When center-to-center spacing was fixed, aspect ratio showed no effect on RA except 64% beyond which size seemed effective. Moreover, our finding showed systematic effect by edge-to-edge spacing rather than center-to-center spacing. Results indicated not only spacing but also size affect readability.
none

[4P2M132] Mixed percepts within binocular rivalry for luminance- and contrast-modulated gratings

Jan Skerswetat, Monika A. Formankiewicz and Sarah J. Waugh
Anglia Ruskin University, UK; Anglia Ruskin University, UK; Anglia Ruskin University, UK

During binocular rivalry, contrast-modulated (CM) gratings with correlated binary noise generate mainly mixed rather than exclusive percepts (Skerswetat et al., 2014, VSS-poster). Mixed states comprise piecemeal and superimposed percepts, which may reflect different levels of binocular integration. We investigated the composition of the mixed percepts and the effects of different noise correlations for binocular rivalry of luminance-modulated (LM) and CM gratings. Orthogonal LM and CM gratings were presented dichoptically with correlated, uncorrelated, and anti-correlated binary noise. The stimuli were 2 degrees in diameter and the spatial frequency was 2c/deg. Participants had to indicate via button presses whether an exclusive, piecemeal, or superimposed percept was seen. Visual exclusivity for LM-stimuli was significantly higher [$p < 0.05$] for all noise conditions compared to CM-stimuli. Visual exclusivity was also higher with uncorrelated and anti-correlated noise than with correlated noise [$p < 0.05$], especially for CM-stimuli. The proportion of piecemeal (rivalry) within the mixed percepts was higher for LM than for CM-stimuli. The highest proportion of superimposed percepts, which imply binocular integration rather than rivalry, was found for CM-stimuli with correlated noise. The results suggest that CM-stimuli might be processed in a visual area that receives more binocular input than the site processing LM-stimuli.
Jan Skerswetat was funded by the Anglia Ruskin University, Faculty of Science and Technology, Ph.D. research studentship and Evelyn Trust.

[4P2M134] Sensory limitation on reading speed: individual differences and experience-dependent changes

Deyue Yu
Ohio State University, USA

Visual-span size imposes a bottom-up sensory limitation on reading speed (Legge, 2007). The supporting evidence was mainly obtained by varying stimulus properties and making within-subject comparisons. Here we investigate whether individual differences in reading speed for text with fixed stimulus properties can be attributed to sensory differences, and whether experience-dependent changes in visual-span size can account for corresponding changes in reading speed. Six groups of subjects participated (a no-training group and five groups trained on letter recognition with different procedures at 10° in the lower field). Reading speed and visual-span size were measured in a pre- and a post-test at 10° in both lower and upper fields. We found a significant correlation between pre-test visual-span size and reading speed for both locations ($r \geq 0.45$, $p \leq 0.003$). Recognizing one extra letter per fixation is associated with a 29% faster reading speed. There is also a significant relationship between post-pre changes of visual-span size and changes of reading speed ($r \geq 0.37$, $p \leq 0.02$). Reading speed increases by an extra 25% for each additional letter improvement in visual-span size. These results indicate that both individual differences and experience-dependent changes in reading speed can be partially accounted for by the differences or changes in sensory limitations.

[4P2M136] Perceptual cancellation of stimulus saliency under dichoptic viewing conditions

Malte Persike and Guenter Meinhardt
Johannes Gutenberg University Mainz, Germany; Johannes Gutenberg University Mainz, Germany

When different stimuli are presented to each eye the resulting percept is typically an unstable mix of different parts from each stimulus. Normally, the composition of the percept mutually exclusive between stimuli. One of the notable exceptions to this rule of mutual exclusivity is abnormal fusion (Wolfe, 1983), as observed with briefly presented stimuli. We use such abnormal fusion to hide target shapes in plain sight. Stimuli were composed from Gabor micropatterns, geometric singletons (square/circle), or coloured discs. Target stimuli contained a highly salient object shape, defined by feature contrast against homogeneous backgrounds. Feature contrast was, however, reversed between eyes. When presented dichoptically, perceptual fusion of both stimuli would therefore attenuate target saliency up until complete invisibility, whereas normal rivalry would leave the target shape visible. We find marked anisotropies in target salience for different between-eyes configurations of target definition. Anisotropies did not depend on presentation time (150 ms/850ms). Target detection performance dropped to chance in many conditions even when each eye was presented with a perfectly visible target object. Our results can neither be explained by abnormal fusion nor by normal rivalry alone and point to higher-level influences on stimulus saliency under dichoptic viewing conditions.

[4P2M138] Blur adaptation, blur sensitivity and visual load

Anete Pausus, Laura Strautina, Peteris Cikmacs and Gunta Krumina
University of Latvia, Latvia; University of Latvia, Latvia; University of Latvia, Latvia; University of Latvia, Latvia

Blur is an important dimension of the image quality. It is important to increase the knowledge about the perception of blur because of its relevance to visual acuity, control of accommodation and other visual functions. The aim of our study was to find out how the blur adaptation influences the blur sensitivity and to evaluate the effect of visual load on the blur sensitivity because of its connection to accommodative functions. We evaluated different blur perception thresholds (just noticeable blur, target recognition, clear image perception) as blur level was gradually changed before and after additional adaptation to optical defocus. Gaussian blur filter was used to simulate different blur levels. We compared the blur sensitivity before and after at least 5 hour long visual load at near distance (reading) to evaluate the effect of visual load to blur sensitivity in our study. The results showed that adaptation to optical blur (1.0 D simulated myopia) increased blur sensitivity. Thus it decreased blur thresholds by 10 – 48% according to specific threshold and refractive group. We did not observed statistically significant change in the blur sensitivity after near distance visual load.
Supported by ESF project No.2013/0021/1DP/1.1.1.2.0/13/APIA/VIAA/001

Symposium – Machine vision

[4S1A001] General-Purpose Models in Biological and Computer Vision

James Elder
entre for Vision Research, York University, Canada

The early days of computer vision were fired with an ambition to build impressive general-purpose vision systems. In these times there was a keen interest in understanding how biological systems operate so gracefully over a wide range of tasks and diverse conditions. As the full complexity of visual inference became apparent, the field of computer vision matured and become channelled into relatively narrow sub-problems. While leading to algorithms that actually work for some important applications, this has been at the expense of broader thinking about general-purpose vision systems. In this talk, I will argue that due to the combinatorial complexity of visual scenes, images and tasks, successful general-purpose vision systems, whether biological or machine, will have in common a generative core in which internal representations are determined not only by the task but also by the physical invariants and statistical structure of the visual scene. To illustrate, I will briefly discuss problems in perceptual organization, shape perception, linear perspective and spatial attention where generative models can play a central role and where research in biological and computer vision has been synergistic. I will also suggest a number of areas where opportunities for such synergy appear to be on the horizon.
This work is supported by NSERC and CIVDDD.

[4S1A002] Modelling Scene Structure: Vision as Inverse Graphics

Christopher K. I. Williams
University of Edinburgh, UK

The basic task of the sensory system (including the visual system) is to learn about the structure of the observed world. This problem can be phrased as one of building statistical models to represent an image in terms of primitives and their associated latent variables. A long-standing view of computer vision is that it is the inverse of a computer graphics problem, i.e., to infer the objects present in a scene, their positions and poses, the illuminant etc. In the language of machine learning, these quantities are latent variables which must be inferred in order to understand the scene. Recent work (see e.g. Kulkarni et al., 2015) is reviving this old idea, which can be formalized in terms of the Helmholtz machine architecture (Dayan et al., 1995). This incorporates a recognition model transforming the image into latent variables, and a generative model going the other way. Training of the recognition model can be greatly facilitated by using computer graphics models of scenes, for which the latent variables are known. Here one can use recent developments in image analysis like deep convolutional neural networks (Krizevsky et al., 2012) to obtain the best recognition network performance.

[4S1A003] Human in the loop computer vision

Gabriel Brostow
UCL, UK

Despite ubiquitous computing, most normal people are not benefiting from advancements in computer vision research. Equally, most vision systems do not improve with time or learn from their users' experience. This is a terrible waste, but is understandable: there are plenty of specific vision problems where progress a) can be made "offline" in labs trying to beat a recognized benchmark score, and b) the specific problem affects a big industry, like scene-flow for cars, or image-retrieval for search engines. In this talk, I advocate that we should be aiming for responsive algorithms, and that these should be measured in terms of accuracy-improvement, and the user's ability to perform their specific tasks. This means we will need new benchmarks, and that we need to engage with real users for our models and experiments to be meaningful. While my group has started making software that adapts to specialist users, e.g. biologists/zoologists, the ageing population is just one mass-scale cohort that will require new computer vision models and interfaces.
EPSRC and ZSL

[4S1A004] The evolution of Computer Vision

Richard Bowden
University of Surrey, UK

The area of computer vision has evolved considerably over the years. From its early routes in AI, it has moved from engineering through to machine learning and big data. While datasets are abundant and performance on specific tasks increases each year, there remains one fundamental truth: that machines cannot understand and reason about what they see in the way that humans do. This talk will look at the state-of-the-art in computer vision from both my own research and the wider academic community covering topics such as tracking, object and activity recognition and interpreting the actions of humans. The state-of-the-art in computer vision relies heavily upon supervised learning and while deep learning has demonstrated huge performance gains over the

last few years, the semantic gap remains. It is evident that learning is the way forward, but the questions of how we achieve this in terms of lifelong learning and high level reasoning at a linguistic level remain open research questions. This talk will not propose solutions to unifying human/machine vision but attempt to stimulate discussion about the common research questions such as higher level reasoning, context and language which we take for granted and machines have yet to master.

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Symposium: Colour Constancy

[4S1B001] What we mean by colour constancy and how to study it

Alexander Logvinenko
Department of Vision Sciences, UK

The colour of an object apparently changes with its illumination implying that strictly speaking colour constancy is a myth. Specifically, illumination changes the whole colour palette. Q1: Why do we call it constancy? A1: Because the inner (hue component) structure remains same. Q2: What underlies an asymmetric object-colour match? A2: As across-illuminant match is impossible, it is not a match. It is a correspondence between the colour palettes corresponding to the different illuminants. It is based on the equality of component hue weights. Q3: Does colour constancy exist? Does the colour of an object retain the same hue component weights when the illumination changes? A3: No. Metamer mismatching causes an unavoidable (colour) shift in these. Q4: What to measure? A4: The colour shift caused by illuminant alteration; i.e. the transformation of the colour of an object induced by illumination. Q5: Can such measurement be done using pictorial displays? A5: No. Pictures are objects of dual nature. They are intrinsically ambiguous. A pictorial image of an object loses some important features, which makes it different from its real prototype. Thus, being special, pictorial perception deserves study on its own, but will tell us little about the perception of real objects.

[4S1B002] Confessions of a Constancy Index Junkie

David Brainard
University of Pennsylvania, USA

Each speaker was asked to identify key questions related to color constancy and provide opinions, with the hope of encouraging lively discussion. Thus: Q1) Why do we call it constancy, when the perception of object color is not in fact perfectly constant? A1) It is useful to situate our understanding of color within the framework of its functional value. The rubric of constancy helps with this. Q2) Should we be interested in color appearance or color performance? A2) Both, and how they are related. Q3) What should the field be trying to achieve? A3) Ultimately, we want a computable model that predicts appearance and performance for any scene, without handwaving. Q4) What do instructional effects tell us? A4) Instructional effects tell us either that there are multiple modes of color appearance or that subjects can reason about what they see, but not which. We need to find better methods and move beyond instructional effects. Q5) Do graphics stimulations produce the same effects as natural scenes? A5) Not yet. Q6) Should we

therefore abandon graphics simulations as stimuli? A6) No. Results obtained for simplified stimuli allow identification of principles that may help us tackle the richness of natural scenes.

[4S1B003] Colour constancy and the challenge of environmental change for perceived surface colour

David Foster
University of Manchester, UK

In a 2001 SPIE article Larry Arend posed a basic question about colour constancy in natural environments: given their inhomogeneity, what does perceived surface colour mean? An indirect answer is offered by operational constancy, which requires judgements of objective properties rather than subjective appearance. For example, can surfaces of constant reflectance undergoing spectral changes in illumination be discriminated from surfaces undergoing spectral changes in reflectance? In practice they can, with constant reflectance signalled by approximately invariant spatial ratios of cone excitations. In natural environments, however, both spectral and geometric illumination changes occur through the day, including changes in mutual illumination and shadows. Can surfaces undergoing these illumination changes be discriminated from those undergoing spectral reflectance changes? In principle they can, since time-lapse hyperspectral radiance data show that spatial cone-excitation ratios over short distances are still approximately invariant. But how should operational constancy be reconciled with varying surface colour perception? One possibility is that surface colours in natural environments are perceived not in isolation but in combination with perceived local illumination, as advocated by Tokunaga and Logvinenko in a 2010 Vision Research article. These combined perceptions might correspond to objective judgements and simultaneously afford a more direct answer to Arend's question.
Engineering and Physical Sciences Research Council, UK

[4S1B004] Real color constancy

Karl Gegenfurtner, Marina Bloj and David Weiss
Giessen University, Germany; University of Bradford, UK; Giessen University, Germany

We suggest that the main purpose of color constancy is to assign particular color sensations to objects and thus aid their identification. Most previous attempts to quantify constancy have deviated from the way we typically use color constancy in real life. Here we present a new and intuitive approach that allows us to measure constancy for almost arbitrary colors, using real objects in fully natural environments with a single full-field illuminant. Participants were asked to bring a personal object that had for them a well-defined color that they were confident they could identify. Without the object being present, participants selected the Munsell chip that best represented the color of "their" object. They performed the task first in a room under neutral daylight illumination and in four other rooms that had non-daylight illuminations provided by windows covered with colored filters. In this task, our participants were perfectly color constant and frequently selected the same chip under all illuminants. We conclude that color constancy does exist, if task and conditions are representative of the uses of color constancy in everyday life.
DFG Ge 879/9 and SFB/TRR 135

[4S1B005] All Illuminations are not Created Equal: The Limits of Colour Constancy

Anya Hurlbert, Bradley Pearce and Stacey Aston
Newcastle University, UK; Institute of Neuroscience, Newcastle University, UK; Institute of Neuroscience, Newcastle University, UK

Colour constancy is a textbook example of perceptual constancy, yet colour scientists frequently report that it is imperfect, approximate, or simply does not exist. Here we address that key dichotomy by adopting the premise that colour constancy is a multi-level phenomenon and suggest that its completeness depends on the level; this premise calls for a distinction between "knowing" and "seeing". Its completeness also depends on the measurement technique and the specific surfaces and illuminations involved. As an example, we take the appearance level, where constancy means there is no change in the appearance of a surface under an illumination change. We measure colour constancy at this level by determining discrimination thresholds for illumination change (parametrised by unit distances in a perceptually uniform space (Lu*v*)). In experiments using real surfaces and real illuminations, produced by tuneable multi-channel LED light sources, we find that thresholds for discriminating illumination changes are highest – i.e. colour constancy is best – for "blue-ish" daylight illuminations. Conversely, colour constancy is worst for atypical illuminations, and fails spectacularly for certain engineered illuminations, even when these are metameric. These findings argue against the notion of "equivalent illuminations", and suggest that colour constancy is optimised for naturally encountered illuminations.
EU FP7 HI-LED; EPSRC EP/H022325/1

[4S1B006] Functional color constancy

Adam Reeves
Northeastern University, USA

Color constancy surely concerns not just appearance, but also function. Considering recognition as just one function, examples include the following: re objects (the classic question), do natural variations in viewing point, lighting, distance, prevent us recognizing objects (say, fruit) important for survival? Re surfaces: can one recognize – from color- whether land is soft or muddy, wet or frozen, well enough to guide walking? Re light: Can we identify an illumination, independent of the surfaces which reflect it to the eye? Do chromatic variations that co-vary with luminance (shadows are bluer and darker) aid constancy? Re range: do natural variations in lighting move surfaces and objects across or merely within color categories? (in the latter case, color constancy is moot). These issues, hard as some of them are, all need research. I will suggest that one way of understanding color constancy in functional terms (like other constancies) is to analyze sensitivity, criteria, and utility together, within a signal detection framework – what is the cost, for example, of a false alarm?
none

[4S1B007] Questions in Surface Color Perception

Laurence Maloney
New York University, USA

The visual system allows to make more-or-less accurate judgments about the locations, orientations, and the material properties (including their color and lightness) of surfaces under a range of lighting conditions. We have accurate models of the retinal image formation process based in physics but, in practice, we approximate these models (which describe photon-molecule interactions) by an intermediate mathematical language that resembles the input to a computer graphic rendering package. An initial set of questions concern the accuracy of these representations and of our simulations of image formation. I will review work concerning the accuracy of models of light and surface. A second set of questions concerns the representations implicitly used in judging surface properties. I will review the considerable evidence concerning what is represented and used by the nervous system, highlighting what we know and do not know. In the last part of the talk I will discuss the impediments to research in this area introduced by our terminology and by our reliance on introspection to "explain" phenomena. Visual perception is an odd example of a field where the researchers are themselves the object of study. This apparent advantage, I will argue, has proven to be a liability.

[4S1B008] Identifying surface colors across illumination conditions: Neural Adaptation, Similarity Judgments and Prior Beliefs

Qasim Zaidi
Graduate Center for Vision Research, State University of New York, USA

Why is it useful to identify surface colors? For discerning illumination differences across scenes, separating shading cues from surface color variations, judging properties of materials, and identifying objects when shape and texture are not informative. What are the environmental cues that help this process? Cone absorptions from sets of natural surfaces are highly correlated across illumination spectra. Consequently, neuronal adaptation can reduce the impact of illumination differences on surface appearance, and algorithms can simultaneously estimate illumination and surface colors by template matching of chromaticity distributions. Correlations are generally not as strong for rough surfaces, so there is less similarity of appearance, unless the viewer-surface geometry stays constant. How do neural processes, cognitive judgments, and prior beliefs contribute? In 3-D scenes, neuronal adaptation to brightness and color reduces the impact of illumination differences, but generally not enough to achieve appearance invariance of 3-D objects. Hence many observers use similarity judgments about surface brightness and color to identify reflectance across illumination conditions. This strategy implies a naïve prior belief in appearance constancy, not just in constant surface reflectance. Other observers use illumination cues provided by appearance differences to identify surface reflectance across illuminations. The latter strategy is statistically optimal, the former opportunistic.

Symposium: Pupillometry

[4S1C001] Pupillary responses to emotionally arousing words in bilinguals' first versus second language

Christoph Scheepers and Wilhelmiina Toivo
University of Glasgow, UK; University of Glasgow, UK

Bilinguals often report stronger emotionality in their first language (e.g., Pavlenko, 2006), which seems supported by findings based on skin-conductance (e.g., Harris et al., 2006). The present study measured pupil dilation in response to high- versus low-arousing words (e.g., riot vs. swamp) in German(L1)-English(L2) and Finnish(L1)-English(L2) bilinguals, both in their first and in their second language. A third sample of English monolingual speakers (tested only in English) served as a control group. The stimuli were selected on the basis of available emotionality norms, and were closely matched (both within and across languages) for length, frequency, emotional valence, and concreteness. During each trial, a mask was presented for 500 ms, followed by a brief presentation of the word (for $50\,\text{ms} + 20\,\text{ms} \times$ length-of-word) and then the mask again for 1700 ms. Participants had to keep looking at the centre of the screen and to indicate (via a prompted button-response at the end of each trial) whether they recognised the word or not. Results indicated no appreciable differences in word-recognition performance, but larger and longer-lasting pupil responses to high-arousing words when stimuli were presented in participants' first rather than second language, confirming less emotional involvement in the language acquired later in life.

[4S1C002] The eyes' many stories about concurrent (cross-modal) action demands: Effects on saccadic latency, pupil response, and blink rate

Aleksandra Pieczykolan and Lynn Huestegge
University of Wuerzburg, Germany; University of Wuerzburg, Germany

Processing load is reflected in several eye-related parameters including saccadic latency, pupil response, and blink rate, indicating that "stressed" eyes hesitate, widen, and eventually shut down. Here, these facets are analyzed under single- vs. dual-action demands. Participants in Experiment 1 switched between single manual, single vocal, and dual (manual-vocal) response demands while fixating a central fixation cross. Results suggest dual-response costs for manual and vocal latencies. However, while blink rate and pupil dilation were also increased in the dual vs. single-manual condition, the data from the single vocal condition resembled those from the dual condition. Thus, vocal demands per se might increase blink rate and pupil dilation, potentially overriding any load-related effects. Experiment 2 compared saccade latency, pupil dilation and blink rate in blocks of trials involving only basic saccade demands vs. blocks with additional manual key press demands. Results suggest increased saccadic latencies and changes in pupil dynamics under dual- (vs. single-) response demands, but no effect on blink rates. Taken together, the results suggest that while all parameters may individually be associated with variants of processing load and appear to interact, the underlying mechanisms appear to be highly distinct.

[4S1C003] Different measurements of pupil size as response to auditory affective stimuli and their application in a visual perception task

Sarah Lukas, Gabriel Yuras and Anke Huckauf
PH Weingarten, Germany; Ulm University, Germany; Ulm University, Germany

It has been shown in a variety of previous studies that pupil size increases as response to emotionally loaded stimuli (images, words, and sounds). It has been assumed that pupil dilation occurs as a response to highly arousing stimuli, independent of the valence of the stimuli. However, different studies use different measures of pupil size. Moreover, low arousing affective stimuli have rarely been used so far.
The goal of the present study was two-fold: first, we are comparing and discussing different measures of pupil size like general pupil size change, change at a certain point of time, maximum, and maximum latency with respect to affective auditory stimuli and with respect to valence and arousal.
In a second step, we use the knowledge of these measurements to apply them in a visual perception task to investigate effects of emotional impact on the visual useful field of view.

[4S1C004] Evaluation of features derived from pupil dilation in a stress induction experiment

Serdar Baltaci and Didem Gokcay
METU, Turkey; METU, Turkey

Using features derived from pupil dilation, can the affective state of a computer user be predicted? In this study, we evaluated the success of classification of neutral versus stressful states. Two experiments were designed with pictures chosen from IAPS: experiment 1 contained neutral, experiment 2 contained negative, highly arousing pictures. Both experiments had 20 trials with 6 s picture viewing time and 12 s rest. The participants were asked to respond to a cognitive criterion, while viewing an array of these pictures simultaneously. In the second experiment, the cognitive criterion was harder. All participants reported higher stress during the second experiment. Pupil dilation data was collected with TobiiTX300 at 60 Hz. Preprocessing steps were as follows: eye-blink extrapolation, moving median filtering, outlier removal. Extracted features were based on absolute value and entropy of the signal. The WEKA 3.7 library is used for classification of neutral versus stressful trials. Out of 18 features, 5 were predicted as informative with feature selection methods. Success of stress prediction was 72.8% sensitivity and 68.2% specificity using bagging with random forest for classification. In sum, it can be said that pupil dilation is a subtle but promising signal to predict the stress of a computer user.

[4S1C005] Voluntary Pupil Control

Jan Ehlers, Christoph Strauch and Anke Huckauf
Ulm University, Germany; Ulm University, Germany; Ulm University, Germany

During the past years, increasing attention is being paid to operationalize pupil dynamics for affective classification in human-machine interaction (HCI) (e.g. Jacobs, 1996). Thereby, pupil

dynamics are regarded as a passive information channel that provides direct and genuine impressions of the user's affective state but defies any voluntary control. However, considering the large number of achievements in the history of biofeedback based on vegetative parameters (e.g. skin conductance or heart rate variability) one may also assume pupil dynamics to be brought under control by techniques of operant conditioning. We applied visual real-time feedback on pupil diameter changes to enable intentional influence on the related dynamics. Nine volunteers underwent a one-week training program and utilized affective autobiographical associations (imaginations of fear) to gradually exert control. Results indicate that every participant was capable of voluntary expanding pupil diameter beyond baseline values; albeit with varying degrees of success and over differing durations. In a follow-up to the training procedure, subject demonstrated voluntary pupil control even without the assistance of real-time feedback. As a consequence, we conclude that pupil size information exceeds affective monitoring in HCI and may constitute an active input channel to interfere by means of simple cognitive strategies.
Collaborative Research Center (sfb transregio 62), Deutsche Forschungsgemeinschaft (DFG)

[4S1C006] Effects of emotion and cognitive load on pupillometric and saccadic responses to anxiety

Piril Hepsomali, Simon P. Liversedge, Julie A. Hadwin and Matthew Garner
University of Southampton, UK; University of Southampton, UK; University of Southampton, UK; University of Southampton, UK

Emotion and cognitive load affect pupillometric and saccadic responses by increasing pupil diameters and error rates-latencies of saccades as a result of increased emotional arousal and effort. These constructs map on to theoretical frameworks in anxiety, where cognitive indices of arousal and effort in high anxious (HA) individuals can be measured using pupillometric and saccadic responses. The purpose of the study was to examine the effects of emotion and cognitive load on pupillary and oculomotor systems in anxiety by manipulating emotion and load by using an emotional oculomotor-delayed-response task with different delay durations. The results showed that threat-related stimuli and long delays elicited increased peak pupillary diameters (PPD). Moreover, HA participants showed increased PPD compared to low anxious (LA) participants and increased PPDs were observed in HA participants regardless of delay duration. Error rates-latencies were affected by delay duration oppositely and latencies were affected by HA. The findings confirm that highly-arousing emotions and tasks that require more effort increased PPD. Additionally increased PPD in HA in long and short delay indicates increased compensatory effort for task demands regardless of task difficulty and lower processing efficiency in this group of individuals. Saccadic results support speed-accuracy trade-off and attentional control theories.
This research was supported by funds from Economic and Social Research Council (ESRC) Doctoral Training Centre (DTC) studentship and the Psychology Academic Unit awarded to Piril Hepsomali, University of Southampton.

[4S1C007] Driver pupil dilation changes and visual perception of pedestrian movement in illuminance from low to highbeam in naturalistic driving conditions

Saikrishna Mulpuru and Kavita Vemuri
IIIT Hyderabad, India; IIITH, India

Our study is to understand pupil dilation change effects on pedestrian motion detection in mesopic and highbeam glare of an oncoming car. Eye movement and pupil dilation was collected by a wearable eye tracker in naturalistic conditions. A driver was exposed to sequence of light off, low and highbeam light. Our findings: 1) At 100 mts and low beam, detection of a pedestrian crossing is in the peripheral vision. At sudden highbeam the left-to-right pedestrian movement was detected in the peripheral vision and when directly in the line of sight while crossing in the opposite direction. 2) At 50 and 25mts with sudden change to highbeam the pedestrian is detected only when directly in the line of sight and is tracked along a predicted path across the glare. The pupil dilation change was uniform across the 3 car separation distances, from 6 mm ('off') to 3 mm (highbeam) with accommodations taking 1–2 ms, off to highbeam and 20–30 ms for reverse switch. The slower dilation accommodation from highbeam to light-off means lower visual sensitivity and inability to detect pedestrian motion. The driver experiences disabling and discomfort glare from the rapid light intensity switching and forces the driver turns on high beam. *The study is partially funded by DIETY, Government of India, underthe National Programme on Perception Engineering Phase II.*

Oral Presentations – Networks and coding

[4T3A001] Mesolimbic confidence signals guide perceptual learning in the absence of external feedback

Philipp Sterzer, Gregor Wilbertz, Martin Hebart and Matthias Guggenmos
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It is well established that perceptual learning can occur without external feedback. Current theories of learning, according to which we learn from the consequences of our actions, have difficulties to explain such perceptual learning without feedback. Here we tested the hypothesis that perceptual learning may be guided by self-generated confidence signals that serve as internal feedback. Functional magnetic resonance imaging (fMRI) was conducted while human participants performed a challenging visual perceptual learning task. They did not receive feedback on their performance, but reported their confidence after each trial. We devised a novel computational model in which perceptual learning was guided by the combination of a confidence-based reinforcement signal and Hebbian plasticity. Model-based fMRI data analysis showed that activation in mesolimbic brain areas reflected pre-stimulus anticipation of confidence and signaled a subsequent stimulus-related confidence prediction error, revealing a striking similarity in the neural coding of internal confidence-based and external reward-based feedback. Importantly, mesolimbic confidence prediction error modulation predicted individual learning success, establishing the behavioral relevance of these self-generated feedback signals. Together, our results provide evidence for an important role of confidence-based mesolimbic feedback

signals in perceptual learning and extend reinforcement-based models of learning to cases where no external feedback is available.
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[4T3A002] Statistical determinants of sequential visual decision-making

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Apart from the raw visual input, people's perception of temporally varying ambiguous visual stimuli is strongly influenced by earlier and recent summary statistics of the sequence, by its repetition/alternation structures, and by the subject's earlier decisions and internal biases. Surprisingly, neither a thorough exploration of these effects nor a framework relating those effects exist in the literature. To separate the main underlying factors, we ran a series of nine 2-AFC visual decision making experiments. Subjects identified serially appearing abstract shapes in varying level of Gaussian noise (uncertainty), appearance probabilities and repetition-alternation ratio. We found a) an orderly relationship between appearance probabilities on different time-scales, the ambiguity of stimuli and perceptual decisions; b) an independent repetition/alternation effect, and c) a separation of bias effects on RT and decision, suggesting that only the latter is appropriate for measuring cognitive effects. We confirmed our main human results with behaving rats making choices based on luminance between stimuli appearing at different locations. These findings are compatible with a probabilistic model of human and animal perceptual decision making, in which not only decisions are taken so that short-term summary statistics resemble long-term probabilities, but higher order salient structures of the stimulus sequence are also encoded.
Sciex 13.065

[4T3A003] Connective field mapping in a hemispherectomized patient

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Background An interesting patient group to study whether and when visual field maps and their connections change after damage to the visual system are hemispherectomy patients. We studied a 16-year-old girl in whom the left hemisphere was removed at age three. Using population receptive field (pRF) mapping (Dumoulin & Wandell 2008) Haak et al. (2014) found normal visual field maps in the early visual cortex of this patient, but an enlarged foveal representation and much smaller population receptive fields in extrastriate cortical areas, compared to normal.

Method Here, we applied connective field modeling (Haak et al., 2013) to the functional Magnetic Resonance Imaging data of this patient and three controls. This method models the activity of voxels in one part of the brain (e.g., V2, target area) as a function of activity in another part of the brain (V1, source area).
Results Our results indicate that connective fields in the early visual cortex of the hemispherectomized patient appear normal. In contrast, those in extrastriate regions are –on average– relatively small compared to those in the controls.
Conclusion This finding suggests that the origin of the smaller extrastriate pRFs found in the previous study may lie in a deviant cortico-cortical connectivity.

[4T3A004] Increased stimulation of the non-classical receptive field region results in more information in occluded V1

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Most input to V1 is non-feedforward, instead originating from lateral and feedback connections. Using functional magnetic resonance imaging (fMRI) and multivariate pattern analysis (MVPA), Smith & Muckli (2010) showed that non-feedforward stimulated regions of V1 (i.e. responding to an occluded portion of a scene) contain contextual information about the surrounding natural scene, fed back from higher visual areas. We investigated how much of the surrounding scene needs to be visible to induce meaningful feedback to V1. Participants viewed two natural scenes, in feedback (occluded lower right quadrant) and feedforward (corresponding quadrant visible) conditions. We modulated the visibility of the surrounding scene with a grey mask punctured with Gaussian bubbles of varying sizes over the surround (Gosselin & Schyns, 2001). Using V1 voxel patterns responding to the quadrant, we decoded the two scenes in the different conditions. We found that a large amount of surrounding scene needs to be visible for meaningful feedback to non-stimulated V1. Secondly, feedforward MVPA classification is better when more surround information is available. Lastly, showing the full image throughout the experiment enhances feedback on a particular trial, if enough spatial context is available, supporting the importance of both spatial and temporal context.
BBSRC DTP Scholarship (Yulia Revina) & ERC grant [ERC StG 2012_311751] (Lars Muckli)

[4T3A005] Bayesian models of perception

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The notion that perception involves Bayesian inference is an increasingly popular position taken by many researchers. While the approach provides great insight into perceptual processes, it has also received strong criticism. In order to evaluate the sometimes grandiose claims made by advocates of Bayesian methods it is crucial to cut through the seemingly complex methods and focus upon the core theoretical claims being made. These claims will be introduced and misconceptions dispelled. Probabilistic graphical models are presented as a concise yet powerful visual notation with which to express Bayesian explanations of perception. The concepts are exemplified with the

alternative-forced-choice and yes/no tasks, and a set of resources are provided for those inspired to apply Bayesian modelling to other perceptual phenomena.

[4T3A006] Individual scene, category and depth information is fed back to retinotopically non-stimulated subsections of early visual cortex

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Even without meaningful direct feedforward input, early visual cortex contains information about context, suggesting that other brain areas provide context via feedback (Smith & Muckli, 2010; Petro et al., 2014). However, the level of specificity contextual feedback provides is unclear. Activity in non-stimulated portions of early visual cortex may represent feature predictions, which would allow for the discrimination of individual scenes. Alternatively, this activity may only provide information about more abstract higher-level scene groupings. To investigate these possibilities, we blocked feedforward input to subsections of retinotopic visual cortex while participants viewed 24 scenes. Scenes spanned six categories and two depths – higher-level properties which group scene representations in early visual cortex during feedforward stimulation (Walther, et al., 2009; Kravitz, et al., 2011). We examined response patterns in non-stimulated V1 and V2 using fMRI and multi-voxel pattern analyses. Individual scenes, category, and depth were all decoded from non-stimulated areas, and scene decoding errors were uniformly distributed, not concentrated within category or depth. These results indicate that non-feedforward processing in early visual cortex is specific to individual scenes, while retaining higher-level structure – ruling out the possibility that feedback to V1 is only higher-level information.
European Research Council Starting Grant, 2012_311751-BrainReadFBPredCode, awarded to L.M.

[4T3A007] Learning Disparity tuned complex-cell like models using Independent Subspace Analysis

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Using a simple linear model, simple cell-like receptive fields can be learned by a variety of statistical techniques (Hyvärinen, Hurri, & Hoyer, 2009; Olshausen, 1996). These techniques produce models with sparse responses to natural images(Olshausen, 1996). Complex cells in the visual cortex cannot be classified with a simple linear model, but can be characterised as an additive combination of simple linear models (Schwartz, Pillow, Rust, & Simoncelli, 2006). Hyvärinen and Hoyer (2000) showed that similar models can be learned using a subspace analysis technique, where the space of image patches is divided into independent spaces. The model attempts to learn a set of features such that responses within the subspace are distributed orthogonally and responses between subspaces are sparse. We used this technique to learn a set of binocularly tuned 'complex-cell' models, using samples from natural binocular image patches (Hibbard, 2008). We found that many of the 'complex-cells' learned could be classified as disparity tuned, exhibiting

invariance to phase in each eye, and a preference for a particular phase difference between the two eyes. We conclude that subspace analysis can learn models tuned for disparity, but also that other, non-disparity tuned cells emerge whose properties are not yet full understood.
Funded by BBSRC Grant BB/K018973/1

[4T3A008] Attention as Gibbs sampling

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Much work has been done on the how, what, and where of attention, but less on the why. Here we propose a framework, based on the information theory of gambling, that attempts to both answer how and importantly why. We argue that attention should optimise the rate of reward, and given certain knowledge of the probability of reward, this predicts we fixated with a density proportional to that probability. Given uncertainty in this probability, we instead sample from a model of this probability, and then assume this sample is correct (Thompson sampling). There are two main problems with this proposal. Firstly the chicken and egg problem: the probability a given feature is associated with reward is dependent on the task; the probability a given task is rewarding is based on the features present. Secondly, many sources of relevant information are represented by different cortical areas, and these areas each have different "views" of the world. We show that by treating cortical areas as (Dirichlet) variables, we can use Gibbs sampling to sample from the full joint reward distribution, and that inhibition of return speeds convergence. We relate the predictions of this model with the results of visual search experiments.

Oral Presentations: Multisensory perception

[4T3B001] White matter connections of the vestibular and visual-vestibular insular cortex

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The parieto-insular vestibular cortex (PIVC) is a central area of the human cortical vestibular network. Moreover, the posterior insular cortex (PIC), posterior to PIVC, seems to be relevant for visual-vestibular interactions. Here, we investigated the structural connectivity of PIVC and PIC using probabilistic fiber tracking based on diffusion-weighted magnetic resonance imaging (MRI) of 14 healthy people. Both brain regions were identified in each hemisphere by functional MRI. Bithermal caloric stimulation served to identify PIVC, whereas PIC was defined by its response to visual motion. Probabilistic tracking based on diffusion-weighted MRI was performed with seeds in PIVC and PIC, respectively. Track terminations were mapped to the cortical surface of a standard brain. White matter connections of PIVC and PIC showed overlapping track terminations to each other, the insular/lateral sulcus, superior temporal cortex, and inferior frontal gyrus. However, we also observed significant differences in the connectivity fingerprint of PIVC and PIC. PIVC tracks primarily projected to the posterior parietal cortex, the frontal operculum, and the Heschl's gyrus, whereas PIC tracks primarily terminated in the temporo-parietal junction, superior temporal sulcus and the inferior frontal cortex. These results suggest

that PIVC and PIC have partially overlapping and partially distinct profiles of white matter connectivity.

[4T3B002] Prioritizing speed over accuracy in audiovisual integration of threatening stimuli

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Non-verbal communication is essential to survival and successful social behavior. Integrating multisensory non-verbal signals can improve the accuracy and the speed with which humans perceive and react to others' emotions (Collignon et al., 2008). Whether these aspects of multisensory facilitation are intrinsically linked together or one may prevail over the other depending on the social situation is unknown. We asked 16 participants to discriminate as quickly as possible the level of angriness between two clips under three different sensory conditions: visual (biological motion of a walker), auditory (sound of footsteps), and audiovisual (both). We tested whether there was a reduction in participants' response variability and reaction time (RT) for the audiovisual condition, as predicted by the maximum likelihood estimation and violation of race model inequality, respectively. While no evidence of audiovisual reduction in response variability was found, we did find evidence of audiovisual reduction in RT when compared to either auditory or visual condition. This reduction exceeded that predicted by the race model for the fastest quantiles of the RT distribution, pointing to a real interaction between modalities. This indicates that under threatening social situations a multisensory mechanism facilitating a speeded reaction is prioritized over one facilitating a robust percept.

[4T3B003] Vision shares spatial attentional resources with haptics and audition, yet attentional load does not disrupt visuotactile or audiovisual integration

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Human information processing is limited by attentional resources. Two questions discussed in multisensory research are 1) whether there are separate spatial attentional resources for each sensory modality and 2) whether multisensory integration is influenced by attentional load. In two experiments, we investigated these questions using a dual task paradigm: Participants performed two spatial tasks (a multiple object tracking task and a localization task) either separately (single task condition) or simultaneously (dual task condition). In the localization task, we presented the localization cues in different sensory modalities: In Exp. 1, participants received either visual, tactile, or redundant visual and tactile location cues, whereas in Exp. 2, they received either visual, auditory, or redundant visual and auditory cues. In both experiments, we found a substantial decrease in participants' performance in the dual task condition relative to the single task condition. Importantly, participants performed equally well in the dual task condition regardless of the location cues' modality. Furthermore, participants integrated redundant multisensory information similarly even when they experienced additional attentional load in the dual task condition. Overall, findings suggest that 1) vision shares spatial attentional

resources with haptics and audition and 2) visuotactile and audiovisual integration occurs at a pre-attentive processing stage.
We gratefully acknowledge the support by H2020 – H2020-FETPROACT-2014 641321 – socSMCs (for BW), FP7-ICT-270212 – eSMCs (for PK & BW) and ERC-2010-AdG #269716 – MULTISENSE (for PK).

[4T3B004] Visual-haptic cue combination in adults with autism spectrum condition

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Performance in several multisensory tasks is predicted by a statistically optimal maximum likelihood estimation (MLE) model, in which unisensory cues are combined additively with the weight of each cue determined by its reliability. This combination rule ensures that variance in the multisensory estimate is minimised (Ernst & Banks, 2002). In the present study we investigated visual-haptic cue-combination in participants with autism spectrum condition (ASC) as there is evidence that multisensory processing is altered in this group (e.g. Stevenson et al., 2014). Thirteen adults with ASC and a matched neurotypical (NT) control group took part in a visual-haptic cue integration task (Gori, Del Viva, Sandini & Burr, 2008). Participants judged the height of blocks presented visually, haptically, or via both senses (multisensory). Multisensory performance was compared to predictions from MLE and a model (SCS) in which participants switch stochastically between cues from trial-to-trial (Nardini, Jones, Bedford & Braddick, 2008). Multisensory variability estimates were significantly higher than predicted by MLE for both ASC and NT groups. However, for both groups variance was well predicted by the SCS model. The failure to replicate optimal multisensory cue combination in NT participants and possible directions for future research in ASC will be discussed.
Medical Research Council (UK)

[4T3B005] Impaired audio spatial abilities in blind adults: a behavioural and electrophysiological study

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The role of visual information in the development of spatial auditory abilities is still debated. Several studies have suggested that blind people can partially compensate their visual impairment with greater sensitivity of the other senses (Lessard, 1998; Roder, 1999). However, in previous studies (Gori, 2013) we have shown that early visual deprivation can impact negatively on spatial but not temporal bisection auditory tasks. Here we investigate neural correlates of these impairments: we study cortical activations by comparing behavioural and electrophysiological parameters reflecting spatial and temporal perception in 16 congenitally blind and 16 normally sighted. Specifically, we test the hypothesis that visual deprivation might affect more neural processing of audio-spatial than audio-temporal information.

On one side, we confirm (Gori, 2013) that blind participants have good temporal bisection performance, but lower spatial bisection abilities compared with sighted controls. On the other side, electrophysiological data reveal differences in the scalp distribution of brain electrical activity between the two groups reflecting lower tuning of early spatial processing mechanisms in the blind subjects. Therefore, joint behavioural and electrophysiological differences suggest that compromised functionality of brain areas in the blind may contribute to an impairment of auditory spatial skill such as those required in audio-spatial bisection.
This research has been supported by the European ABBI project (FP7-ICT 611452)

[4T3B006] How well do we know whether we are seeing or hearing? On the robustness of modality discrimination

Yuanyuan Aimee Zhao and Colin Blakemore
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Although perception is underpinned by multimodal integration, we are normally aware of the modality of each element of experience. If sensory signals are "tagged" as visual, auditory etc, how robust is the modal tag? We tested whether the modalities of individual visual and auditory stimuli, randomly interleaved, can be distinguished close to detection thresholds. We compared detection of stimuli and identification of their modality, using a 2-Alternative Forced Choice localization task and a simple detection task (with confidence rating as the criterion for detection). Results showed that: 1) detection performance for each stimulus is entirely unaffected by random interleaving of modalities; 2) surprisingly, identification of modality is, if anything, more reliable than stimulus detection. We also examined the effect of backward visual masking on the detection of visual and auditory stimuli, and the identification of modality. Visual masking raised visual but not auditory thresholds, and did not affect the ability to identify modality. These results suggest that: 1) attentional capacity is not shared between sensory modalities; 2) perceptual distinction between modalities is extraordinarily robust, right down to threshold. This implies that modality "tagging" occurs at a very early stage in sensory processing.
Supported by The Silk Charitable Trust and an AHRC grant (Rethinking the Senses)

[4T3B007] We all live in the anisotropic submarine – differences in perceived distance anisotropy trough senses

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People tend to perceive distances above them as larger than physically same distances in front of them, which is called perceived distance anisotropy. Aim of this research was to examine possible differences in this anisotropy, between various sensory modalities. We compared results from five experiments in which participants matched distances of stimuli, on horizontal and vertical directions. In first 3 experiments participants ($14 + 13 + 15$) matched distances visually: in experiments 1 (upright position) and 2 (lying on the left side) they changed viewing direction by moving their head, while in the third one, by moving their body. In the forth experiment (upright position) 15 participants matched distances by their hand (proprioceptive information), while in the fifth 16 participants matched distances auditory. We computed ratio between vertical and

horizontal estimated distances, which was used as dependent variable. Results show that there is a significant effect of experiment (sensory modality), stimuli distance, and interaction of the two. When we combine visual or auditory information with proprioceptive and vestibular, anisotropy is larger than when we combine visual information with prorioceptive or vestibular only, or when we use only proprioceptive information. Anisotropy enlarges when system combines both, proprioceptive and vestibular information with other sensory modalities.
This research was supported by Ministry of education and science of Republic of Serbia, project number ON179033.

[4T3B008] Neural population codes, decisional confidence and cross-modal facilitation

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When making perceptual decisions, humans evidently have a reliable trial-by-trial estimate of encoding success, as reported confidence typically correlates well with objective performance in the absence of feedback, missed trials, or concentration lapses. When making perceptual decisions, people also benefit from encoding physically redundant information in separate sensory modalities. We explored the possibilities that these observations might be inter-related, and driven by neural population coding. For global direction and orientation judgments, we found performance can be equated for stimuli containing different ranges of physical signals (by modulating mean signal magnitudes), but this failed to equate confidence, which was disproportionately undermined by increasing signal range. For audio-visual rate judgments, our data suggest cross-modal coding benefits are contingent on unimodal signals having elicited different levels of confidence. We contend that these observations are explicable in terms of encoded signal precision being estimated on a trial-by-trial basis from the range of differently-tuned mechanisms active during evidence accumulation. This has a disproportionate influence on confidence relative to sensitivity, demonstrating relatively independent transforms of sensory information for the underlying computations. Moreover, encoded signal range can inform decisions when more than one cue is encoded in different sensory modalities, explaining why cues can be optimally weighted.
Australian Research Council

Oral Presentations: 3D vision, depth and stereo

[4T3C001] The finite depth of visual space inferred from perspective angles

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Retinal images are perspective projections of the visual environment. Despite this, it is not self-evident that visual space is a perspective representation of physical space. Analysis of underlying spatial transformations shows that visual space is perspective only if its depth is finite. Three

subjects judged perspective angles, i.e. angles perceived between parallel lines in physical space, between real rails of a straight, disused, railway track. The subjects also judged the perspective angle from pictures taken from the same point of view. Perspective angles between real and depicted rails ranged from 27% to 83% of their angular size in the retinal image. Perspective angles prescribe the distance of vanishing points in visual space. Computed distances were all shorter than six meters! The extent of a hypothetical space inferred from perspective angles does not match the depth of visual space, as it is perceived. The incongruity between perspective angles and depth of visual space is huge but apparently so unobtrusive in human vision that it has remained unnoticed. The current results argue against methods that have been used to measure the geometry of visual space. The mismatch between perceived angles and distances casts doubt on the concept of a consistent visual space.

[4T3C002] 3-D Perception from Anomalous Motion perceived in Still Figures

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Human vision has ability to perceive 3-D from motion. Recently, as a new category, volume was added to the previously reported depth, shape, structure and surface (Cheng, 2010, Optical Review 17-5 439–442; Cheng, 2011, Optical Review 18-4 297–300). We found that 3-D perception could be obtained not only in the continuous real motion but also in the velocity field produced by the repetition of one stroke apparent motion or a piece of motion in time course with suitable ISI (Cheng, 2014, Psychology Research 4–9 685–692). The anomalous motion perceived in still figure (http://www.ritsumei.ac.jp/∼akitaoka/) was explained as the similar mechanism that in the velocity field (Idesawa, 2010, Optical Review 17-6 557–561); then, 3-D perception could be expected from the anomalous motion perceived in still figures We examined the picture of suitably distributed anomalous motion elements with different properties in direction and strength so that the other cues (perspective, occlusion, pictorial and shading) were almost removed; then the 3-D perception excepting volume perception were proved. Using the Poggendorff probe(Wang,2008, Appl. Phys. Express 1 078001), it was proved that surface perception could be obtained with the anomalous motion but could not be obtained without the anomalous motion.

[4T3C003] Insect stereo vision demonstrated using virtual 3D stimuli

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Stereo or 3D vision is a marvellous visual ability but the mechanisms that underlie it have only been studied in vertebrates. Stereopsis has been demonstrated in only one invertebrate – the praying mantis – but no detailed investigation has been possible because of a lack of techniques. We developed stereo displays for insects ('insect 3D cinemas') using a polarization-based approach

and a spectral content based approach and tested the utility of both at delivering an illusion of 3D to praying mantises. We find that a polarization-based approach failed to deliver an illusion of 3D to the mantis but a spectral content based approach clearly managed to do this. With the latter approach, mantises struck at targets that were 10 cm away from them when the disparity of the target stimuli simulated a distance of 2.5 cm but not when the disparity was reversed or was zero. We thus definitely demonstrate insect stereopsis and open up novel avenues of research into different invertebrate-specific algorithms of depth perception and the parallel evolution of stereo computation.

VN, GT and RR are funded by a Leverhulme Trust Research Leadership Award RL-2012-019 to JR

[4T3C004] The interaction between familiar size and stereoscopic depth cues

Paul Hands and Jenny Read
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Stereoscopic three-dimensional (S3D) technology is a rapidly advancing area in the entertainment and medical field. As with all fast developing technology, problems are found which need solving. One important issue regarding S3D is cue conflicts: the brain receiving different depth information from different signals. One conflict: differing familiar size and stereo information, may lead to the belief that something is incorrectly shown. In industry this issue is widely referred to as miniaturisation. Although the conflict is well known in the commercial world of S3D, it has not been studied much in research. We consider whether humans prefer a familiar size or a stereo depth cue. Using a credit card displayed in S3D, we varied size and disparity information to test which cue was preferred. The subjects were required to make a decision as to whether the card appeared bigger or smaller than a standard credit card. Analysis using probability heat maps revealed humans prefer familiar size cues, and often ignored disparity. Mathematical modelling verified heavier weighting toward the familiar size cue, which was reflected in the weaker reliability of the disparity cue. This could have repercussions for medical operations that use S3D technology, if the image shown has size distortions.

EPSRC, Bskyb

[4T3C005] A stereoscopic look at frequency tagging: Is a single frequency enough?

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Stereopsis has been extensively researched primarily by psychophysics in humans, and by electrophysiological recordings in animals. Comparatively few human studies are employing Electroencephalography(EEG). An exception is a study by Norcia&Tyler(1984), which used frequency tagging to isolate cortical mechanisms sensitive to binocular disparity.

We now return to this technique using high-density EEG which will admit source localisation. Our display is a mirror-stereoscope with two identical CRT monitors; the stimuli were a dynamic

random-dot stereogram (white and black dots on a grey background) updated at every 8.3 ms, presented in 4 s trials. The disparity shows a horizontal grating with an amplitude of 0.065°, with a spatial frequency of 0.25cycles/deg. The tagging frequency is half the grating inversion rate. Grating trials were interleaved with control trials, consisting of two transparent planes at +/−0.065° disparity. From 11 participants providing about 67 trials, our preliminary analysis indicates significantly higher coherency at integer harmonics of the tagging frequency, but does not indicate significant difference in spectral amplitude, when compared to control trials.
Based on our results, we suggest that a single tagged frequency component is enough for reliable analysis, when a high-level function such as disparity processing is investigated.
This study is funded by the Wellcome Trust.

[4T3C006] The perception of straightness and parallelism in extended lines

Olga Naumenko and Brian Rogers
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Rogers and Naumenko (2014) reported that observers' judgements of the alignment of three artificial 'stars' projected onto a planetarium dome was biased substantially when the angular separation of the outer stars was > 60° (horizontal azimuth). In the first of three new experiments, observers adjusted the curvature of extended (90° horizontal azimuth) lines projected onto the planetarium dome until they appeared to be straight. There were substantial biases away from the veridical, great circle loci. Biases decreased with increasing elevation of the lines and were almost eliminated when the horizon was not visible. These results are consistent with the curved appearance of straight-line jet-trails across the sky and our explanation of the New Moon illusion (Rogers and Anstis, 2015). Judgements of when a pair of lines appeared to be both straight and parallel were also biased by the presence of the horizon: their separation being biased towards a constant angular separation. A similar pattern of results was found when observers adjusted the curvature of a set of multiple vertical or horizontal lines. These results show that the perceived straightness and parallelism of extended lines depends crucially on the perceived distance of the surface on which those lines are seen.
The authors acknowledge Saint Petersburg State University for a research grant 8.50.2098.2013

[4T3C007] The functional significance of stereopsis does not follow a developmental trajectory

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Accurate judgement of depth plays a fundamental role in a number of activities. Furthermore, an advantage for binocular viewing and good stereoacuity has been demonstrated in hand-eye coordination tasks. It is unknown whether this functional significance of stereopsis follows a developmental trajectory. We sought to determine how motor performance is impacted by (a) monocular vs. binocular viewing, (b) stereoacuity and (c) age. Seventy-two children, aged 4 – 11 years, performed three different motor tasks (ball-catching, bead-threading and balancing on a

beam) both binocularly and monocularly. Crossed and uncrossed stereoacuity thresholds were measured using the TNO stereotest. The scores for each activity (balls caught, beads threaded and foot touchdowns) were standardised and analysed using a linear mixed model. The relative utility of binocular viewing was most important for catching (average z-score difference of .95 between binocular and monocular viewing) and least important for balance (z-score difference of .26). However, stereoacuity only affected balance, with individuals with poor stereopsis demonstrating worse postural stability. Performance on all motor tasks improved with age, but there was no age-dependent effect of binocular vs. monocular viewing or stereoacuity, indicating that the functional significance of stereopsis is not moderated by age.

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Arnold	Derek	4T3B008 3P1M137
Arnoldussen	David	4P1M051
Arranz-Paraíso	Sandra	3P1M023
Arrighi	Roberto	3T2C003
Asai	Tomohisa	4P1M067
Asano	Akira	4P2M084
Asanoi	Chihiro	3P2M026
Ashida	Hiroshi	4P1M105 1P1M037 3P1M037 1T2B005
Ashinoff	Brandon	4P2M030
Ashkenazi	Sarit	3P1M007
Astle	Andrew	4P2M120 1S1B006
Aston	Stacey	2P2M067 2P1M088 2P1M076 4S1B005
Atkinson	Janette	1T3A008
Axtens	Jenna E	1T2A003
Ayhan	Inci	4P2M046
Babenko	Vitaly	2P2M005
Bach	Michael	4P2M032 3P1M043
Bachy	Romain	1T3C004
Badcock	David R.	3P1M115 3P2M128
Baddeley	Roland	4T3A008 1P2M010 2P2M107 2P1M120
Baeck	Annelies	3S1B005
Bahrami	Bahador	1P2M038
Bailão	Ana	2P1M134
Bailey	John	3P1M003
Baker	Daniel	2T3B005 3P1M135
Bakshi	Ashish	3P2M098
Bala	Kavita	1T2B003
Baltaci	Serdar	4S1C004
Ban	Hiroshi	4P1M109
Baranowski	Andreas	4P2M060
Barca	Laura	1P1M027
Barendregt	Maurits	4P1M121
Barisic	Iva	3S1A004
Barnes	Louise C.	1P1M041
Barraclough	Nick	3P2M048 1P1M055 3P1M077
Barraza Bernal	Maria	4P1M031
Barrett	Brendan T.	3P2M064 3P2M080
Barrett	David	3T3A006

Barrett	Doug J. K.	1P2M004
Bartlett	Laura	2P2M049
Barton	Jason J.S.	1T3B007 1P2M044
Bartov	Jenny	3P1M081
Bartsch	Mandy V.	2P1M066
Baruch	Orit	2P2M009
Baseler	Heidi	4P1M053 4P2M050
Basso	Daniel	4P1M125
Basyul	Ivan	1P1M049
Batare	Aiga	4P1M037
Bate	Sarah	1P1M077
Battaglini	Luca	3P1M019
Bäumer	Silke	1S1B006
Baxendale	Alex	1P2M022
Bayliss	Andrew	1T2A002
Becchio	Cristina	3S1A001
Beck	Valerie	3T3B004
Becker	Stefanie I.	1T3A006 1T2A003 1T3A003
Beebe	Nathan C.	3P2M064 3P2M080
Beer	Anton	4T3B001
Beers	Amanda M.	4P2M008
Bellacosa Marotti	Rosilari	4P1M131
Ben Shalom	Asaf	1P1M003
Ben-Shahar	Ohad	4P2M110 1T2B004
Benedetto	Alessandro	2P2M083
Bennett	Kate	4P2M044
Bennett	Katrina	4P1M023
Bennett	Matthew	4P2M124
Bennett	Patrick J.	4P2M008 1T3B007
Bennett	Simon J.	3P2M064
Bennett	Simon	3P2M080
Bennetts	Rachel	1P1M077
Benton	Christopher	1P2M070
Benwell	Christopher	4P1M001
Berchicci	Marika	1S1B007
Bernard	Jean-Baptiste	3T2A006 2S1A006
Bernardis	Paolo	3P1M073
Bertalmío	Marcelo	2P1M092
Bertamini	Marco	3S1B001 1T2C005 3P2M006 1P2M112 3P2M114 1P1M133 2T3C001 4P2M070 3T3C003
Bertoni	Sara	4P1M131 4P1M003
Bex	Peter	4P1M119 4P2M112
Bichot	Alain	3P2M138
Billock	Vincent	4P1M059
Bindemann	Markus	2P2M011
Blagrove	Elisabeth	2P1M026
Blakemore	Colin	4T3B006
Blakeslee	Barbara	1T3C006

Blakeway	Stewart	1P2M124
Bliem	Harald R.	1P2M084
Blinnikova	Irina	1P1M123 2P1M122
Bloj	Marina	4S1B004
Boggio	Paulo Sérgio	2P1M078
Bognár	Anna	3P1M127
Bona	Silvia	3S1B003
Bossard	Martin	3P1M011
Bosten	Jenny	2P2M095
Both	Bernhard	2T3C001
Boucard	Joyce	4P2M048
Bourke	Lorna	4P1M075 4P1M013
Boutsen	Luc	1P1M057
Bove	Giuseppe	1P2M118
Bowden	Richard	4S1A004
Bowman	Howard	1P1M009
Bowns	Linda	3P2M014
Boyacı	Hüseyin	2P2M087
Boyadzhiev	Ivaylo	1T2B003
Boyce	Tian	1P1M077
Bozzacchi	Chiara	3P1M065
Braddick	Oliver	1T3A008
Bradley	Pearce	2P1M088 2P1M076
Brady	Nuala	3P2M076
Brainard	David	4S1B002
Braithwaite	Jason	4P2M018
Brand	Andreas	4P2M036
Brascamp	Jan W	2P2M017
Braun	Doris	2P1M130 3P1M041
Braun	Jochen	3P1M129 3T2A002
Brayda	Luca	4P1M077
Brecher	Kenneth	2P2M079
Brederoo	Sanne	4P1M057
Breitenbach	Sonja	4P2M040
Breitmeyer	Bruno	2P1M040
Bremner	Andrew	3P1M121
Brenner	Eli	2T2A006 4P2M052 4P2M114
Brewster	Stephen	4P1M089
Bridge	Holly	1P1M031 1S1B001
Brinkhuis	Manje	2P2M017
Brooks	Joseph	1P1M009
Brooks	Kevin	2T3B001
Brostow	Gabriel	4S1A003
Brouwer	Harm	2P2M021
Brown	Holly	3P1M131
Brunner	Freimuth	4P1M063
Bruno	Nicola	2P1M058
Bruyns-Haylett	Michael	4P1M035
Brysbaert	Marc	3S1B002

Buckingham	Gavin	3P2M070 2T3A007 3P1M059
Buckley	David	4P2M094 4P2M050 4P1M053
Buckley	John	3P2M080 3P2M064
Buiteman	Stijn	4P2M114
Bülthoff	Heinrich	3P1M061
Bülthoff	Isabelle	1P2M056 3P1M077
Bultitude	Janet	2P2M113
Burnett	Gary	2P2M047
Burnett	Katherine	1T2A006
Burr	David	2P2M083 3T2C001 1S1B007 3T2C003
Burton	A. Mike	2P2M011
Butler	Emily E.	1P2M098
Butler	Joe	2P1M046
Caetano	Marcelo S.	1P1M041
Caharel	Stéphanie	1P2M066
Calabrèse	Aurélie	2S1A006
Call	Josep	1P2M110 1P1M119
Calmels	Claire	3P1M057
Calzolari	Sara	4P1M011
Camp	Sarah	4P2M128
Campbell	Charlotte	4P1M053
Campos	José	4P1M125
Campus	Claudio	4T3B005
Camurri	Antonio	4P2M092
Canal-Bruland	Rouwen	3S1A005
Canessa	Andrea	4P2M116
Cao	Robin	3P1M129
Caparos	Serge	2P1M014 3P1M121
Cappagli	Giulia	4P1M073 2T3B002 1P2M076 3T2C001
Cappe	Céline	4P2M036
Caramazza	Alfonso	3T2C006
Carbon	Claus-Christian	2S1B001 2P2M057 1P2M046 1P1M013 1P1M091 1P2M064 2S1B004 1P1M129 1P1M109 1P2M102 3P1M095 1P1M125 1P2M130 1P2M120
Carefoot	Olivia	1P2M092
Carlisle	Nancy	1T3A004
Carmel	David	1P2M108
Carrasco	Marisa	2P1M038 4P2M030
Casco	Clara	4P2M010 4P1M011
Cass	John	4P1M087 2T2C002
Cassanello	Carlos R.	3T2A005
Castellano	Marta	3P1M113
Castellanos	F. Xavier	4P2M030
Castelli	Luigi	2P2M119
Castet	Éric	2S1A006 3T2A006

Catchpole	Gemma	1T2C001
Catmur	Caroline	3S1A002
Cattaneo	Zaira	3S1B003
Cavanagh	Patrick	3P2M040
Cecchetto	Stefano	4P1M061 4P2M062
Cecchini	Marco	2P2M123 1T3B004
Cecconi-Marcotti	Claudia	4P1M085
Chadwick	Alice C	2P2M101
Chakravarthi	Ramakrishna	3T2C005 2T2C003 3P1M091
Chamberlain	Rebecca	3P2M118
Chambers	Alison	2P1M100
Champion	Rebecca A.	3P1M027 3P1M025
Chang	Chien-Kai	1P1M081
Chang	Dorita H.F.	3T3C007
Chang	Franklin	3P1M053
Chassy	Philippe	1P2M124
Chaston	Anthony	3P1M003
Chater	Nick	1P2M002
Chauhan	Tushar	2P2M065
Chen	Chien-Chung	4P1M101 4P2M098 4P1M099 2P2M099
Chen	Chun-Man	1P2M068
Chen	Pei-Yin	4P1M099
Chen	Rongrong	3P2M074
Chen	Yi-Chuan	4P2M068
Cheng	Xiaohong	4T3C002
Chernishova	Marina	2P2M125
Chetverikov	Andrey	1T2C002
Cheung	Sing-Hang	4P1M127
Cheung	Yuk Ting Leo	4P1M127
Chien	Sarina Hui-Lin	1T3B003 1P2M068 1P1M081
Chkonia	Eka	4P2M036
Chockley	Alexander S.	4P1M095
Chotsrisuparat	Chayada	3P2M044
Chow	Hiu Mei	3T3B007
Cicchini	Guido Marco	3T2C001
Cikmacs	Peteris	4P2M138
Clarke	Aaron	3P1M085 3P2M086 1T3B001
Clarke	Alasdair	3T2A004 3T3B002
Clarke	Michael	1S1B002
Clawson	Hannah	3P2M106
Clery	Stéphane	1P2M114
Clifford	Colin W G	3P1M107
Coates	Daniel	2T2C004
Codina	Charlotte	4P2M050 4P1M053
Coello	Yann	3P2M054 3P1M063
Cole	Jonathan	3P2M070
Collier	Elizabeth	2T3A002
Collins	Thérèse	3T2A005 4P2M014

Colomb	Michèle	1P1M027
Conci	Markus	1P1M029
Contemori	Giulio	4P2M010 4P1M011
Cooney	Sarah	3P2M076
Cooper	Natalia	4P2M072
Cormack	Rosannah	3P1M045
Cornelissen	Frans W	2S1A004 4P2M052
Cornelissen	Frans W.	2T3C007 4P2M048
Cornelissen	Frans	4T3A003
Corradi	Guido B.	1P1M111
Correia	Marta	1P1M035
Corrow	Sherryse	1T3B007 1P2M044
Costa	Marcelo	2P1M094
Costa	Thiago	2P1M078
Coullon	Gaëlle	1S1B001
Cowan	Nelson	1P1M019
Cowardin	Venice	1T3C004
Cox	George	2P2M101
Cranwell	Matthew	2T3B004
Cravo	Andre M.	1P1M041
Crichton	Stuart	4T3C003
Cristino	Filipe	4P2M100 2P2M113 2P1M046
Croft	Rodney	1T3A005
Cross	Ian	4P2M092
Cruickshank	Alice G.	3P2M064
Cruickshank	Alice	3P2M080
Csépe	Valéria	4P1M093
Csete	Gerg	3P1M127
Csibri	Péter	3P1M127
Cucu	Maria	3P1M015
Cunningham	Darren	3P1M135
Curcic-Blake	Branislava	4P2M048
Cuthill	Innes C.	2P1M120
Cuthill	Innes	3P2M030 2P2M107
Cutts	Megan	4P2M076
Cuturi	Luigi	2T2A001
Czanner	Gabriela	4P2M044
D'Argenzio	Michela	1T3B004
d'Avossa	Giovanni	1P2M024 1T3B006 1P1M043 2P1M046
Dakin	Steven	2T2B004
Dalmaso	Mario	2P2M119 1T2A002
Daniela	Herzig	1T3B001
Date	Munekazu	4P2M096
Daum	S. Oliver	2T3C001
Davidoff	Jules	3P1M121
Davies	Simon	4P1M013 4P1M075 1P2M026
Davies-Thompson	Jodie	1P2M044
Davis	Greg	3P1M045

Davis	Helen	4P2M094
Davletshina	Maria	4P1M029
Day	Mhairi	4P2M108
Day	Mhari	4P2M024
De Bezenac	Christophe	4P2M070
de Almeida	Vasco	2P1M132
de Fockert	Jan	3P1M121
de Freitas	Maria Helena	2P1M134
de La Malla	Cristina	4P2M114
de La Rosa	Stephan	3P1M061 3S1A005 3P1M077
De Sá Teixeira	Nuno	2P1M114
De Sousa	Gabriela	4P2M050 4P1M053
De-Wit	Lee	3P2M112 3P2M118
Deas	Lesley M.	4P2M102
Dechterenko	Filip	3P2M018 4P1M123
Deiana	Katia	3P2M126
Deibel	Simone	1P2M102
Dekker	Tessa	1S1B004
Delevoye-Turell	Yvonne	3P1M063
Delicato	Louise	1P1M061 1P1M069
Demarco	Paul	4P2M090
Demeyer	Maarten	3P2M100
Demidov	Alexander	1P1M049
Denk-Florea	Cristina	4T3A004
Denniss	Jonathan	4P1M137
Dent	Kevin	4P1M115
Derzsi	Zoltán	4T3C005
Devita	Miriam	4P2M002
Devue	Christel	1P2M108
Devyatko	Dina	3P2M004
Di Luca	Massimiliano	3P2M002 3P1M005
Di Russo	Francesco	1S1B007
Dickinson	Abigail	4P1M035 4P1M023
Dickinson	J Edwin	3P2M128
Dickinson	J. Edwin	3P1M115
Dickson	Ruth	3P1M075
Dillenburger	Barbara	2P2M115
Dirk	Seidel	4P2M108
Dittmer	Lieke	1P1M097
Ditye	Thomas	1P2M034
Dodgson	Daniel B.	2P1M024
Doerschner	Katja	1T2B004
Dombrowe	Isabel	2P1M044
Domdei	Niklas	4P2M058 2P1M124
Domini	Fulvio	3P1M065
Dong	Junyu	2P2M105 1P1M131 2P1M104
Donohue	Sarah E.	2P1M066
Donovan	Tim	1P1M005
Dore	Patricia	2P2M069

Dörschner	Katja	4P2M110
Dovencioglu	Dicle	1T2B004
Dövencio_lu	Dicle	4P2M110
Downing	Paul	1P1M127 4P2M064 1P2M024
Doyle	Edward	4P2M046
Dresp-Langley	Birgitta	3P1M117
Drewes	Jan	2P2M037 2P1M036
Drewing	Knut	4P2M088
Dugué	Laura	2P1M038
Duke	Philip	4P2M094
Dumani	Ardian	2P2M069
Dundon	Neil	1P1M043 1P2M024
Dunn	Matt	3P1M047
Dunn	Stephanie	4P1M019
Durant	Szonya	2P2M127
Edwards	Stephen Gareth	1T2A002
Ehlers	Jan	4S1C005
Eimer	Martin	1T3A007 2P2M013 2P2M029 1T3A004 1P1M085
Ekroll	Vebjørn	1S1A003
Elbaum	Tomer	4P1M071
Elder	James H.	2T2B001
Elder	James	4S1A001
Elipot	Marc	3P1M057
Ellison	Amanda	2P2M035
Endres	Dominik	1P1M099
Eng	Vivian	1T3A002
Ennis	Robert	1T3C007
Erhardt	Stefanie	4P2M066
Erichsen	Jonathan T.	4P1M039
Erkelens	Casper	4T3C001
Erle	Thorsten Michael	2S1B003
Ermakov	Pavel	2P2M005
Eskew	Rhea	3T3C005
Essock	Edward	4P2M090
Estal	Victor	2T2A006
Ettner	Jennifer	1P2M120
Ewing	Louise	1T3B002 1P1M095 1P2M054
Facoetti	Andrea	4P2M002 4P1M003
Fademrecht	Laura	3P1M077
Fahle	Manfred	4P1M063
Falkenberg	Charlotte	2P1M098
Fallis	James	4P1M075
Farkas	Attila	1P1M087
Farran	Emily	1T3B002
Fassnidge	Chris	4P1M085 4P2M086
Faul	Franz	2P2M097 2P1M098
Faure	Géraldine	2S1A006
Favrod	Ophélie	4P1M021

Fedorov	Leonid	2T2A003
Feldmann-Wüstefeld	Tobias	2P1M052
Fernandes Costa	Marcelo	3P2M010 3P1M009
Fernandez	Ana	4P2M108
Ferrari	Vera	2P1M058
Ferreira	Patricia	1P1M095
Fiehler	Katja	3P2M052 4P1M065
Finocchietti	Sara	2T3B002 4P1M073
Fischer	Uwe C.	1P1M109
Fiser	József	4T3A002
Fisher	Carmen	3P1M111
Fisher	Katie	1P1M085
Flavell	Jonathan C.	3P2M064 3P2M080
Fleming	Roland W.	2P1M096 2T3A007
Fletcher	Kimberley	1P2M044
Fletcher	Paul	2T2B004
Fomins	Sergejs	4P1M135
Forder	Lewis	2P1M062
Foreman	Nigel	3P2M134
Formankiewicz	Monika A.	4P2M132
Fornaciai	Michele	3T2C003
Förster	Julia	2P2M117
Foster	David	4S1B003
Foster-Thornton	Georgie	4P1M015
Foulkes	Andrew	3P1M035 1P2M124
Foulsham	Tom	1S1C004 1S1C003
Franceschini	Sandro	4P1M003
Franchin	Laura	4P1M003
Frangou	Polytimi	1P1M035
Frank	Sebastian	4T3B001
Franke	Ivana	1P1M135
Franklin	Anna	1T2C001 2P1M062 2P2M063 2P2M059
Freeman	Elliot D.	4P2M086 4P1M085
Freeman	Tom C	3P1M015 4P2M016 4P1M039
Freeth	Megan	1S1C001 4P1M019
Freitag	Christiane	1S1B001
Frielink-Loing	Andrea	2P1M018
Fründ	Ingo	2T2B001
Fujimoto	Kanon	4P1M105
Fujita	Ichiro	2P2M131
Fujiwara	Kazumi	4P1M017
Fukui	Takao	3P1M069
Fung	Jeffrey	2T2A004
Furlan	Michele	2P1M110 1T2B005
Gabree	Scott	3T3C005
Gabrielli	François	3P2M054
Galambos	Péter	4P1M093
Galfano	Giovanni	2P2M119

Galna	Brook	4P1M015
Galuta	Ilja	4P1M029
Gan	Su Ren	1T3A002
Gan	Yanhai	2P2M105
Ganel	Tzvi	1P2M048 1P1M003
Ganis	Giorgio	3P1M019
Garcea	Frank	3P2M058
Garner	Matthew	4S1C006 1P1M137
Garofalo	Gioacchino	2P1M058
Gartus	Andreas	1P2M132
Gebauer	Fabian	1P1M013 1P2M102 1P2M120
Gegenfurtner	Karl	4S1B004 3T3C004 1T3C007 2P1M130 3P1M041 2T3A007
Geier	János	4P2M118
George	Nithin	2P2M001
Georgeson	Mark	4P1M117
Gepshtein	Sergei	2T3C005
Geringswald	Franziska	4P1M047
Geyer	Thomas	2P2M081 1P1M029
Gheorghes	Tamara Nicoleta	3P2M092
Ghose	Tandra	2P1M128
Ghosh	Kuntal	3P2M098
Gibaldi	Agostino	4P2M116
Giese	Martin A.	1P1M099 2T2A003
Giesel	Martin	3P1M081
Gilchrist	Alan	1T3C005
Gilchrist	Iain	2P1M118
Gilligan	Therese	2P2M113
Gilman	Hannah	1P2M080
Giordano	Bruno	4P2M092
Giusti	Debora	1T3B004
Gledhill	Johanna	4P1M049
Glowinski	Donald	4P2M092
Gobel	Matthias	1S1C005
Godau	Christoph	3T2B005
Goebel	Rainer	4P1M109
Goettker	Alexander	4P1M065
Goffaux	Valerie	4P1M005
Gokcay	Didem	4S1C004
Goldfarb	Liat	2P2M009
Gomez	Rosanna	4P1M023
Gómez-Puerto	Gerardo	1P1M119 1P2M110 1P1M111
Goncalves	Nuno R.	4P1M109
Goodale	Melvyn A.	2T3A007
Goodbourn	Patrick	2P1M042
Gordienko	Ekaterina A.	2P1M108
Gordon	Gael E	3S1C005
Gorea	Andrei	3T2C004

Gori	Monica	2T3B002 4P1M073 4T3B005 4P1M077
Gori	Simone	4P1M003 4P2M002
Gouws	Andre	3P2M132 3P1M131 3P2M106
Gowen	Emma	4P2M026 3P1M083 4T3B004 1P2M092 2T3A001
Grace	Tom	1P1M087
Gracheva	Maria	4P1M027 4P1M045
Graf	Erich	1T3C001 2P2M049
Grandison	Alexandra	1P1M117 2P2M059
Granjon	Lionel	3T2C004
Grassi	Massimo	3P1M033
Grassini	Simone	2P2M041
Gravel	Nicolas	4T3A003 2T3C007
Gray	Katie	1P1M137
Gray	Lyle S.	4P2M108 4P2M024
Green	Corinne	1P2M050
Greenlee	Mark W.	2T2B005 4P1M095 2S1A003 3P2M116 4T3B001
Greenwood	John A.	2T2C005
Greven	Inez	1P1M127
Grierson	Ian	2S1A005 4P2M044
Grimshaw	Gina	1P2M108
Groombridge	James	2P2M067
Grubert	Anna	1T3A004 2P2M013 2P2M029 1T3A006
Grün	Sonja	2P2M131
Grzeczkowski	Lukasz	3P2M086
Guadagno	Angela	1T3B004
Güçlütürk	Ya_mur	1P1M089 1P2M106
Guest	Duncan	4P1M133
Guggenmos	Matthias	4T3A001
Guilhe	Jessica	1P1M027
Guimaraes	Diego	2P1M074
Gunnell	Daniel	1P2M006
Guo	Kun	1P2M050 1P1M093
Gutmanis	Natasha	2P2M093
Gutu	Tatiana	4P2M044
Haak	Koen	4T3A003
Hadad	Bat Sheva	4P2M012
Hadwin	Julie A.	4S1C006
Haenschel	Corinna	1P1M025
Haley	Krystle	3P2M128
Halfmann	Marc	4P1M097 2T2A002
Hands	Paul	4T3C004
Hanekamp	Sandra	4P2M048
Hansmann-Roth	Sabrina	1T2B002
Haque	Yousra	1P2M078
Harada	Daisuke	3P2M024

Harasawa	Masamitsu	2P1M034
Harauzov	Alexey	3P1M125
Hardiess	Gregor	4P2M066 2T2A002
Harding	Simon	4P2M044
Hardy	Robert	2P2M047
Harmening	Wolf	2P1M124 4P2M058
Harrington	Alexandra	1P2M078
Harris	Julie	1P2M122 3P2M080 3P2M064
Harris	Samantha	2P2M093
Harrison	Neil	2P1M048 4P1M013
Harrison	William	4P1M119
Harry	Bronson	1P2M024
Harvey	Monika	2P2M007 4P1M001
Harwood	Mark	3T2A005
Harwood	Sarah	1P1M101
Hatta	Takeshi	4P1M017
Hatton	Christopher	1P2M082
Hauch	Valerie	2T3A005
Hausdorff	Jeffrey	4P1M015
Havard	Catriona	3T3A006
Hawkins	Sarah	4P2M092
Hayn-Leichsenring	Gregor	1T2C003
Hayward	William	1P2M058
Hazenberg	Simon Jan	3P2M130
He	Xun	2P1M062
Heard	Priscilla	1P1M079
Hebart	Martin	4T3A001
Hecht	Heiko	2T3C001 4P2M060
Hedger	Nicholas	1P1M137
Hein	Elisabeth	3P1M101
Heinrich	Sven P.	4P2M032
Helmy	Mai	2P1M112
Henik	Avishai	1T2A006 3P1M007
Henning	G. Bruce	3T3C002
Henriksson	Linda	3P2M122
Henson	David	3S1C003
Hepsomali	Piril	4S1C006
Hermens	Frouke	2P2M011 1T3C003 3S1A004
Herold	Lisa	4P2M032
Hertz	Uri	1P2M038
Herzog	Michael H.	4P1M021 2T3C002 3P1M085 1T3B001 3P2M086 4P2M036
Hess	Robert F.	3T3C007
Hesse	Constanze	3P1M059 3P1M079 2T3A003
Hesselmann	Guido	3P1M013
Hesslinger	Vera M.	1P1M129 2P2M057
Heywood	Charles	3T2B002
Hibbard	Paul	1S1A006 4T3A007
Higashiyama	Atsuki	4P1M107

Hilano	Teluhiko	3P1M103
Hills	Charlotte	1P2M044
Hine	Kyoko	1P2M014
Hirai	Keita	4P1M043 1P1M033
Hirota	Risa	4P2M084
Hocketstaller	Johanna	4P1M095 3P2M116
Hodgson	Eric	4P1M059
Hoffart	Louis	2S1A006
Höfler	Margit	2P1M118
Hogan	Benedict	3P2M030
Holcombe	Alex	2P1M042
Holland	Martin	4P2M044
Hollingworth	Andrew	3T3B004 3T2A003
Holmes	Tim	1P2M116 2P2M127
Holz	Frank	4P2M058
Holzleitner	Iris	3T3A001
Honbolygó	Ferenc	4P1M093
Honda	Yuma	4P2M096
Hongo	Maya	1P2M060 1P2M062 1P1M059
Hopf	Jens-Max	2P1M066
Horiuchi	Takahiko	1P1M033 4P1M043
Hörnig	Frederic	3P1M095
Horowitz	Todd	3T3B006
Horr	Ninja Katja	3P2M002
Hu	Shun-Fu	1P1M081
Huang	Lingyun	2P2M081
Huang	Pi-Chun	3P2M136
Huang	Shwu-Lih	1P1M115
Hubbard	Timothy L.	1P2M134
Huckauf	Anke	4S1C003 4S1C005
Hudák	Mariann	4P2M118
Huestegge	Lynn	4S1C002
Hughes	Anna	3P2M020
Hunt	Amelia	1S1C002 3P1M079 3T2A004 3T3B002
Hunter	David	4T3A007
Hurlbert	Anya	4S1B005 2P1M076 2P2M077 2P2M067 2P1M088
Hussain	Zahra	1S1B006 4P1M051
Hutchinson	Claire	3P1M017
Huygelier	Hanne	3P2M118
Hyönä	Jukka	2P1M016
Iannoni	Maria Elena	2P2M123
Ichihara	Shigeru	4P2M080
Ida	Masahiro	4P2M048
Idesawa	Masanori	4T3C002
Ikaunieks	Gatis	4P2M042
Imaizumi	Shu	4P1M067
Imura	Tomoko	3P1M097

Ince	Robin	1P2M080
Irvine	Alex	3T2A004
Ischebeck	Anja	2P1M118
Ishihara	Masami	4P2M080
Ishikane	Hiroshi	2P1M034
Ito	Junji	2P2M131
Itoh	Yuji	1P2M014
Ivanov	Vladimir	2P2M125
Izaute	Marie	1P1M027
Izmalkova	Anna	2P1M122 1P1M123
Jachim	Stephen	3P1M083 4P2M026
Jackson	Jade	1P2M012
Jacob	Jane	2P1M040 1P1M021
Jacob	Namita	1S1B005
Jacobs	Christianne	1P1M021 2P1M040
Jacobs	Richard	1P2M106 1P1M089
Jakovljev	Ivana	2P1M072
Jankovic	Dragan	1P2M136
Jansonius	Nomdo M.	4T3A003
Janssens	Eva	1S1B006
Jardine	Nicole	2T2B002
Jeans	Rhiannon	1T3A005
Jeantet	Coline	1P2M066
Jellema	Tjeerd	1P1M055 3P1M055 1P2M032 3P2M048
Jenkins	Michael	2P2M013
Jenkins	Rob	1P2M076
Jennings	Ben	3T2B003
Jeon	Seong Taek	4P2M056
Jessop	Andrew	3P1M053
Ji	Luyan	1P1M067
Jian	Muwei	1P1M131
Jiang	Yi	4P2M082 1P2M100 2T2A005
Jingling	Li	3P1M087 3P2M088 3T3B007
João	Catarina	2P1M134
Johannesson	Ómar I.	2P2M121
Jóhannesson	Ómar I.	3T3B005 1T2C002
Johnston	Richard	4P2M038
Johnston	Robert A	3T3A004
Johnston	Stephen	2P2M109
Jones	Katie	1P1M107
Jones	Luke	2T3A001
Jones	Myles	4P1M035
Jones	Nicholas	3P2M020
Jones	Pete R.	3S1C004
Jones	Peter	1S1B004
Jonsdottir	Lilja	2P1M010
Joos	Ellen	3P2M120
Jordan	Gabriele	2P1M088 2P2M075

Joshi	Mahesh Raj	4P2M056
Jovanovic	Ljubica	2T3C004
Juttner	Martin	1P1M065 1P1M057
Kalwarowsky	Sarah	3S1C004
Kamachi	Miyuki G.	3P2M024 1P2M060 1P1M059 1P2M062
Kane	David	2P1M092
Kaneko	Sae	2P1M102
Kano	Fumihiro	1P1M119
Kapteine	Liva	4P2M042
Karaminis	Themis	3T2C001 1P2M076
Karlaftis	Vasileios	1P2M036
Karmiloff-Smith	Annette	1T3B002
Kashino	Makio	4P1M041
Kashyap	Raagini	1P1M079
Kassaliete	Evita	3P1M021
Kastrup	Andreas	4P1M063
Kato	Nobumasa	4P1M041
Katshu	Zia	1P2M024
Kawabata	Hideaki	1P2M090
Kawaguchi	Katsuhisa	1P2M114
Kawahara	Jun-Ichiro	3P2M068
Kawakami	Fumito	3P1M097
Kawashima	Tomoya	2P1M028
Kayano	Jun	2P2M003
Kaye	Helen	4P2M004
Keeble	David	1P1M083
Keefe	Bruce	3P2M106 3P1M131 1P1M055 3P2M048
Keil	Andreas	2S1C005 2P1M082
Keitel	Christian	2S1C004 2S1C002
Kelly	Eleni	1P2M078
Kennard	Christopher	1P1M031
Kentridge	Robert W	2P2M101 3T2B002
Keramati	Mehdi	1P2M038
Kerridge	Jon	4P2M006
Kerzel	Dirk	1T3A006
Khani	Abbas	2P1M106 4T3A002
Kietzmann	Tim C.	2P2M023
Kim	Jong-Jin	1P2M078
Kim	Seok-Hun	3P2M042
Kimchi	Ruth	2T3C006 3P2M090
Kimura	Takahiko	4P1M017
Kincses	Zsigmond Tamás	3P1M127
Kingdom	Frederick	3T2B003 3P2M082
Kingstone	Alan	1S1C006 1S1C003
Kiorpes	Lynne	2T3B007
Kirita	Takahiro	1P2M096
Kiritani	Yoshie	1P2M074

Kirpichnikova	Anna	1P2M124
Kitaoka	Akiyoshi	2P1M060
Kitching	Rebecca	2P2M093
Knight	Helen C.	2P2M035
Knights	Ethan	2T3A006
Knoblich	Guenther	3S1A003 3P2M060
Knoeferle	Pia	2P2M021
Knox	Paul	1P2M112 2P2M111 2P1M112
Knudsen	Synove	4P2M086
Kobor	Andrea	4P1M093
Koenderink	Jan	1S1A005 3P2M110 3P2M126
Kogure	Reishi	2P2M033
Kohama	Takeshi	2P2M129 2P1M050
Kohler	Peter	3S1B007
Koivisto	Mika	2P2M041
Kojima	Haruyuki	1P1M113
Kojima	Takehito	4P2M096
Koller	Kristin	1P2M082
Komatsu	Hidemi	4P1M079 4P2M080
Komeilipoor	Naeem	3P1M051
Komuro	Yurina	1P2M074
Kondoni	Tatenda	3P1M017
König	Peter	4T3B003 2P2M023
Koning	Arno	2P1M018 3P2M044
Körner	Christof	2P1M118
Kornmeier	Jürgen	3P2M120 3P1M043
Korolkova	Olga A.	1P1M063
Kosilo	Maciej	1P1M025
Kourtzi	Zoe	2S1A002 1P1M035 1P2M036
Kovalev	Artem	3P2M104
Kranz	Laura	1P2M108
Krasimirova Kiryakov	Reneta	1P2M022
Krastina	Anete	3P1M021
Kravchenko	Eduard	3P2M134
Kristensen	Stephanie	3P2M058
Kristjansson	Arni	2P1M010 2P2M121
Kristjánsson	Árni	2P2M017 3T3B005 1T2C002
Krivykh	Polina	3P2M102
Krol	Manon	3P1M055 1P2M032
Krüger	Hannah Marie	2P2M015
Krumina	Gunta	3P2M124 4P1M037 4P2M138 4P1M135 4P2M042 3P2M038
Kubilius	Jonas	3P2M112
Kulikova	Alena	2P2M043
Kulke	Louisa	1T3A008
Kumar	Neeraj	2P1M002 2P2M019
Kume	Yuichiro	4P1M083
Kunar	Melina	1P2M002 1P1M107
Kunchulia	Marina	1T3B001

Kuniecki	Micha_	1P1M139 1P1M105
Kuriki	Ichiro	1T2B001
Kurita	Naoki	2P1M068
Kurman Petrozzelli	Constanza	2T3C007
Kurosumi	Motonori	1P2M062 1P1M059 1P2M060
Kurppa	Lilja-Maaria	3T3C003
Kuvaldina	Maria	1T2C002
Kwon	Si Mon	1T3A002
Kyberd	Peter	1P2M092
Lachmann	Thomas	1P2M016
Lacis	Ivars	3P1M021
Laguesse	Renaud	1P2M072
Lai	Carlo	1T3B004 4P2M034 2P2M123
Laicane	Ilze	3P2M038
Laidlaw	Kaitlin	1S1C006
Lamaddalena	Stefania	1P2M118
Lancier	Stephan	1P1M011
Landwehr	Jan R.	2S1B006
Landwehr	Klaus	3P2M096
Langley	Keith	4P2M126
Langner	Robert	2P1M022
Laprevote	Vincent	1P2M066
Larcombe	Stephanie	1P1M031
Lauffs	Marc M.	2T3C002
Laurent	Xavier	3P2M066
Lavie	Nilli	1T3A001
Lawrence	Samuel	3P1M131
Lawrie	Sophie	1P2M022
Lawson	Rebecca	4P2M062 4P1M061 2T3A002
Le Couteur	Ann	2T3B004
Learmonth	Gemma	4P1M001
Leder	Helmut	1P2M132
Ledgeway	Timothy	4P2M038 3P1M029 3P1M017
Lee	Anna	2P2M059
Lee	Rob	2P2M103 3T2B006
Lee	Xuan K.	2T2C005
Leek	Charles	1P2M024 4P2M100
Lei	Quan	3T2C002
Lelandais	Sylvie	3P2M138
Leonards	Ute	3P2M062
Lepecq	Jean-Claude	3P1M011
Levi	Dennis M.	1P2M042
Levine	Alexandra	4P2M050 4P1M053
Lew	Timothy	2T2B003
Lewis	Elizabeth	2T3A001
Lewis	Terri L.	4P2M068 4P2M012
Lezkan	Alexandra	4P2M088
Li	Junru	1P1M099
Li	Li	3P2M074

Li	Min	3P1M005
Li	Roger W.	1P2M042
Liaci	Emanuela	3P1M043
Liakhovetckii	Vsevolod	3P2M124
Liao	Wen-Hung	1P1M115
Lighezzolo-Alnot	Joëlle	1P2M066
Likova	Lora	4P1M081
Lillikas	Linda	1P2M078
Lillywhite	Amanda	4P2M092
Lin	Yih-Shiuan	4P2M098
Lin	Yu Ying	1P1M037
Linhares	João	2P1M132 2P1M134
Linnell	Karina	2P1M014 3P1M121 2P1M020
Linnert	Szilvia	1P1M017
Litchfield	Damien	1P1M005
Liu	Dong	4P2M082 2T2A005
Liu	Jun	2P1M104 2P2M105
Liu	Peipei	4P2M054 4P1M089
Liu	Rui	1P2M100
Liu	Yishi	2T2C005
Liversedge	Simon P.	4S1C006
Ljubica	Jovanovic	3P2M072
Lo	Shih-Yu	2P1M042
Lochy	Aliette	3T3A007 1P2M072
Loffler	Gunter	3S1C005
Logan	Andrew J	3S1C005
Logvinenko	Alexander	4S1B001
Long	Mike	2P2M047
Lopez-Moliner	Joan	2T3A004
Lord	Sue	4P1M015
Lorenceau	Jean	2P1M126
Lorenzi	Elena	3P1M033
Love	Scott	2T3B006
Lowers	Victoria	4P2M044
Luciani	Massimiliano	4P2M034
Lukas	Sarah	4S1C003
Lukavsky	Jiri	4P1M123 3P2M018
Luke	Christopher	1P1M045
Lunghi	Claudia	1S1B007
Lyakhovetskii	Vsevolod	3P2M038
Macdonald	James S. P.	2P1M020
Macgillivray	Carol	1P2M128
MacInnes	Joseph	2P2M043 2P2M015 2P1M108 2P2M055
Macinska	Sylwia	1P2M032
Macleod	Mary J.	2T3A003
MacNeilage	Paul	2T2A001
Macrae	C. Neil	1S1C002
Maddison	Sarah	4P2M078

Maehara	Goro	1P1M121
Magalhaes	Adsson	3P2M010 3P1M009 2P1M094
Mahon	Aoife	3P1M079 3T2A004
Mahon	Brad	3P2M058
Makin	Alexis	3S1B006 3S1B001 3P2M114 1T2C005 3T3C003
Makwana	Mukesh	3P2M050
Mallick	Arijit	3P2M098
Mallot	Hanspeter	2T2A002 4P2M066 1P1M011 4P1M097
Maloney	Laurence	4S1B007
Maloney	Ryan	3P1M107
Mamassian	Pascal	1T2B002
Manassi	Mauro	3P1M085
Manjaly	Jaison	2P2M019
Manning	Catherine	1S1B004
Mantiuk	Rafa_	1T3C001
Marchenko	Olga	1P2M018 1P1M123
Marcotte	Mélanie	1P1M027
Marhöfer	David J.	4P2M032
Mari-Beffa	Paloma	3P2M008 3P2M066 1P2M022
Markovic	Slobodan	2S1B005 1P2M094
Marosi	Diana-Maria	3T2C005
Martin	Anne B	2T2B006
Martin	Frances	3P1M031
Martin	Joel	2P2M109
Martinovic	Jasna	3T3C003 1P1M025
Martins	Isabelle Christine	2P1M074
Mast	Fred	3P2M086
Mastandrea	Stefano	1P2M118
Masuda	Naoe	4P1M079 4P2M080
Mather	George	3P2M012 3P2M028
Matsumoto	Eriko	1P2M126 2P1M028
Matsushita	Soyogu	3P1M089
Mattia	Maurizio	3P1M129
Mattingley	Jason	1T3A003
Mattschey	Jennifer	2P1M004
Maule	John	2P2M063
Maurer	Daphne	4P2M012 4P2M068
May	Keith	2T2C006
Mayer	Stefan	2S1B006
Mazza	Marianna	1T3B004
Mazza	Veronica	3T2C006
McCourt	Mark	1T3C006
McGinn	Tomohawk Paul	3T3C003
McGovern	David	4P2M120
Mcgraw	Paul	3P1M029 4P2M120 1S1B006 4P1M051 1P2M042
Mcgruer	Fiona	3P2M034

Mcilhagga	William	3T3C006
Mcilreavy	Lee	4P1M039
McIntyre	Morgan	4T3B008
McKeefry	Declan	3P1M131
Meinhardt	Guenter	3T3B001 4P2M136
Melcher	David	2P1M036 2P2M037
Melke	Kristine	3P1M021
Melo	Maria	2P1M134
Melton	Hollie	2P2M093
Menneer	Tamaryn	1P2M004
Menshikova	Galina	3P2M102 3P2M104
Mentus	Tatjana	1P2M094
Meredith	Zoe	4P2M016
Mermillod	Martial	1P1M027
Mestre	Daniel R	3P1M011
Meyer	Georg	4P2M072
Mikellidou	Kyriaki	3P2M106
Mikulskaya	Elena	3P1M031
Miller	Louisa	3P1M059
Milne	Elizabeth	4P1M019 4P1M023 4P1M035
Minami	Tetsuto	1P1M053 2P1M030 1P2M008 2P1M090
Mineff	Kris	4P1M081
Minemoto	Kazusa	1P1M075
Miyao	Masaru	4P2M096
Mizukoshi	Koji	1P2M060 1P1M059 1P2M062
Mizuno	Tota	4P1M083
Moehler	Tobias	3P2M052
Mohler	Betty	1P2M056
Möller	Michael	3P1M095
Mollon	John	2P2M095 2P2M075
Molteni	Massimo	4P2M002
Mond	Jonathan	2T3B001
Montagner	Cristina	2P1M134
Moody	Rosie	1P2M108
Moore	Cathleen	2T2B002
Moors	Pieter	3P1M119
Moran	Rani	3T3B003
Morgan	Andrew T.	4T3A006
Morgan	Graham	1S1B002
Morgan	Hannah	1P2M026
Morgan	Michael	2T3C003 2P2M115 2P2M117 3P1M109
Mori	Masaki	4P1M103
Morita	Ichizo	4P2M096
Morland	Antony	3P2M132 3P2M106 3P1M131
Morrone	Maria Concetta	1S1B007 2P2M083
Moscoso Del Prado	Fermin	3T2A006
Motoyoshi	Isamu	3P2M024

Mouta	Sandra	4P1M125
Moutoussis	Konstantinos	4P1M129
Moutsiana	Christina	1T3A001
Movshon	J. Anthony	2T3B007
Muckli	Lars	4P2M124 3P2M034 4P1M069 4T3A004 4T3A006
Mueller	Matthias	2S1C002
Mueller	Stefanie	4P1M065
Mullen	Kathy	3T3C006 3T3C007
Müller	Hermann	1P1M029 2P2M081
Müller	Matthias M.	2P2M039 2S1C004
Müller	Matthias	2P1M082
Mullin	Caitlin	3P2M112
Mulpuru	Saikrishna	4S1C007
Munar	Enric	1P1M119 1P1M111
Munar Roca	Enric	1P2M110
Muraki Asano	Chie	4P2M084
Murata	Kayoko	4P2M080 4P1M079
Murley	Alexa	2T3B001
Murray	Ebony	1P1M077
Muschter	Evelyn	2P2M037
Mustafar	Faiz	2P1M106
Muth	Claudia	1P1M129
Myszkowski	Karol	1T3C001
Naccache	Lionel	3P1M057
Nadal	Marcos	1P2M110
Nagahata	Moe	2P1M034
Nagai	Masayoshi	3P2M068
Nagino	Koji	4P1M017
Naito	Tomoyuki	1T2B006
Nakajima	Kae	1P1M053
Nakajima	Yasoichi	3P1M069
Nakamura	Anna	3T2B001
Nakamura	Koyo	1P2M090
Nakano	Yasushi	4P1M079 4P2M080
Nakauchi	Shigeki	1P1M053 2P1M030 1P2M008 2P1M090
Nakaura	Yoshiya	3P2M032
Nakayama	Minoru	1P1M047
Nakayama	Ryohei	3T2B001
Nako	Rebecca	2P2M029
Namdar	Gal	1P2M048
Nardini	Marko	3S1C004
Nascimento	Sergio	2P1M132 2P1M134
Nasiopoulos	Eleni	1S1C003
Naumenko	Olga	4T3C006
Navajas	Joaquin	1P2M038
Neil	Louise	1P2M076 3T2C001
Ng	Michelle	2P2M059

Nicholas	Spero	4P1M081
Nicolas	Judith	4T3C003
Nienborg	Hendrikje	1P2M114
Nieuwenstein	Mark	4P1M057
Nihei	Yuji	1P2M008
Nishigaki	Masami	3P1M093
Nishino	Makoto	2P2M129
Nishizaki	Yukiko	3P2M068
Nityananda	Vivek	4T3C003
Noceti	Nicoletta	4P1M007
Noens	Ilse	4P2M020
Noonan	May	2P1M076
Norcia	Anthony	3S1B007
Nordhjem	Barbara	2T3C007
Norman	Liam	3T2B002
Norman	Roseanna	2P2M093
Novikova	Kristina	3P2M134
Nowakowska	Anna	3T3B002
Nummenmaa	Lauri	2P1M016
O'Connor	Anna	4P2M104
O'Hare	Louise	4P2M022
O'Hashi	Norifumi	1P1M033
O'Keefe	Eleanor	4P2M090
O'Regan	Kevin	2P1M070 3T2B005
O'Shea	Alanna Oshea	3P2M076
O'Sullivan	Noreen	4P2M070
Oda	Koichi	4P2M130 4P1M025 3P2M026
Odone	Francesca	4P1M007
Offiah	Amaka	1P2M030
Ofir	Shiran	3P1M007
Ö_men	Haluk	2T3C002
Ohnishi	Madoka	4P1M025 4P2M130
Ohta	Akira	3P2M078
Ohtsuka	Satoko	2P2M033
Okajima	Katsunori	2S1A001 2P1M064 4P2M074 4P2M084
Okazaki	Akane	1P2M074
Oksama	Lauri	2P1M016
Okubo	Noriko	1P2M074
Okuda	Shino	2P1M064 4P2M074
Oliver	Jonathan P	2P2M101
Olivers	Christian N.L.	2T2C002
Olzak	Lynn	4P1M059
Op de Beeck	Hans	3S1B005 3P2M112
Or	Charles C.-F.	1P1M071
Or	Kazim Hilmi	2P1M086
Orekhova	Elena	4P1M029
Orlandi	Andrea	3P2M022
Orlov	Pavel	2P2M125

Ortibus	Els	1S1B006
Ortlieb	Stefan A.	1P1M109 1P2M120 1P1M125
Ossandón	José P.	2P2M023
Otazu	Xavier	1P2M122
Otsukuni	Terumi	4P2M130
Ott	Florian	2T2A002
Otters	Wilmer	4P2M114
Ouhnana	Marouane	3P2M082
Ozolinsh	Maris	3P1M123
Pachai	Matthew V.	1T3B007
Palmer	Luke	1T3A001
Palumbo	Letizia	1P1M133 1P1M055
Pamir	Zahide	2P2M087
Pancaroglu	Raika	1P2M044
Pandolfo	Anna Lucia	2P2M123
Panesar	Harpal	1P2M038
Panis	Sven	1P1M001
Panke	Karola	4P2M042
Pannasch	Sebastian	3T2A001
Papasavva	Michael	1P1M095
Papathomas	Thomas	1P1M087
Papera	Massimiliano	2P1M032
Paramei	Galina	1P2M124 4P1M021
Paris	Sylvain	1T2B003
Park	Emily	1T2A004
Parker	Andrew	1S1B001
Parkosadze	Khatuna	4P2M014
Parraga	C. Alejandro	2P1M056
Parton	Andrew	2P2M045
Pasqualotto	Achille	1P2M020
Pastukhov	Alexander	3T2A002 1P2M130 3P1M129
Paton	Angus	4P1M069
Paulewicz	Borys_aw	2P2M025
Paulins	Paulis	3P1M123
Paulun	Vivian C.	2T3A007
Pausus	Anete	4P2M138
Pavan	Andrea	3P2M116
Pearce	Bradley	4S1B005 2P2M067 2T3B004
Pearson	Nathan	1P1M057
Pedley	Adam	1P1M117
Peirce	Jonathan	3P1M135
Pellicano	Elizabeth	2P2M063 1S1B004 1P2M076
Pellicano	Liz	3T2C001
Penacchio	Olivier	1P2M122
Pepperell	Robert	1S1A001 1P1M111
Perini	Francesca	4P2M064
Peromaa	Tarja	3P1M051
Perrett	David	3T3A001
Perry	Gavin	3T3A002

Persa	Gyorgy	4P1M093
Persike	Malte	4P2M136 3T3B001
Perz	Malgorzata	2P1M080
Petre	Yasmine	1S1B006
Petrini	Karin	4T3B002 2T3B006
Petro	Lucy S.	4T3A004 4T3A006 3P2M034 4P1M069 4P2M124
Pezzulo	Giovanni	1P1M027
Pfeiffer	Till	2P2M027
Piano	Marianne	4P2M112
Pichlmeier	Sebastian	2P2M027
Pieczykolan	Aleksandra	4S1C002
Pilarczyk	Joanna	1P1M105 1P1M139
Pilling	Michael	4P1M133 4P2M128
Pilz	Karin	1T3B001
Pinna	Baingio	3P2M126
Pinto	Yair	1P2M028
Piotrowska	Barbara	4P2M006
Piovesan	Andrea	4P2M070
Pipa	Gordon	3P1M113
Pitchford	Nicola J.	4P2M038
Plaisted-Grant	Kate	3P1M045
Plank	Tina	2S1A003
Plantier	Justin	3P2M138
Plewan	Thorsten	4P1M113
Poder	Endel	2P2M053
Pohl	Ladina	2T2A002
Poliakoff	Ellen	1P2M092 4T3B004 2T3A001
Politis	Ioannis	4P1M089
Pollick	Frank	4P2M054 2T3B006 4P1M089 4P2M092
Pollmann	Stefan	4P1M047
Pollux	Petra	1P1M093 1P1M045
Poncet	Marlene	3T2C006
Poncin	Aude	4P1M005
Pont	Sylvia	1T2B002 4P1M111
Poole	Daniel	4T3B004
Porcu	Emanuele	2P1M082
Portron	Arthur	2P1M126
Pourriahi	Paria	1P2M114
Pourtois	Gilles	1P1M067
Powell	Georgina	4P2M016
Prescot	Andrew P.	1P1M035
Pronin	Sergei	3P2M134
Proverbio	Alice Mado	3P2M022
Prozmann	Viktoria	4P1M097
Pushina	Natalia	4P1M029
Putzeys	Tom	3P2M046
Qi	Lin	2P1M104

Quesque	Francois	3P1M063
Quétard	Boris	1P1M027
Quinlan	Katherine	1P1M065
Quinton	Jean-Charles	1P1M027
Raab	Marius Hans	1P2M120
Radley	Hannah	4T3C007
Rafal	Robert	2P2M113 1P2M082
Rainer	Gregor	4T3A002 2P1M106
Rampone	Giulia	1T2C005 1P2M112 3S1B006
Ramsey	Richard	1T2C004 1P1M127 1P2M098
Raphael	Sabine	2P2M075
Rashal	Einat	3P2M090 2T2C001
Ratnam	Kavitha	2P1M124
Rausch	Manuel	2P1M008
Raymond	Jane E.	2P1M024
Rea	Francesco	4P1M007
Read	Jenny	1S1B002 4T3C004 4P2M028 3P1M023 4T3C005 4T3C003
Reber	Rolf	2S1B003
Redfern	Annabelle	1P2M070
Redmill	David	3P2M062
Reeves	Adam	4S1B006 3T2C002 3P2M126
Regener	Paula	2T3B006 4P1M089
Regolin	Lucia	3P1M039 3P1M033 1P1M039
Reid	Vincent	1P1M017
Reidy	John	2P1M084 3P2M092
Reinvalde	Agnese	4P1M135
Reiter	Theresia K.	1P1M125
Remington	Roger	1T3A003
Renaud	Laguesse	3T3A007
Renken	Remco	2T3C007
Retter	Talia L.	1P1M071 3T3A003
Reuther	Josephine	2T2C003
Revina	Yulia	4T3A004
Reyes	Marcelo B.	1P1M041
Riby	Deborah	2T3B004
Richards	Anne	1P1M097 2P1M032 1P1M095
Richardson	Daniel	1S1C005
Rider	Andrew T.	3T3C002
Rider	Delphine	3T2C004
Rifai	Katharina	4P1M031
Rinkenauer	Gerhard	4P1M113
Risko	Evan	1S1C003
Risuenho	Barbara	2P1M074
Ritcher	Stephanie	3T3A006
Roach	Neil W.	4P2M078 4P2M038 2P1M100
Roberts	Craig	1P2M024
Roberts	Daniel	1P2M024
Roberts	Mariel	4P2M030 2P1M038

Robson	John	3S1C001
Rochester	Lynn	4P1M015
Röder	Susanne	1P1M091
Rogers	Brian	4P2M106 4T3C006
Roinishvili	Maya	4P2M036
Rolfs	Martin	3T2A005
Rolke	Bettina	2P1M022 3P1M101
Romero-Ferreiro	Verónica	3P1M023
Ronconi	Luca	4P1M131 4P2M002 4P1M003
Roorda	Austin	2P1M124 4P2M058
Ropar	Danielle	4T3C007
Rosa Salva	Orsola	3P1M033 1P1M039 3P1M039
Rose	David	2P2M061
Rosemann	Stephanie	4P1M063
Rosengarth	Katharina	2S1A003
Rosenholtz	Ruth	1T2A004
Rosner	Ronny	4T3C003
Ross	Alasdair I.	2T3A003
Ross	Nicholas	3P1M041
Rossi	Marta	1P2M028
Rossion	Bruno	2S1C001 3T3A003 1P1M071 3T3A007 1P2M072
Rossit	Stephanie	3P1M071 1P2M086 2T3A006
Roumani	Daphne	4P1M129
Roumes	Corinne	3P2M138
Rousselet	Guillaume	1P2M080
Routledge	Jack	1P1M061
Roy	Sourya	3P2M098
Rozhkova	Galina	4P1M045 4P1M027
Rubin	Gary S.	3S1C004
Rudd	Michael	1T3C002
Rugani	Rosa	3P1M039
Ruppel	Susan E.	1P2M134
Rushton	Simon	3P1M047 3P1M035
Ruta	Nicole	1P2M118 1P1M133
Rychkova	Svetlana	4P1M027 4P1M045
Sabatini	Silvio P.	4P2M116
Sabu	Simily	2P1M002
Sahni	Jayashree	4P2M044
Sahraie	Arash	1S1C002 3T3B002
Saida	Shinya	1P1M121
Salasc	Charles-Antoine	3P2M138
Salmela	Viljami	3P2M122
Salomao	Railson	2P1M074
Salter	Sarah	1P1M087
Sandini	Giulio	4T3B005 4P1M007
Santolin	Chiara	1P1M039
Santos	Jorge	4P1M125 2P1M132
Sapir	Ayelet	1T3B006 2P1M046

Saruyama	Makiko	1P2M052
Sáry	Gyula	3P1M127
Sasaki	Masaharu	2P1M116
Satel	Jason	1T3A002
Sato	Hiromichi	1T2B006
Sato	Takao	3T2B001
Sato	Yusuke	2P1M116
Saville	Christopher W. N.	1P2M098
Sawada	Tadamasa	1P1M007
Sayim	Bilge	3P1M099 3P2M108 1P1M135 2T2C004
Scheepers	Christoph	4S1C001
Schelske	Yannik T. H.	2P1M128
Schenk	Thomas	2T3A003 2P1M006
Schettino	Antonio	2P1M082
Schilbach	Leonhard	3S1A004
Schiller	Florian	3T3C004
Schiltz	Christine	4P1M005
Schluppeck	Denis	3P1M029 4P1M051
Schlüter	Nick	2P2M097
Schmack	Katharina	4P1M033
Schmidt	Filipp	2T3A005
Schmidt	Thomas	2T3A005 1P1M001
Schmidtmann	Gunnar	3P2M082
Schmitt	Andreas	1P2M016
Schneider	Tobias Matthias	1P2M064
Schoenfeld	Mircea A.	2P1M066
Schofield	Andrew J	4P1M009
Schönhammer	Josef G.	1T3A006
Schreiber	Kai	3P1M109
Schubert	Torsten	2P1M054
Schubö	Anna	2P1M052
Schuetz	Alexander	2P1M130
Schulz	Johannes	3T2A001
Schütz	Alexander	3P1M041
Schwan	Raymund	1P2M066
Schwarzkopf	D. Samuel	1T3A001
Schwertner	Emilia	1P1M105
Schyns	Philippe	1P2M080
Sciutti	Alessandra	4P1M007
Scott	Christina	2P2M093
Scott-Samuel	Nicholas	3P2M030 2P2M107 2P1M120
Scott-Samuel	Nick	1T2B005
Sebanz	Natalie	3S1A003 3P2M060
Seglina	Madara	4P2M042
Seibold	Verena C.	2P1M022
Seidel	Dirk	4P2M024
Sekine	Shiori	3P2M016
Sekuler	Allison B.	4P2M008 1T3B007

Sekulovski	Dragan	2P1M080
Serrano-Pedraza	Ignacio	3P1M023 1S1B002
Seya	Yasuhiro	3P2M032 2P2M089 3P2M036 2P1M068 2P2M091
Seymour	Kiley	2T3B003
Shaqiri	Albulena	1T3B001 4P2M036
Sharan	Lavanya	1T2A004
Sharman	Rebecca J.	3P2M028 3P2M012
Sharp	Craig	1S1B002
Shelepin	Yuri	3P2M134 3P1M125
Shen	Ching-Hua	3P2M136
Shen	Mowei	1T2A005
Shepard	Timothy	3T3C005
Shepherd	Alex	2P2M069
Sherry	Katie	4P1M075
Shi	Yaxin	2P1M104
Shi	Zhuanghua	2P2M081
Shigemasu	Hiroaki	4P1M091
Shiina	Kempei	3P2M094
Shiina	Kenpei	3P1M133
Shim	Leeseul	4P1M089
Shimono	Koichi	4P1M107 2P2M003
Shinkai	Takahiro	2P1M030 2P1M090
Shinoda	Hiroyuki	3P2M032 2P1M068 2P2M091 2P2M085 2P2M089 3P2M036
Shirai	Nobu	3P1M097
Shirama	Aya	4P1M041
Shore	David I.	4P2M068
Shoshina	Irina	3P2M134
Siedlecka	Marta	2P2M025
Sikl	Radovan	1P1M023
Silva	Carlos	4P1M125
Silvanto	Juha	3S1B003 1P1M021 2P1M040
Silveira	Luiz Carlos	2P1M078 2P1M074
Simmers	Anita	4P2M112 4P2M056
Simmons	David R.	1T2C006
Sincich	Lawrence	4P2M058
Singh	Divita	1P1M103
Singh	Manish	1S1A002
Skelton	Alice	1T2C001
Skerswetat	Jan	4P2M132
Skilters	Jurgis	3P2M038 3P2M124
Slavat	Natalie	1P2M078
Smeets	Jeroen B.J.	2T2A006 4P2M114
Smith	Andrew T.	2P1M110
Smith	Anika	2T3B005 2P2M093
Smith	Daniel T.	2P2M035
Smith	Daniel	2P1M006 2P1M012
Smith	Danielle	4T3C007

Smith	Fraser	1P2M086
Smith	Laura	2P2M095 3P1M015
Smith	Marie L	1P1M095
Smith	Marie	1P2M054 1T3B002 1P1M097
Smith	William	1P2M088
Smithson	Hannah E	2P2M101
Smithson	Hannah	3T2B006 2P2M103
Solomon	Joshua	3P2M084
Solomon	Samuel G.	2T2C005
Soo	Leili	3P1M091
Sopov	Mikhail	1P1M015
Soranzo	Alessandro	2P1M084 3P2M092
Sormaz	Mladen	1P2M088
Souto	David	1P2M004
Souza	Givago	2P1M074 2P1M078
Sowden	Paul	2P2M059 1P1M117
Spehar	Branka	2T3C006
Spence	Morgan	4T3B008
Sperandio	Irene	3P1M111
Spinelli	Donatella	2P2M083
Spokes	Tara	1T3A005
Spray	Helen	3P1M121
Sreeenivas	Shubha	3T3A005
Srinivasan	Narayanan	3P2M050
Stafford	Tom	1P2M030
Stakina	Yulia	2P2M055
Stephen	Ian	2T3B001 1P1M083
Stephenson	Lisa	1T2A002
Sterzer	Philipp	4T3A001 3P1M013 4P1M033 2T3B003
Stevanov	Jasmina	1T2B005 1P2M116
Stevenson	Dick	2T3B001
Steyaert	Jean	4P2M020
Stockman	Andrew	3T3C002
Storrs	Katherine	3P1M137
Strasburger	Hans	4P2M122
Strauch	Christoph	4S1C005
Strautina	Laura	4P2M138
Stroganova	Tatiana	4P1M029
Stuijfzand	Bobby	1P2M010
Stuijzand	Bobby	4T3A008
Stuit	Sjoerd	4P1M121
Styrkowiec	Piotr	3P2M056
Sullivan	Brian	2P2M021
Sun	Xin	2P2M105
Sun	Zhongqiang	1T2A005
Sunny	Meera	2P2M019 1P1M103 3P1M049 3P1M001 2P2M001 2P1M002
Sutherland	Margaret	4P2M054

Suzuki	Naoto	1P2M052
Suzuki	Yuta	2P1M090
Svatonova	Hana	1P1M023
Svede	Aiga	4P1M037
Swalwell	Robert	2P1M012 2P1M006
Syed	Zeeshan	2P1M020
Sysoeva	Olga	4P1M029
Szczepanowski	Remigiusz	3P2M056
Szukalski	Susann	2P2M039 2S1C002
Szymanek	Larissa	1T2C006
Tai	Chu-Lik	1T3B003
Tajima	Daisuke	4P1M083
Takacs	Jadwiga	1P2M132
Takada	Hideaki	4P2M096
Takagi	Ryu	1P1M059
Takahashi	Aoi	4P2M130
Takahashi	Chie	4P2M018
Takahashi	Nobuko	3P1M093 3P2M094
Takano	Ruriko	1P2M074
Takehara	Takuma	1P2M052
Takehi	Shinya	4P1M043
Takemura	Akihisa	4P2M074
Takemura	Hiromasa	3P1M037
Talas	Laszlo	2P2M107 1T2B005
Tambelli	Renata	1T3B004
Tamm	Gerly	1P1M019
Tamura	Hiroshi	2P2M131
Tan	Ken W. S.	3P1M115
Tanaka	Shota	3P2M078
Tarawneh	Ghaith	4T3C003 4T3C005
Taroyan	Naira A.	2P1M084
Tas	Caglar	3T2A003
Taubert	Nick	1P1M099
Te Pas	Susan	4P1M121
Tebartz van Elst	Ludger	3P1M043
Teufel	Christoph	2T2B004
Thaler	Lore	4P2M076
Tham	Diana Su Yun	2P2M059
Thirkettle	Martin	1P2M030 3T3A006
Thomas	Tony	3P1M049
Thompson	Peter	3P2M106
Thornton	Ian M.	3T3B005 1P2M056
Thoroddsen	Theodora A.	2P2M121
Thut	Gregor	4P1M001 2P2M007
Tiainen	Mikko	3P1M051
Tidbury	Laurence	4P2M104
Tiddeman	Bernard	3T3A001
Tiippana	Kaisa	3P1M051
Timm	Silja	2P2M023

Timmermans	Bert	3S1A004
Timrote	Ieva	4P1M135
Ting	Yun	3P2M088
Tino	Peter	1P2M036
Tkacz-Domb	Shira	2T2C001
Todorovic	Dejan	2T3C004
Togoli	Irene	3T2C003
Toivo	Wilhelmiina	4S1C001
Tokunaga	Rumi	2P2M085
Tolhurst	David	3P2M020
Tomonaga	Masaki	3P1M097
Tonelli	Alessia	4P1M077
Tonin	Diana	2T3A006
Topolinski	Sascha	2S1B003
Torii	Shuko	2P1M116
Torok	Agoston	4P1M093
Toscani	Matteo	1T3C007
Toskovic	Oliver	4T3B007 3P2M072
Towler	John	1T3A007 1P1M085
Trevelyan	Andrew	4P2M028
Truksa	Renars	3P1M021
Tseng	Chia-Huei	3P1M087
Tseng	Chiahuei	3T3B007
Tsetlin	Marina	4P1M029
Tsetsos	Konstantinos	1P2M002
Tudge	Luke	2P1M054
Turvey	Michael	3P2M042
Tyler	Christopher	3P2M084 4P1M101 4P1M081 4P1M099
Ueda	Takashi	3P1M133
Uesaki	Maiko	3P1M037
Ul Haq Katshu	Mohammad Zia	1P1M043
Ulrich	Philip I N	3T3A004
Urabe	Hirotaka	2P2M085
Usher	Marius	3T3B003 2P2M045
Utochkin	Igor	2P2M055 3P2M004
Utz	Sandra	1P2M046
V. McGraw	Paul	4P1M137
Vablas	Andrius	1S1C001
Vainio	Lari	3P1M051
Vainio	Martti	3P1M051
Vakhrameeva	Olga	3P1M125
Vallortigara	Giorgio	1P1M039 3P1M039 3P1M033
Valsecchi	Matteo	3T3C004
Van Alphen	Carlijn	3T2B005
van Assen	Jan Jaap R.	2P1M096
Van der Burg	Erik	2T2C002 4P1M087
Van Der Haegen	Lise	3S1B002
Van der Hallen	Ruth	3P2M118

van der Helm	Peter A.	3S1B004
van der Smagt	Maarten	4P1M121
van Dijk	Mirjan	4T3A003
van Dijk	Pim	4T3A003
van Doorn	Andrea	3P2M110 1S1A005 3P2M126
van Ee	Raymond	1T3B005
Van Humbeeck	Nathalie	3P2M046
van Leeuwen	Cees	2T3C005
van Lier	Rob	3P2M044 2P1M018 1P2M106 1P1M089 3P2M130
van Vliet	Christine	3P2M108
van Wezel	Richard	1T3B005
Vancleef	Kathleen	1S1B006 1S1B002
Vangorp	Peter	1T3C001
Vanmarcke	Steven	4P2M020
Vanni	Simo	3P2M122
Vañó-Viñuales	Javier	1P1M111
Vemuri	Kavita	4S1C007
Veniero	Domenica	2P2M007
Ventura	Dora	2P1M078
Vergeer	Mark	3P1M119
Verma	Ark	3S1B002
Vernon	Richard	3P2M132 3P1M131
Vershinina	Elena	3P2M134
Vicente	Raul	3P1M113
Vigano	Gabriel J	3P1M107
Vignolo	Alessia	4P1M007
Vilarigues	Marcia	2P1M134
Vilidaite	Greta	2P2M093
Vince Nagy	Balazs	3P2M010 3P1M009
Vincent	Benjamin	4T3A005
Vinnikov	Margarita	1T2A001
Vishwanath	Dhanraj	4P1M055
Vivian-Griffiths	Solveiga	3T2A002
Vizioli	Luca	4P1M069 4T3A006
Vogels	Ingrid	2P1M080
Voinov	Pavel	3P2M060 3S1A003
Volberg	Gregor	2T2B005 4P1M095
Volcic	Robert	3P1M065
Volná	Blanka	1P2M054
Volonakis	Timothy N.	2P1M120
von der Heydt	Rüdiger	2T2B006
Vota	Roby Michelangelo	4P2M110 4P1M111 1T2B004
Voudouris	Dimitris	4P1M065
Voyles	Angela	2T3B007
Vromen	Joyce	1T3A003
Vroomen	Jean	4P1M087
Vul	Edward	2T2B003
Vuong	Quoc C	3T3A007 1P2M072

W. Roach	Neil	4P1M137
Wada	Makoto	3P1M069
Wade	Alex	3P2M132 2T3B005 4P1M049 3P1M131
Wade	Nicholas J	4P2M122
Wagemans	Johan	1S1A004 3P1M119 3S1B005 2T2C004 3P1M099 3P2M110 3P2M046 4P2M020 3P2M112 3P2M118 1S1B006
Wagner	Michael	4P1M071
Wahl	Siegfried	4P1M031
Wahn	Basil	4T3B003
Wailes-Newson	Kirstie	2P2M093
Wake	Hiromi	1P1M121
Wake	Tenji	3P2M078
Walker	Peter	1P1M005
Walker	Robin	2P1M110
Wallis	Stuart	4P1M117
Walter	Sabrina	2P2M039
Walthes	Renate	1S1B001
Wamain	Yannick	3P2M054
Wang	Li	4P2M082
Wang	Lina	2P2M105
Wang	Rui	1P1M035 1P2M036
Wang	Yi-Zhong	3S1C002
Wang	Ying	2T2A005
Ward	James	3P2M048
Ward	Robert	3T3A005 1P2M098
Warren	Paul A.	3P1M025 3P1M083 3P1M027 4P2M026 4T3B004 3P1M035
Watanabe	Kana	2P2M003
Watanabe	Toshio	4P1M103
Watanabe	Tsukasa	2P2M003
Watson	Derrick	1P2M006 2P1M026 1P1M107 1P2M002
Watt	Simon	3P1M075 4P2M064
Waugh	Sarah J.	4P2M132
Webb	Ben	1S1B006 4P1M051 1P2M042 4P2M078
Weilnhammer	Veith	2T3B003 3P1M013
Weiss	David	4S1B004
Welbourne	Lauren	4P1M049
Welchman	Andrew E.	4P1M109 1P2M036
Wentura	Dirk	1P2M138
Wereszczynski	Karol	2P2M045
Werner	Annette	3T2B004
Westermann	Gert	1P1M017
White	Mark	4P2M072
Whittaker	Roger	4P2M028

Wierzchon	Michal	2P2M025
Wiggett	Alison	3P1M067
Wijntjes	Maarten	4P1M111 4P2M110 1T2B004
Wilbertz	Gregor	4T3A001
Wilcox	Laurie M.	4P2M102
Wilder	John D.	2T2B001
Wilkins	Arnold	1P2M122
Wilkinson	David T	3T3A004
Wilkinson	Frances	1P2M078
Wilkinson	Victoria	4P1M049
Willenbockel	Verena	3T3A007 1P2M072
Williams	Christopher K. I.	4S1A002
Williams	Dawn	1P1M061
Williams	Guy	1P2M036
Williams	Stacey	1P1M097
Willis	Alexandra	4P2M006
Wilson	Hugh R.	2T2A004
Wincenciak	Joanna	1P1M069 1P1M055 3P2M048
Winkielman	Piotr	2S1B002
Wirth	Anna	4T3B001
Wirth	Benedikt Emanuel	1P2M138
Witzel	Christoph	2P1M070 2P2M077 3T2B005
Wolohan	Felicity	2P2M111 2P1M112
Wong	Hoo Keat	1P1M083
Wong	Kai Pong James	3P2M074
Woodhouse	Rob	2P1M048
Woolgar	Alexandra	1P2M012
Wörner	Rike	3P1M043
Wright	Damien	3P2M114 3S1B006
Wu	Chia-Ching	2P2M099
Wuerger	Sophie	2P2M077 4P2M044 4P2M104 2P2M065 2P2M071
Xiao	Kaida	2P2M071 2P2M065
Xiong	Yingzi	1P2M040
Xu	Qian	2T2A005
Yabuzaki	Jiro	1P2M062
Yamada	Shogo	2P2M089
Yamada	Yohei	3P2M068
Yamaguchi	Motonori	1P1M101
Yamaji	Ryo	3P2M036
Yamakawa	Tatsuya	4P2M096
Yanaka	Kazuhisa	3P1M105 3P1M103
Yaname	Yukako	2P2M131
Yang	Jisien	1P1M073
Yang	Yung-Hao	2P2M051
Yasuda	Masahiro	1P1M047
Yasuda	Takashi	3P1M133
Yates	Julian	2P2M071
Yavna	Denis	2P2M005

Yazdani	Partow	4P2M028
Yeh	Su-Ling	2P2M051
Yen-Wen	Chen	2P2M051
Yeshurun	Yaffa	2T2C001 3P2M090 2T3C006
Yokoi	Kazushi	4P1M017
Yoshida	Hisashi	2P1M050 2P2M129
Yoshida	Masaki	4P2M048
Yoshida	Takako	3P2M078 4P1M083
Yoshikawa	Sakiko	1P1M075
Yoshizawa	Tatsuya	3P2M016
Young	Andrew W.	1P2M088
Yu	Cong	1P2M040
Yu	Deyue	4P2M134
Yu	Miao	1P2M002
Yu	Wenjun	1T2A005
Yue	Yue	1P2M104
Yuen	Kenneth	3P1M007
Yun	Xuyan	3P2M130
Yuras	Gabriel	4S1C003
Yusuke	Fujimoto	2P2M091
Zaidi	Qasim	4S1B008 3P1M081 1T3C004
Zamboni	Elisa	3P1M029
Zamuner	Edoardo	1P2M058
Zang	Xuelian	2P2M081
Zani	Alberto	3P2M022
Zanker	Johannes	4P2M046 2P2M127 1P2M116
Zavagno	Daniele	2P2M073
Zdravkovic	Suncica	1T3C003
Zdravkovi_	Sun_ica	2P1M072
Zehetleitner	Michael	2P1M008 3T3B003
Zhang	Junyun	1P2M040
Zhang	Meng	1T2A005
Zhang	Xue	2T2A005
Zhao	Yuanyuan Aimee	4T3B006
Zhaoping	Li	3T3C001 2T2C006
Zharikova	Aleksandra	2T3C005
Zhou	Jifan	1T2A005
Zhou	Wen	1P2M100
Zhu	Weina	2P1M036 2P2M037
Ziemba	Corey	2T3B007
Ziemele	Anda	4P1M115
Zimasa	Elina	3P2M038
Zimmermann	Friederike G S	1P2M072 3T3A007
Zimmermann	Jan	4P1M109
Zito	Michele	3P2M006
Zlatkute	Giedre	4P1M055
Zoumpoulaki	Alexia	1P1M009
Zubair	Hamza	3P1M001
Zupan	Zorana	2P1M026