Multimodal parcellations and extensive behavioral profiling tackling hippocampus' gradient

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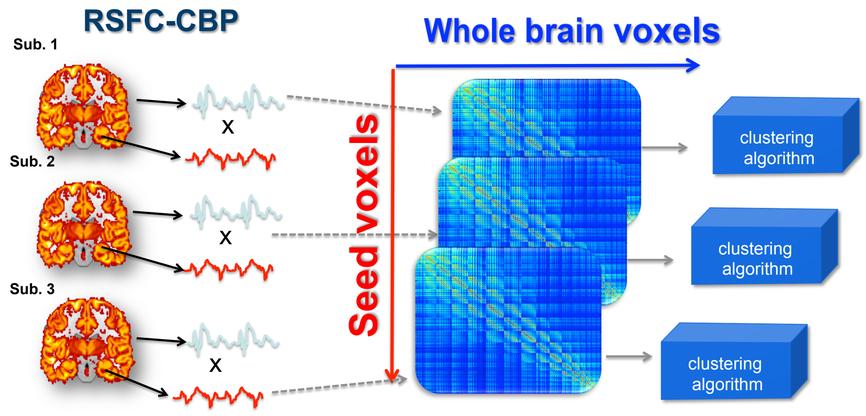
Introduction

- Hippocampus is histologically organized in the medio-to-lateral direction [1], and displays a **functional differentiation** along the **longitudinal axis** at the macro-level
- This study investigated the **functional organization** of the hippocampus with **Connectivity-Based Parcellation (CBP)** applied to different neuroimaging data: task-(in)dependent functional connectivity (RSFC, MACM) and structural covariance (SC)
- The derived multimodal map was **characterized with behavioral profiling** of two complementary databases, **BrainMap** and **NeuroSynth**

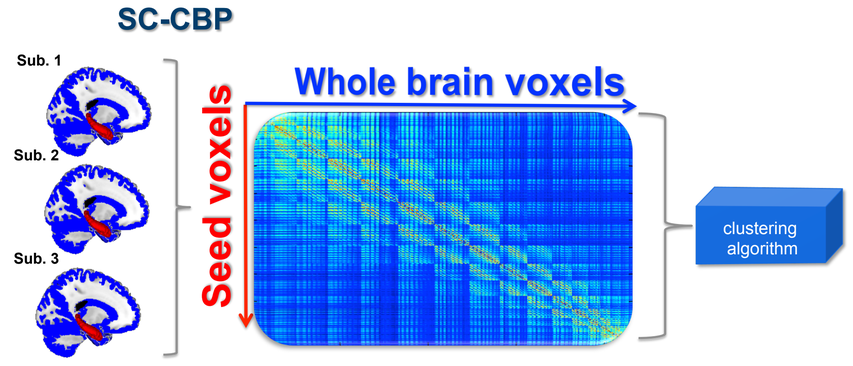
Methods

- Hippocampus **VOI**  from SPM Anatomy Toolbox & Harvard-Oxford Atlas
- **RSFC**: task-independent functional connectivity at rest
- **MACM**: task-dependent functional connectivity across BrainMap experiments
- **SC**: proxy for coplasticity, Voxel Based Morphometry (VBM) for grey matter probabilities modulated for non-linear transformations only
- RSFC-CBP and SC-CBP performed on functional and structural MRI data of a young cohort: **HCP (n = 323)**



Clustering:

- k-means for k=2-7, 500 repetitions, 255 iterations



Reliability and validity assessment:

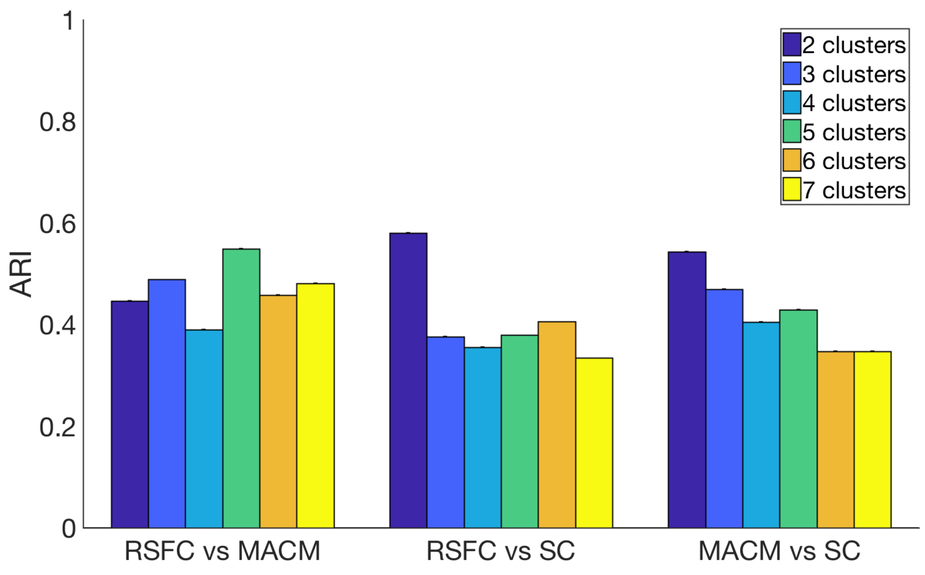
- Internal stability: 10 000 split-half resampling
- Biological plausibility: across modalities with 10 000 bootstrap cross-validation
- Consistency measure: adjusted Rand Index (aRI)

Statistics:

- Analysis of Variance (ANOVA) performed on split-half-, bootstrap samples, RSFC voxels' time-course similarity, voxels' connectivity profile dissimilarity

Results

Multimodal parcellations



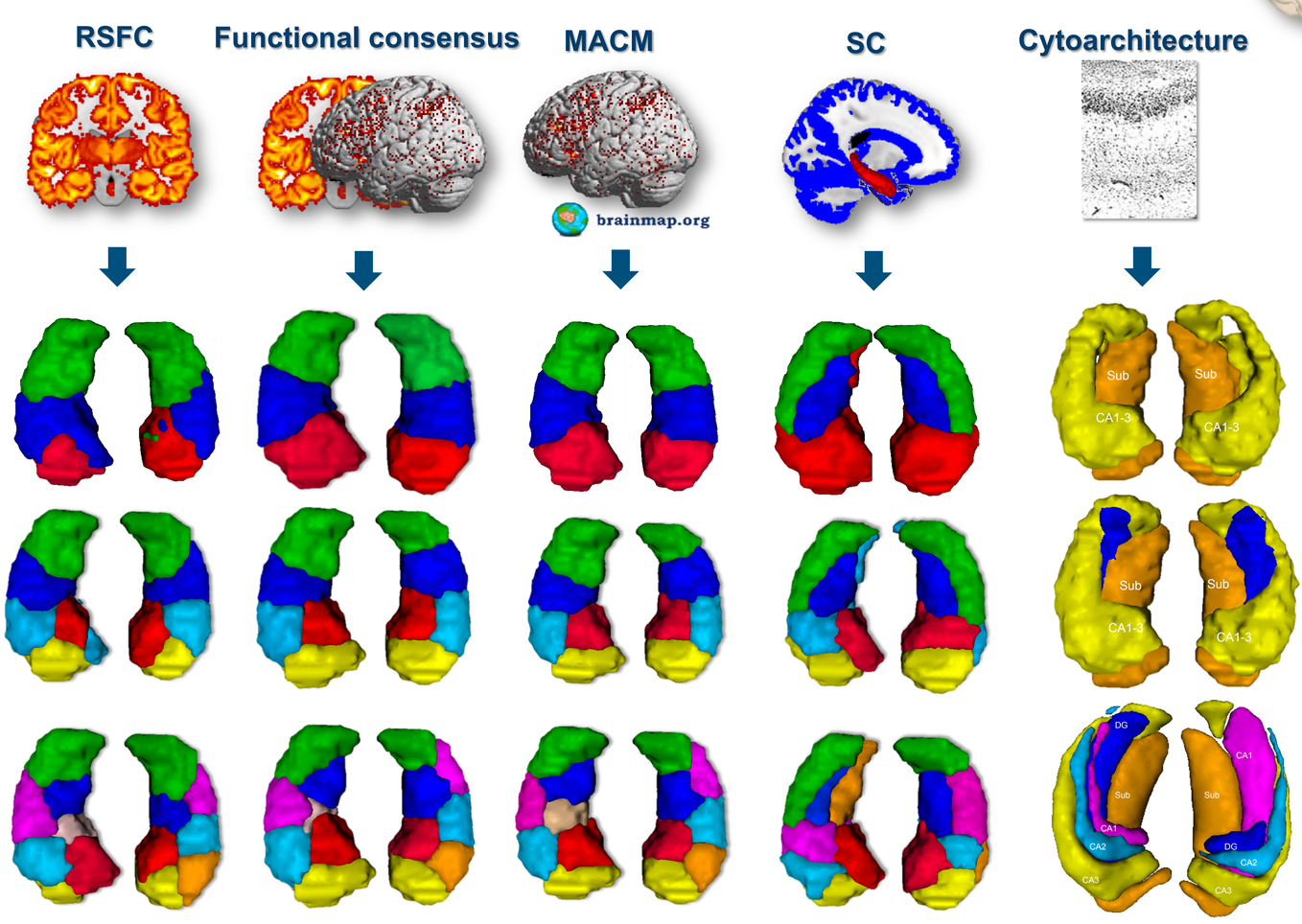
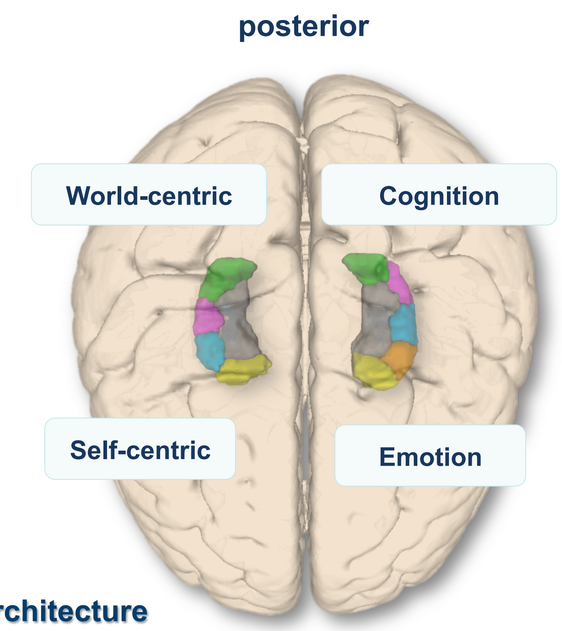


Figure 1. Multimodal parcellations compared to cytoarchitecutre. Note: bars represent mean and +/- standard error.

Behavioral profiling



Emotion-cognition gradient

	lateral	posterior	intermediate lateral 1	intermediate lateral 2	anterior lateral	anterior rostral
Emotion	Emotion.Sadness					
	Emotion.Disgust					
	Emotion.Fear					
	Emotion.Happiness					
	Emotion					
Cognition	Cognition.Memory					
	Cognition.Language.Semantics					
	Cognition.Memory.Explicit					

General psychological processes

	lateral	posterior	intermediate lateral	anterior lateral	anterior rostral
Encoding					
Reward anticipation, reinforcement					
Learning					
Familiarity					
Recognition					
Memory					
Recollection					
Retrieval					
Neutral*					

* neutral stimuli, neutral faces, emotional neutral

Self-world centric gradient

	lateral	posterior	intermediate lateral	anterior lateral	anterior rostral
Navigation					
Context					
Scenes, pictures					
Episodic memory					
Autobiographical					
Face					
Emotion*					
Anxiety					
Fear**					
Threat					

* emotional valence , ** fearful faces

Figure 2. Behavioral profiling of functional consensus hippocampus with BrainMap and NeuroSynth.

- Cross-modal consistency promoted **cluster solutions 3, 5 and 7** ($p < .0001$) as the highest convergence between RSFC and MACM
- **SC** showed low similarity for the two purely functional estimates (RSFC and MACM) and displayed most notably a **medial-lateral organization** mirroring cytoarchitectonic subfields in the body and tail
- Behavioral profiling confirmed a **functional emotion-cognition gradient along the anterior-posterior axis** and suggested additionally with NeuroSynth **a self vs world centric processing gradient**

Discussion

- For the first time, our multimodal parcellations showed that organizational pattern based on purely functional connectivity estimates differed from the pattern derived based on co-plasticity in healthy adults
- The latter reminded of the cytoarchitecture differentiation in addition to the anterior-posterior differentiation
- Importantly, both functional connectivity estimates converge towards the same pattern allowing a robust cross-modal functional map of the hippocampus
- Our behavioral profiling suggested a self- world centric processing gradient complementing the well-known emotion-cognition gradient

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