

Sharing in neuroimaging: collecting with **Brainmap**, quantitatively analysing and sharing with **ANIMA**

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Institute of Neuroscience and
Medicine (INM-1)
Research Centre Jülich, Germany

Sharing in neuroimaging

- Relating brain and behavior
- Brainmap database
- Quantitative approaches
 - Meta-analyses
 - MACM
 - MACM-based CBP
- ANIMA
- Summary and perspectives

Relating brain and behavior

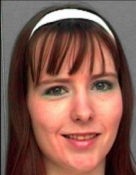
BRAIN

BEHAVIOR



Relating brain and behavior

What is her name?



1. Caroline Ravin
2. Stéphanie Dupont
3. Stéphanie Rufon
4. Caroline Martin

Plant or animal?

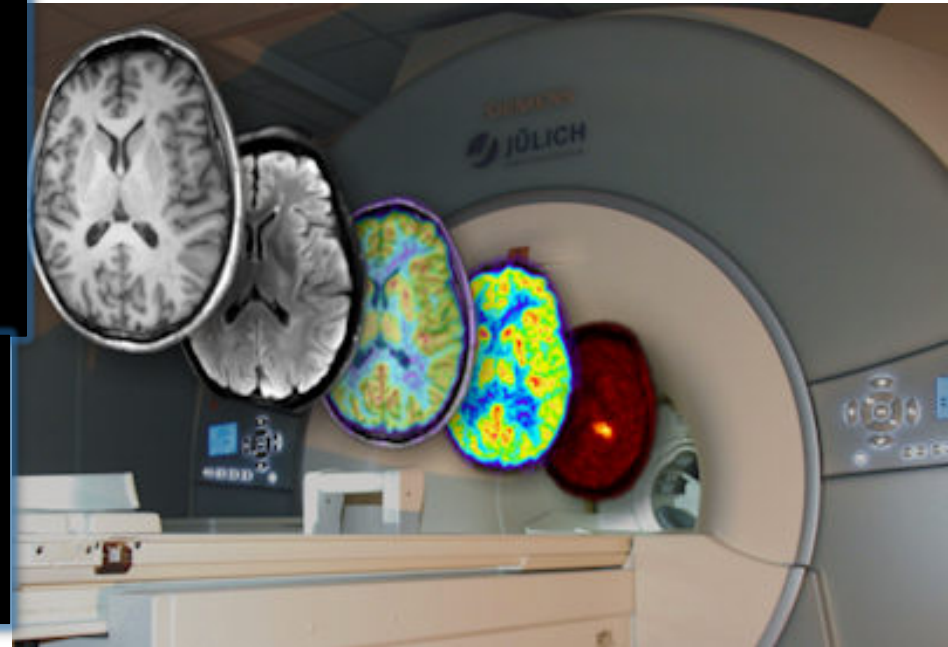
horse

Font color?

Green

Similar to 2-back?

M



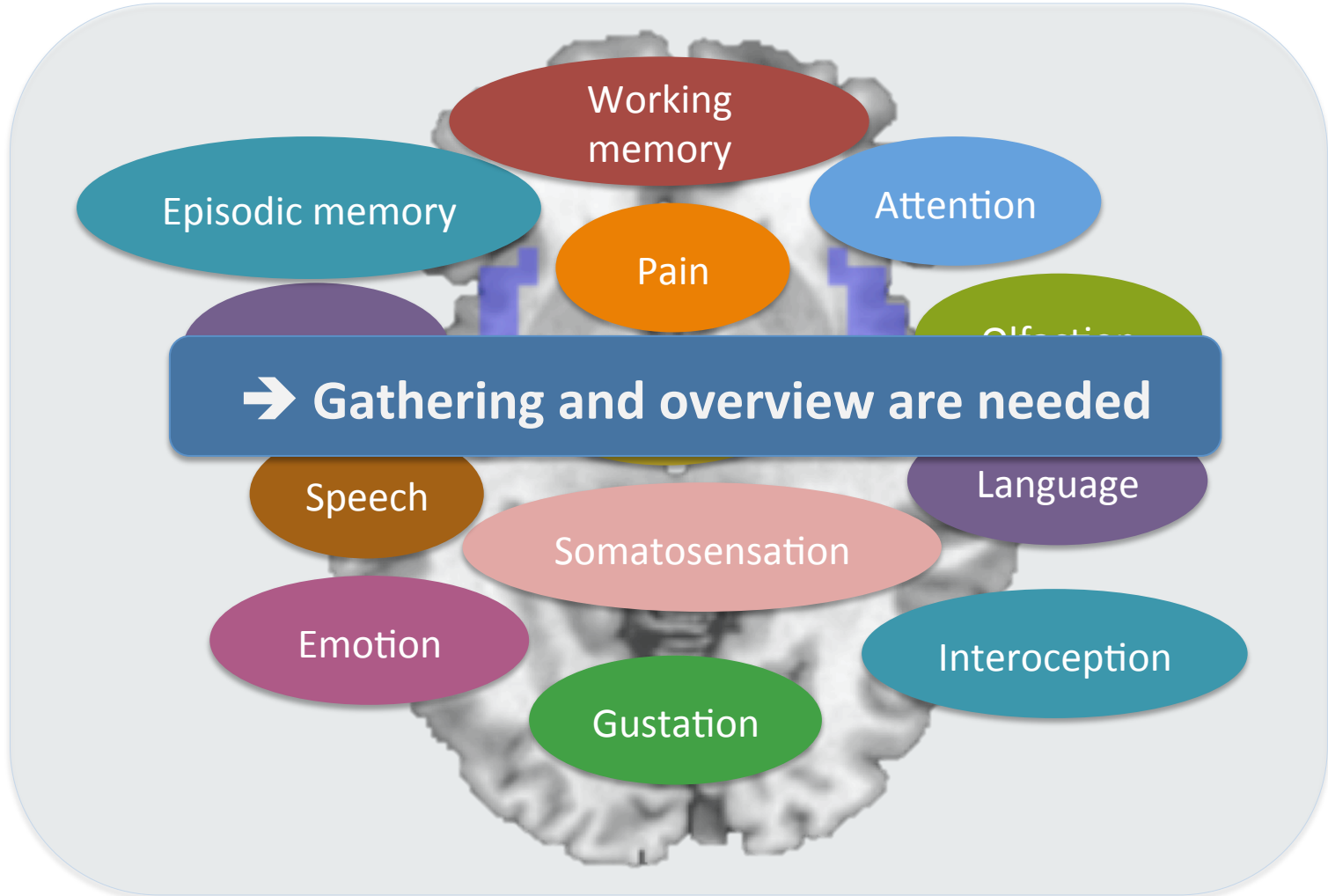
Task-based PET and fMRI studies

more than 20 000 published studies

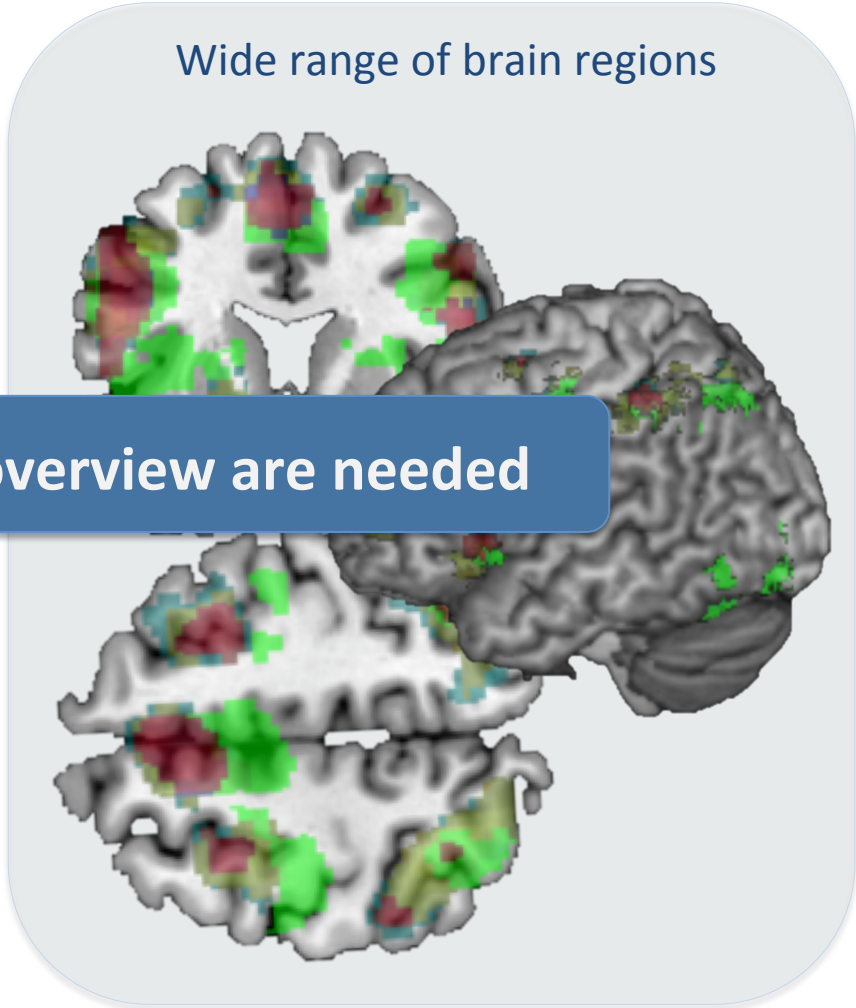
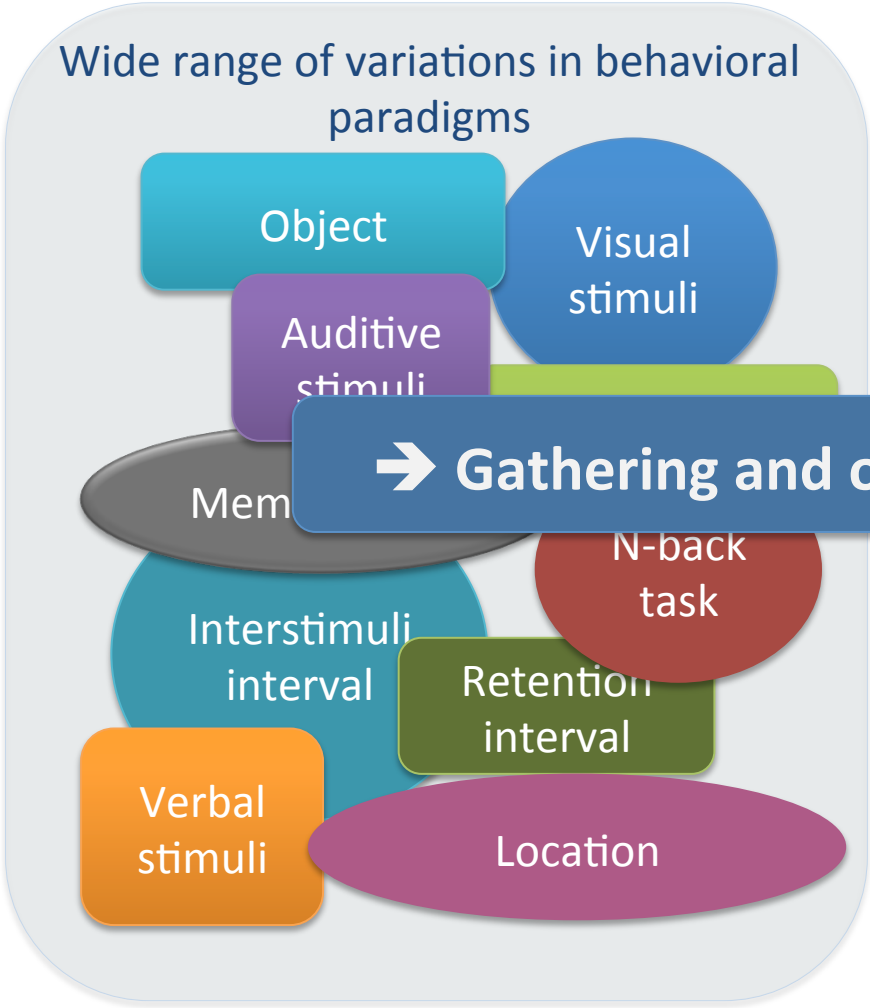
Morphological studies (e.g.: VBM)

more than 1 000 published studies

Functionally characterizing the insula



Neuroimaging working memory



→ Gathering and overview are needed

Gathering data: Brainmap database

- Database of published neuroimaging studies:
 - 2714 functional studies (13034 experiments)
 - 905 VBM studies (2892 experiments)
- Coordinate-based results
 - x,y,z in MNI or talairach space
- Software and concepts for quantitative integration

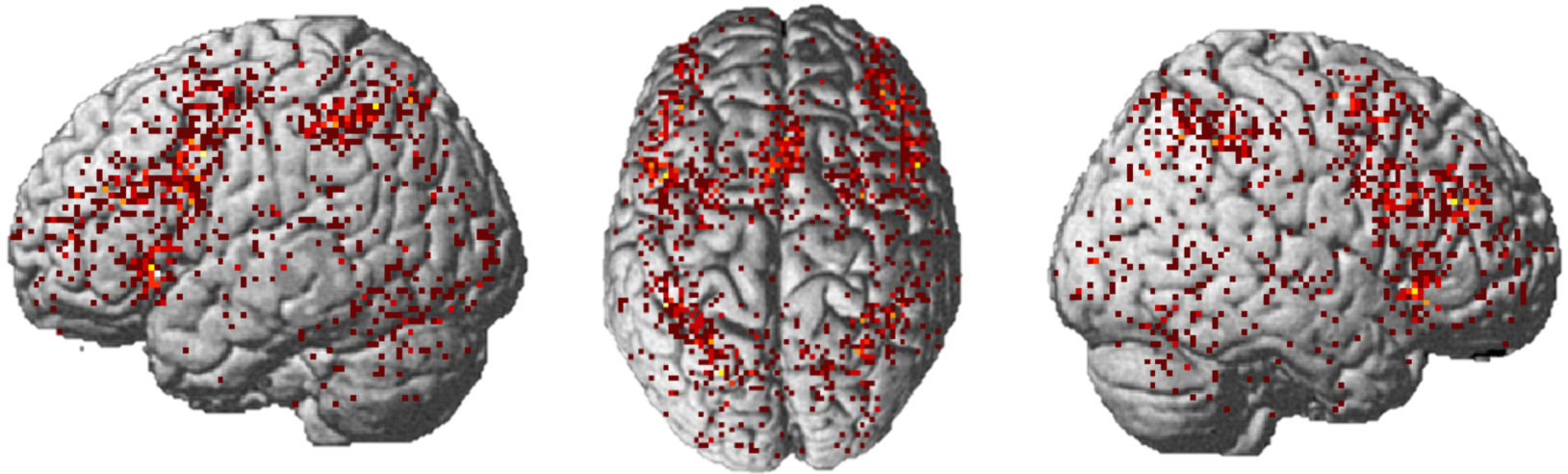


brainmap.org

Quantitative methods: meta-analytic approaches

Functional meta-analysis

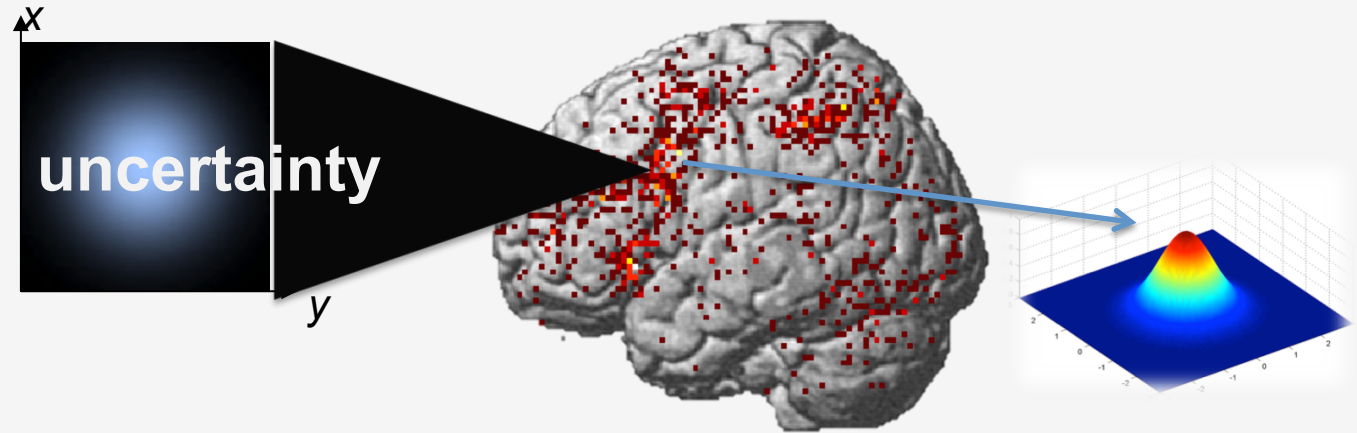
Brain regions most consistently activated by a particular type of function/paradigm/behavioral condition



Where do these foci converge ?

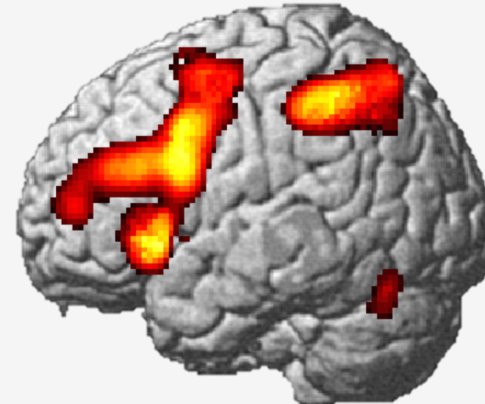
Quantitative methods: meta-analytic approaches

Activation Likelihood Estimation (ALE)



Union over experiments

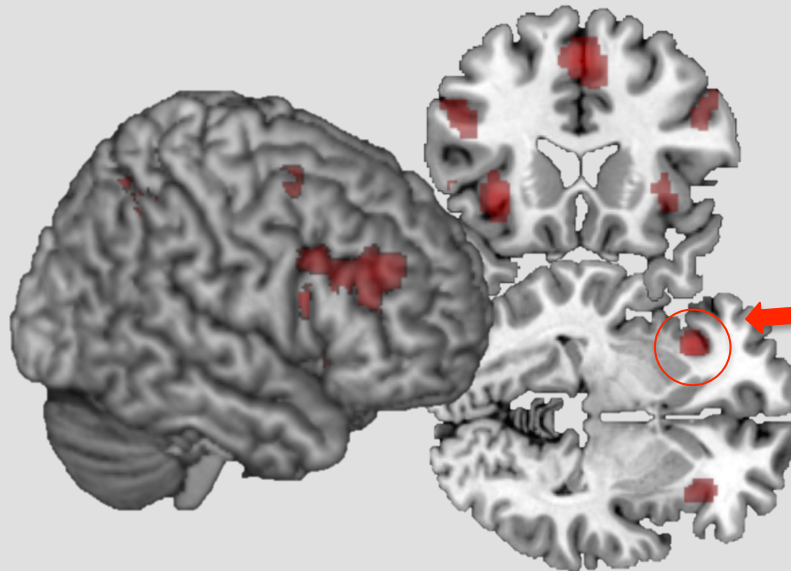
Significance assessed against
random spatial association



Quantitative methods: meta-analytic approaches

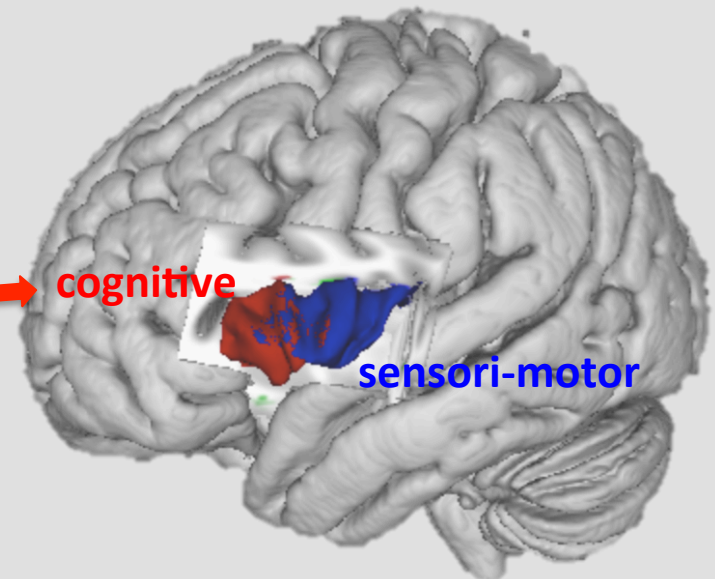
Core working memory network across 113 studies

(Rottschy et al., 2012)



Functional differentiation within the insula

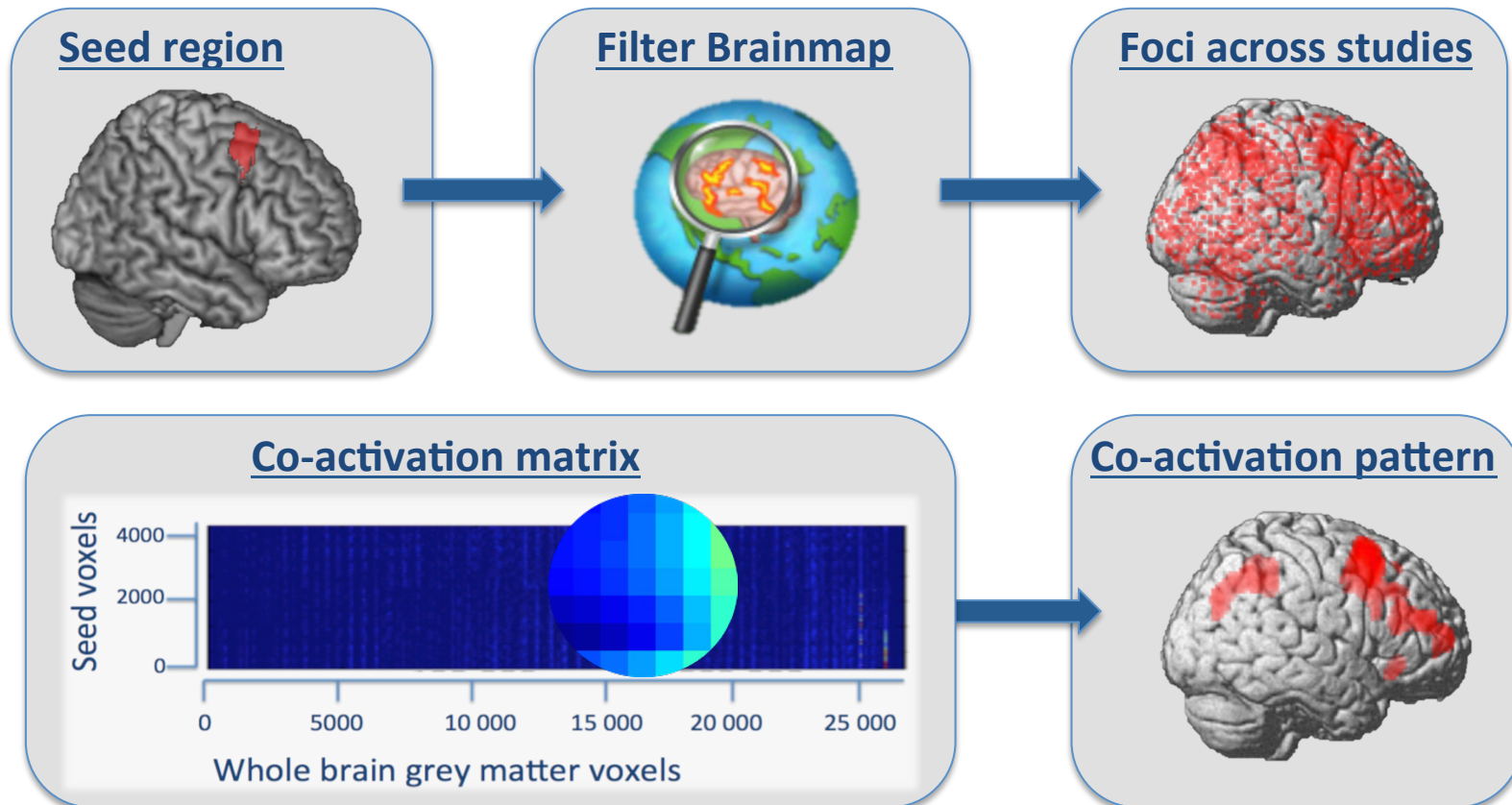
(Kurth et al., 2010)



Quantitative methods: meta-analytic approaches

MACM Meta-analytic Connectivity Modeling

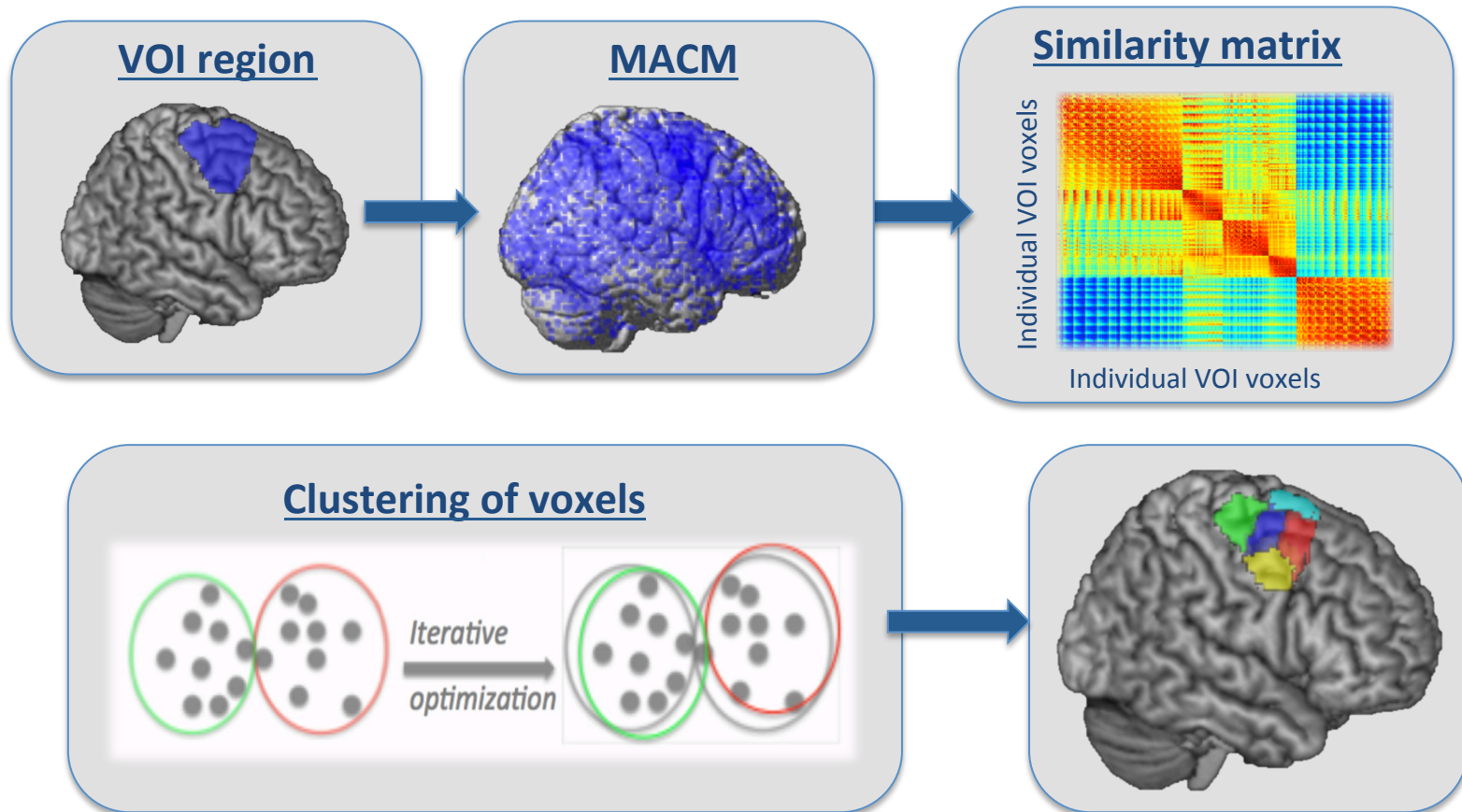
Identification of co-activation pattern of voxels of interest across studies



Quantitative methods: meta-analytic approaches

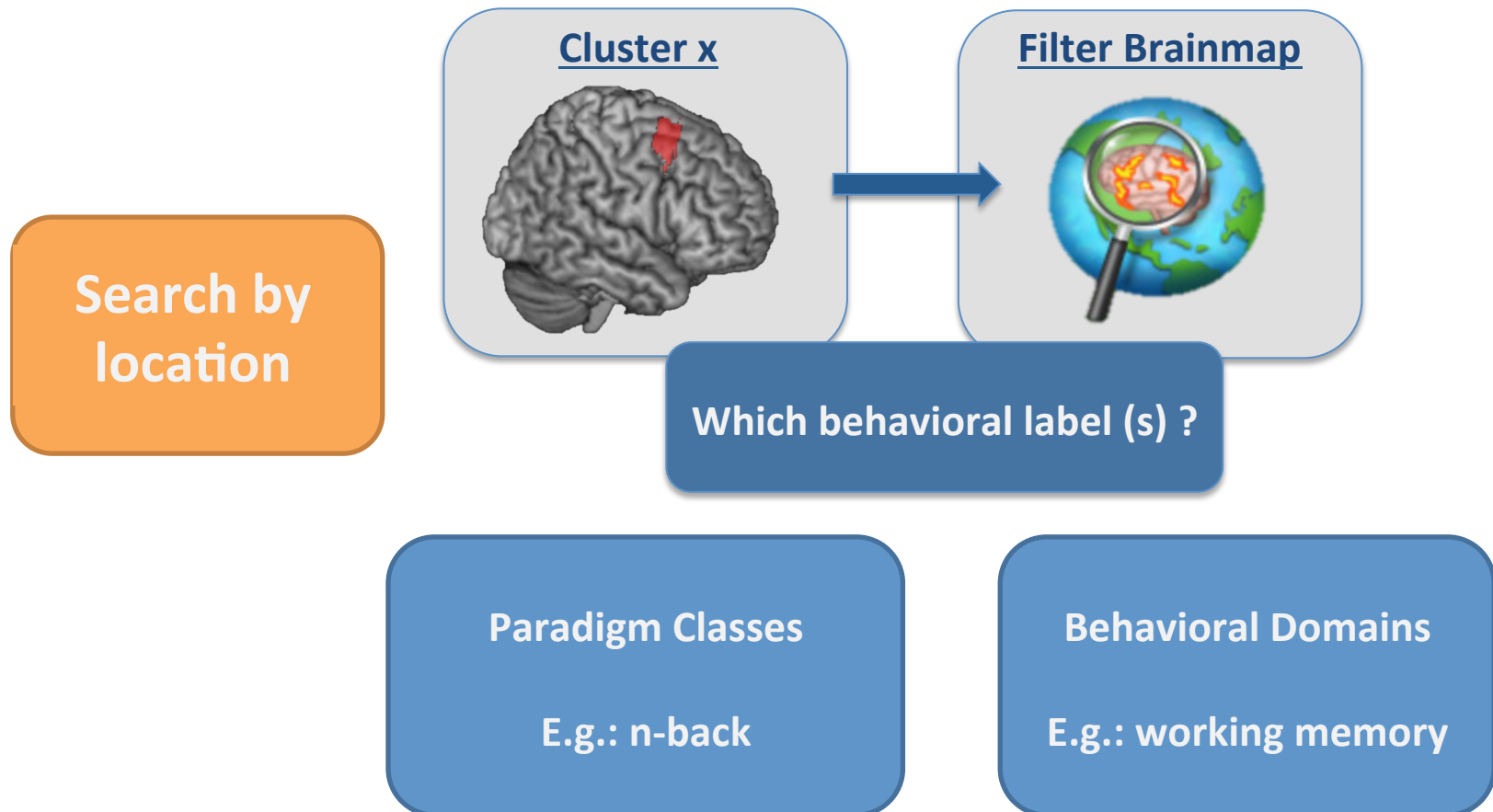
MACM-based parcellation (MACM-CBP)

Parcellation of brain regions according to the co-activation pattern of their voxels



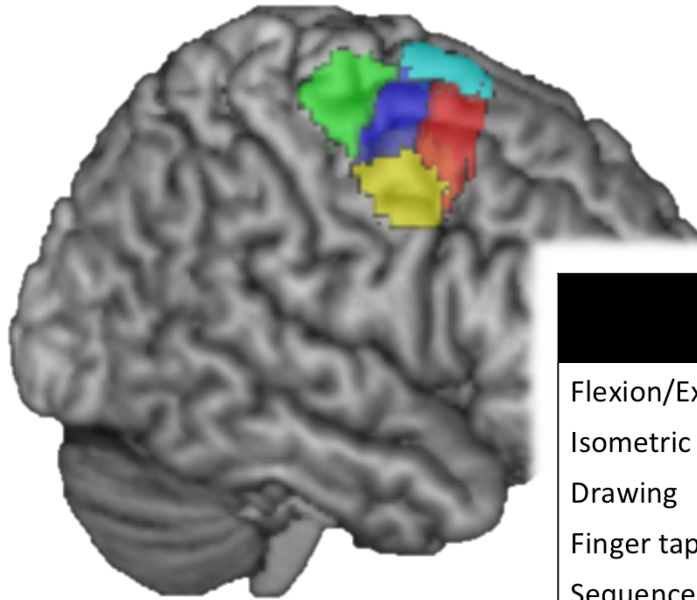
Quantitative methods: meta-analytic approaches

Functional decoding of clusters



Quantitative methods: meta-analytic approaches

MACM-based CBP



(Genon et al., in revisions)

Functional decoding in Brainmap database

	Rostral	Caudal	Central	Ventral	Dorsal
Flexion/Extension		Green			
Isometric force		Green			
Drawing		Green	Blue		
Finger tapping		Green	Blue		Cyan
Sequence recall/learning			Blue		
Visual pursuit/tracking			Blue		
Visual attention/distractor			Blue	Yellow	
Saccades	Red		Blue	Yellow	
Anti-saccades	Red		Blue	Yellow	
Mental rotation	Red		Blue		
Imagined movement			Blue		
N-back	Red				
WCST	Red				

Quantitative methods: meta-analytic approaches

VBM meta-analysis



Goodkind et al., 2015:

193 VBM studies:

Schizophrenia

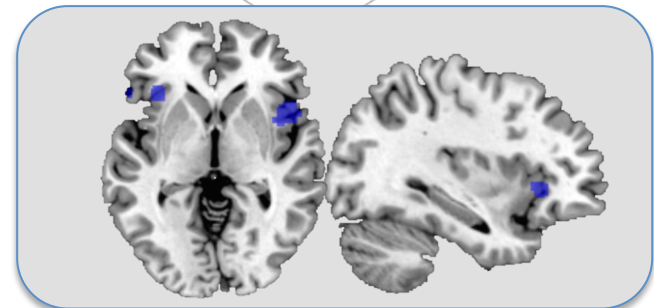
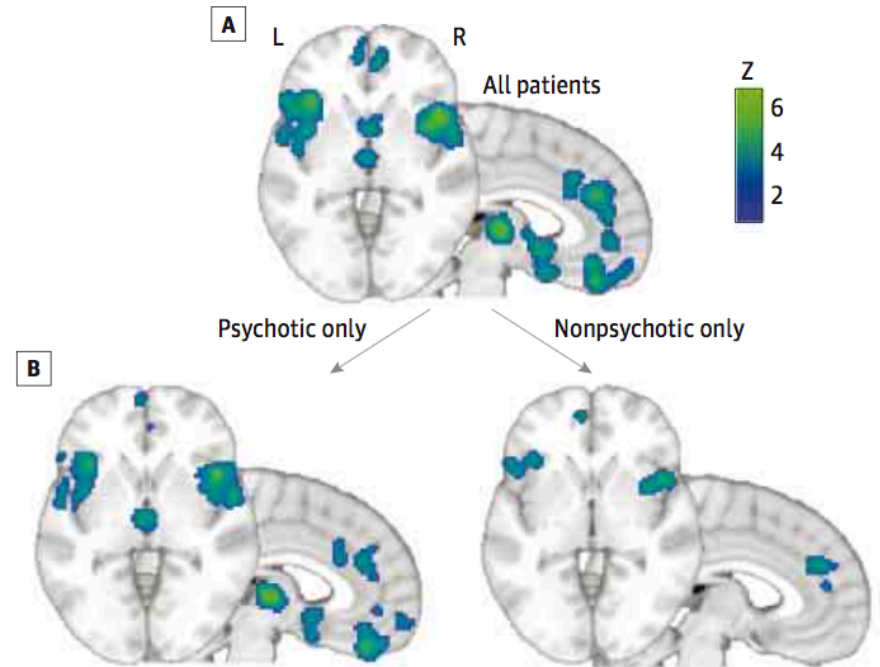
Major depression

Anxiety disorders

Substance abuse disorders

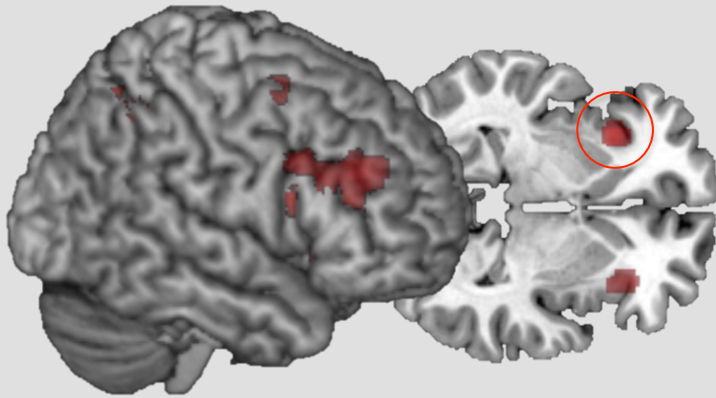
Obsessive-compulsive disorders

Decreased gray matter in psychiatric patients



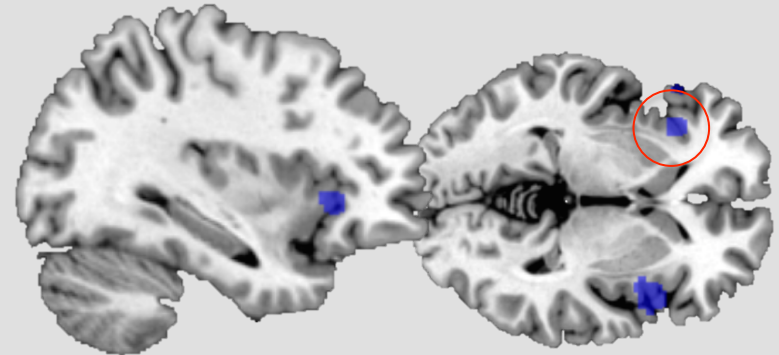
Outcomes of quantitative approaches to big data

Functional meta-analysis:
Working memory core network



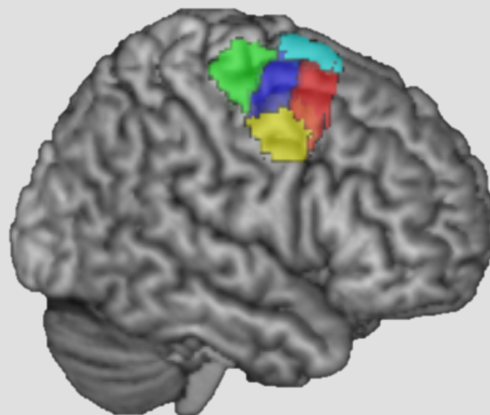
(Rottschy et al., 2012)

VBM meta-analysis:
decreased gray matter in psychiatric patients

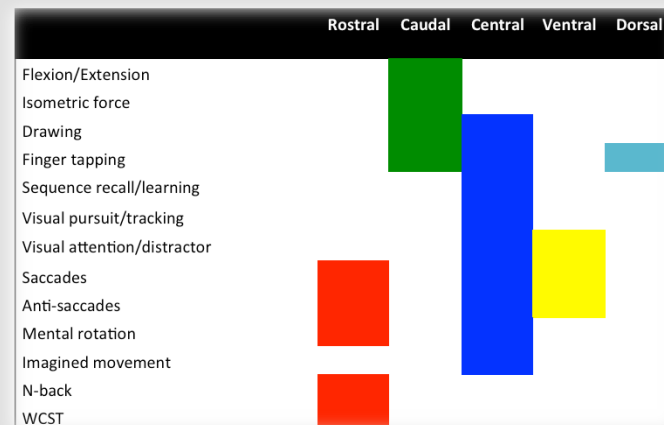


(Goodkind et al., 2015)

MACM-based CBP and functional decoding: right PMd



(Genon et al., in revisions)

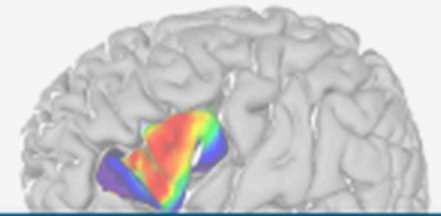


Outcomes of quantitative approaches to big data

Archive of NeuroImaging Meta-Analysis

ANIMA

[beta edition]



WELCOME

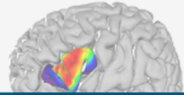
Andrew Reid, Danilo Bzdok, Sarah Genon, Robert Langner, Veronika Müller, Claudia Eickhoff, Felix Hoffstaedter, Edna-Clarisse Cieslik, Svenja Caspers, Peter Fox, Angela Laird, Katrin Amunts and Simon Eickhoff. **Neuroimage. In press.**

<http://anima.modelgui.org/>

ANIMA: download data

ANIMA

[beta edition]



WELCOME

[QUERY](#) [SUBMIT](#) [ABOUT](#)

Search by author:

Sort by author A-Z

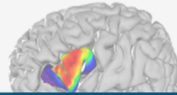
1-5 of 5

<input type="checkbox"/>	Study	Description	Size	Files
<input type="checkbox"/>	<p>Hardwick et al., 2013 A quantitative meta-analysis and review of motor learning in the human brain. <i>Neuroimage</i>. 67: 283-297.</p>	<p>We used activation likelihood estimation (ALE) meta-analysis to examine activations related to motor learning (70 experiments). We searched for converging activations across different motor learning experiments and for specific activations related to serial response time task (SRTT) and sensorimotor tasks. We found a consistent pattern of activity across paradigms in the dPMC, SMC, M1, S1, SPL, thalamus, putamen and cerebellum.</p>	1.7M	5
<input type="checkbox"/>	<p>Krall et al. 2015 The role of the right temporoparietal junction in attention and social interaction as revealed by ALE meta-analysis. <i>Brain Structure and Function</i>. 220(2): 587-604.</p>	<p>We conducted activation likelihood estimation (ALE) meta-analyses to test competing hypotheses about the functional organization of the right temporoparietal junction (rTPJ). A conjunction analysis across ALE meta-analyses delineating regions consistently recruited by reorienting of attention and false belief studies revealed the anterior rTPJ, suggesting an overarching role of this specific region. An anatomical difference analysis revealed the posterior rTPJ as converging more with false belief than with reorienting of attention tasks. Additional meta-analytic connectivity mapping (MACM) and resting-state functional connectivity (RSFC) analyses showed that the posterior rTPJ has connectivity patterns with typical ToM (Theory of Mind) regions, whereas the anterior part of rTPJ co-activates with the attentional network.</p>	648.1K	5
<input type="checkbox"/>	<p>Müller et al. 2014 Interindividual differences in cognitive flexibility: influence of gray matter volume, functional connectivity and trait impulsivity. <i>Brain Structure and Function</i>. 220(4): 2401-2414.</p>	<p>We examined whether cognitive flexibility is associated with gray matter volume (GMV) and functional connectivity (FC) of regions of a core network of multiple cognitive demands as well as with different facets of trait impulsivity. Card-sorting performance correlated positively with GMV of the right anterior insula, FC between bilateral anterior insula and midcingulate cortex/supplementary motor area. GMV, FC and impulsivity together accounted for more variance of card-sorting performance than every parameter</p>	471.6K	3

ANIMA: download data

ANIMA

[beta edition]




STUDY INFORMATION

QUERY SUBMIT ABOUT

STUDY

ELEMENTS

VIEW

Rottschy et al. 2012

Modelling neural correlates of working memory: A coordinate-based meta-analysis

Neuroimage. 60: 830-846.

C. Rottschy, R. Langner, I. Dogan, K. Reetz, A.R. Laird, J.B. Schulz, P.T. Fox, S.B. Eickhoff



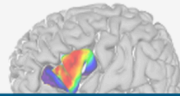
ABSTRACT: Working memory subsumes the capability to memorize, retrieve and utilize information for a limited period of time which is essential to many human behaviours. Moreover, impairments of working memory functions may be found in nearly all neurological and psychiatric diseases. To examine what brain regions are commonly and differently active during various working memory tasks, we performed a coordinate-based meta-analysis over 189 fMRI experiments on healthy subjects. The main effect yielded a widespread bilateral fronto-parietal network. Further meta-analyses revealed that several regions were sensitive to specific task components, e.g. Broca's region was selectively active during verbal tasks or ventral and dorsal premotor cortex were preferentially involved in memory for object identity and location, respectively. Moreover, the lateral prefrontal cortex showed a division in a rostral and a caudal part based on differential involvement in task set and load effects. Nevertheless, a consistent but more restricted "core" network emerged from conjunctions across analyses of specific task designs and contrasts. This "core" network appears to comprise the quintessence of regions, which are necessary during working memory tasks. It may be argued that the core regions form a distributed executive network with potentially generalized functions for focussing on competing representations in the brain. The present study demonstrates that meta-analyses are a powerful tool to integrate the data of functional imaging studies on a (broader) psychological construct, probing the consistency across various paradigms as well as the differential effects of different experimental implementations.

Keywords: Activation likelihood estimation -- DLPFC -- Manipulation -- Memory load -- Short-term memory -- Storages
Submitted by: andrew
Current version: 2
Last modified: 2015-02-01 18:05:08
Redistributable: true
ANIMA ID: 931420

ANIMA: download data

ANIMA

[beta edition]



STUDY INFORMATION






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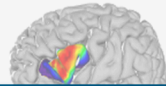
VIEW

Study elements for Rottschy et al. 2012:

Name	Type	File	Caption	Size	View
Overview	VolumeViewerSession	meta_wm.vvs	Volume Viewer Session containing all figure images with appropriate colour mapping.	21.0M	
Figure 1	VolumeFile	WM_cFWE05_001_114.nii.gz	Figure 1. Main effect across all 189 working memory experiments revealing consistent bilateral activation of a fronto-parietal network.	49.0K	
Figure 2b	VolumeFile	MoreWM_cFWE05_001_182.nii.gz	Figure 2B. A conjunction analysis of task set and load effects displayed a bilateral fronto-parietal network similar to the main effect.	22.9K	
Figure 3b	VolumeFile	NbackSternbergVerbalNonve...i.gz	Figure 3B. A conjunction analysis over verbal and non-verbal tasks revealed activation of a fronto-parietal network similar to the main effect.	8.5K	
Figure 4b	VolumeFile	What--Where_uc05.nii.gz	Figure 4B. Conjunction analysis of object identity and object location.	87.6K	
Figure 5	VolumeFile	WM_AND_MoreWM_cFWE05.nii.gz	Figure 5. The working memory core network. Left dominant bilateral activation of regions showing converging activations in each of the following analyses: task effects for n-back and Sternberg tasks, verbal and non-verbal tasks, load effects and all three phases (encoding, maintenance, recall).	21.0K	

ANIMA: compare data

ANIMA [beta edition]



STUDY INFORMATION

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File View Options

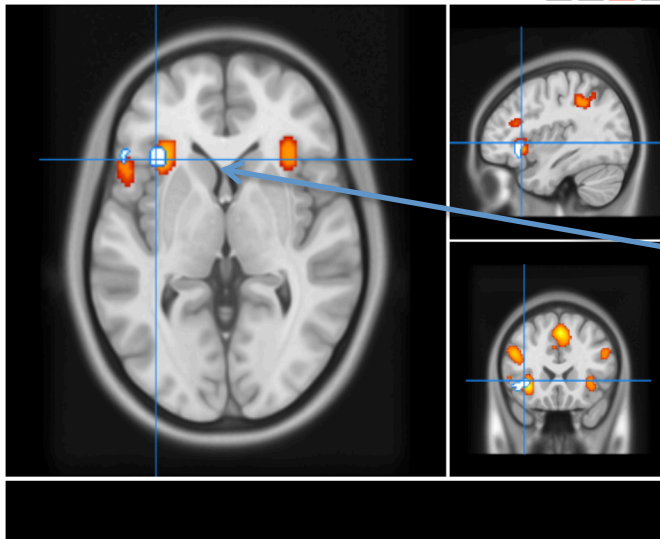


Figure 2b

Figure 2B. A conjunction analysis of task set and load effects displayed a bilateral fronto-parietal network similar to the main effect.

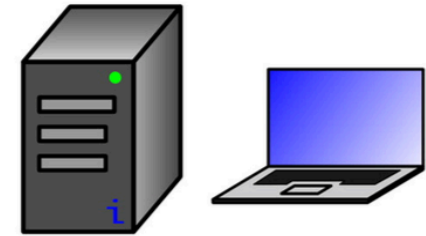
Quantity: Conjunction

Coordinate space: ICBM-152

Threshold method: FWE corrected

Left insula decrease in psychiatric patients (Goodkind et al., 2015)

ANIMA: Overview



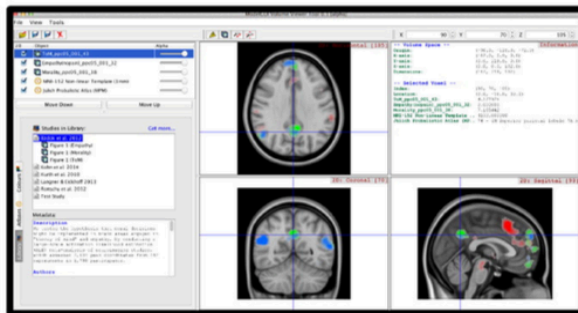
Local storage



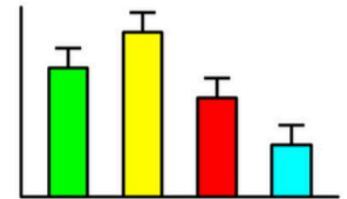
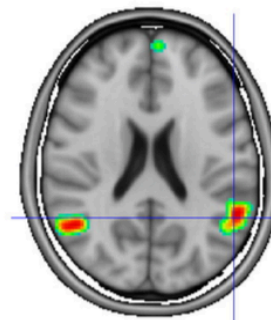
look directly

import

use directly



Volume Viewer



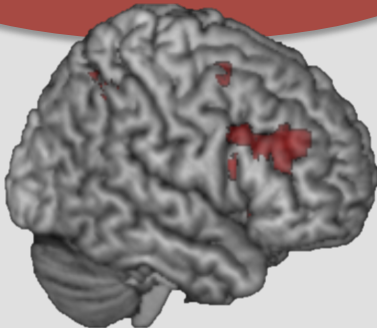
Further analyses

Summary and perspectives

- Thousands of neuroimaging studies
- Brainmap collects and organizes the data
- Meta-analytic methods consolidate patterns

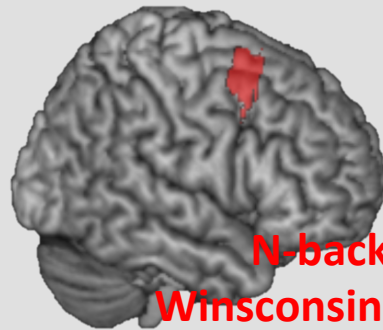
Where (brain) ?

Working memory

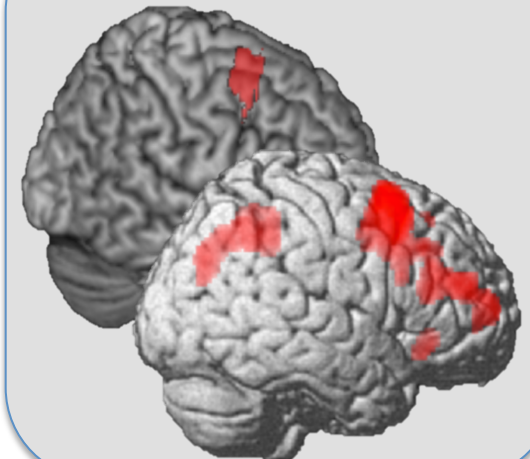


What (behavior) ?

N-back
Wisconsin Card
Sorting Test
Mental rotation



Coworkers (brain) ?



Summary and perspectives

- Sharing and integrating with ANIMA
- Collaborative neurosciences and Human Brain Project:
 - Multimodal and multiscale brain atlases
 - Multiscale: from cell to structure entity
 - Multimodal: from structural to functional data



Summary and perspectives

From structural properties to behavioral functions



Structural

Microstructure: Jubrain

Structural connectivity: PDT-based CBP

Resting state functional connectivity: RSFC-based CBP

Task-based functional connectivity: MACM-based CBP

Functional

Behavioral functions?



Simon Eickhoff
Robert Langner
Veronika Müller
Edna Cieslik
Andrew Reid
Danilo Bzdok
Claudia Rottschy
Felix Hoffstaedter
Julia Camilleri
Rachel Pläscke
Deepthi Varikuti
Alessandra Nostro

Düsseldorf

Katrin Amunts
Alfons Schnitzler
Karl Zilles

San Antonio

Peter T. Fox

Miami

Angela R. Laird

Funding:



Thank you for your attention.



Structured behavioral taxonomy

Behavioral domain

Action
 Execution
 Speech
 Imagination
 Inhibition
 Motor Learning
 Observation
 Preparation
 Rest

Cognition
 Attention
 Language
 Orthography
 Phonology
 Semantics
 Speech
 Syntax
 Memory
 Explicit
 Implicit
 Working
 Music
 Reasoning
 Soma
 Space
 Time

Emotion
 Anger
 Anxiety
 Disgust
 Fear
 Happiness
 Humor
 Sadness

Cognition

- Attention
- Language
- Orthography
- Phonology
- Semantics
- Speech
- Syntax
- Memory
- Explicit
- Implicit
- Working
- Music
- Reasoning
- Soma
- Space
- Time

Paradigm class

Action Observation
 Acupuncture
 Anti-Saccades
 Braille Reading
 Breath-Holding
 Classical Conditioning
 Counting/Calculation
 Cued Explicit Recognition
 Deception Task
 Deductive Reasoning
 Delayed Match to Sample
 Divided Auditory Attention
 Drawing
 Eating

Olfactory Monitor/Discrimination
 Orthographic Discrimination
 Pain Monitor/Discrimination
 Paired Associate Recall
 Passive Listening
 Passive Viewing
 Phonological Discrimination
 Pitch Monitor/Discrimination
 Pointing
 Posner Task
 Reading (Covert)
 Reading (Overt)
 Recitation/Repetition (Covert)
 Recitation/Repetition (Overt)
 Rest
 Reward Task
 Saccades
 Semantic Discrimination
 Sequence Recall/Learning
 Simon Task
 Spatial/Location Discrimination
 Sternberg Task
 Stroop Task
 Syntactic Discrimination
 Tactile Monitor/Discrimination
 Task Switching
 Theory of Mind Task
 Tone Monitor/Discrimination
 Transcranial Magnetic Stimulation
 Vibrotactile Monitor/Discrimination
 Visual Distractor/Visual Attention
 Visual Pursuit/Tracking
 Wisconsin Card Sorting Test
 Word Generation (Covert)
 Word Generation (Overt)
 Word Stem Completion (Covert)
 Word Stem Completion (Overt)
 Writing

Examples of paradigm

- N-back
- Sternberg task
- Wisconsin Card Sorting Test

Grasping
 Imagined Movement
 Imagined Objects/Scenes
 Isometric Force
 Mental Rotation
 Micturition Task
 Music Comprehension/Production
 n-back
 Naming (Covert)
 Naming (Overt)
 Non-Painful Electrical Stimulation
 Non-Painful Thermal Stimulation
 Oddball Discrimination

Gathering and sharing data: Brainmap database



BrainMap Sleuth 2.3.3

Functional Database Voxel-Based Morphometry Database

Search Results Workspace Plot

Choose your search criteria:

Experiments is

Experiments is

Choose your search logic: Experiments must match of the following groups of criteria

Paradigm Class

Activation

Paradigm Class is n-back

Activation is Activations Only

The BrainMap Functional database contains 2714 papers, 106 paradigm classes, 54271 subjects, 13034 experiments and 104291 locati...



Gathering and sharing data: Brainmap database



BrainMap Sleuth 2.3.3

Functional Database

Voxel-Based Morphometry Database

Search Results Workspace Plot

Your search returned 137 papers, with 561 of 669 experiments matching criteria. Check papers to download them.

Download	BMapID	Year	First Author	Journal	Citation
<input type="checkbox"/>	30139	2002	Hasson U	Neuron	Prose Description
<input type="checkbox"/>	30199	2002	Shaw M E	NeuroImage	Experiment Info
<input type="checkbox"/>	30200	1999	Shen L	Human Brain Mapping	
<input type="checkbox"/>	30214	2002	Zago L	Neuroscience Letters	
<input type="checkbox"/>	30243	2000	Clark C R	Human Brain Mapping	
<input type="checkbox"/>	30283	1996	Maquet P	NeuroImage	
<input type="checkbox"/>	30371	2001	Braver T S	NeuroImage	
<input checked="" type="checkbox"/>	30372	1997	Braver T S	NeuroImage	
<input type="checkbox"/>	30374	1999	Callicott J H	Cerebral Cortex	
<input type="checkbox"/>	30375	1998	Carlson S	Cerebral Cortex	
<input type="checkbox"/>	30381	2001	Druzgal T J	Cognitive Brain Research	
<input type="checkbox"/>	30420	2003	Veltman D J	NeuroImage	
<input type="checkbox"/>	30425	1998	Casey B J	NeuroImage	
<input type="checkbox"/>	30428	1994	Cohen J D	Human Brain Mapping	
<input type="checkbox"/>	30429	1997	Cohen J D	Nature	

Paper #30372

● Citation

Paper ID: 30372

Title: A parametric study of prefrontal cortex involvement in human working memory

Authors: Braver T S, Cohen J D, Nystrom L E, Jonides J, Smith E E, Noll D C

Journal: NeuroImage

Volume: 5

Pages: 49-62

Date: Jan 1997

Medline Number: 9038284

PubMed URL: http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9038284&dent=Abstract

Clear Results

Download Checked

Download All



brainmap.org

Gathering and sharing data: Brainmap database



BrainMap Sleuth 2.3.3

Functional Database Voxel-Based Morphometry Database

Search Results **Workspace** Plot

1 paper, 8 subjects, 1 experiment, 4 conditions, 12 locations

BMapID	Year	1st Auth.	Journal	#	Experiment Name	Behavioral Domain	#Loc		
<input checked="" type="checkbox"/>	30372	1997	Braver T S	NeuroImage	1	Brain Areas Showing Monoto...	Cognition.Memory.Working	12	

- Citation
- Submitter
- Prose Description
- Subjects
- Conditions**
- Brain Template
- Experiments
- Results Synopsis

Paper #30372

- **Conditions**
 - 1. Zero-Back Task**
Stimulus: Visual, Letters,
Response: Hand, Button Press,
Instruction: Attend,
External Variable: Accuracy, Reaction Time,
 - 2. One-Back Task**
Stimulus: Visual, Letters,
Response: Hand, Button Press,
Instruction: Recall,
External Variable: Accuracy, Reaction Time,
 - 3. Two-Back Task**
Stimulus: Visual, Letters,
Response: Hand, Button Press,
Instruction: Recall,

Remove All Papers View Plot



Gathering and sharing data: Brainmap database

