Recent and upcoming developments

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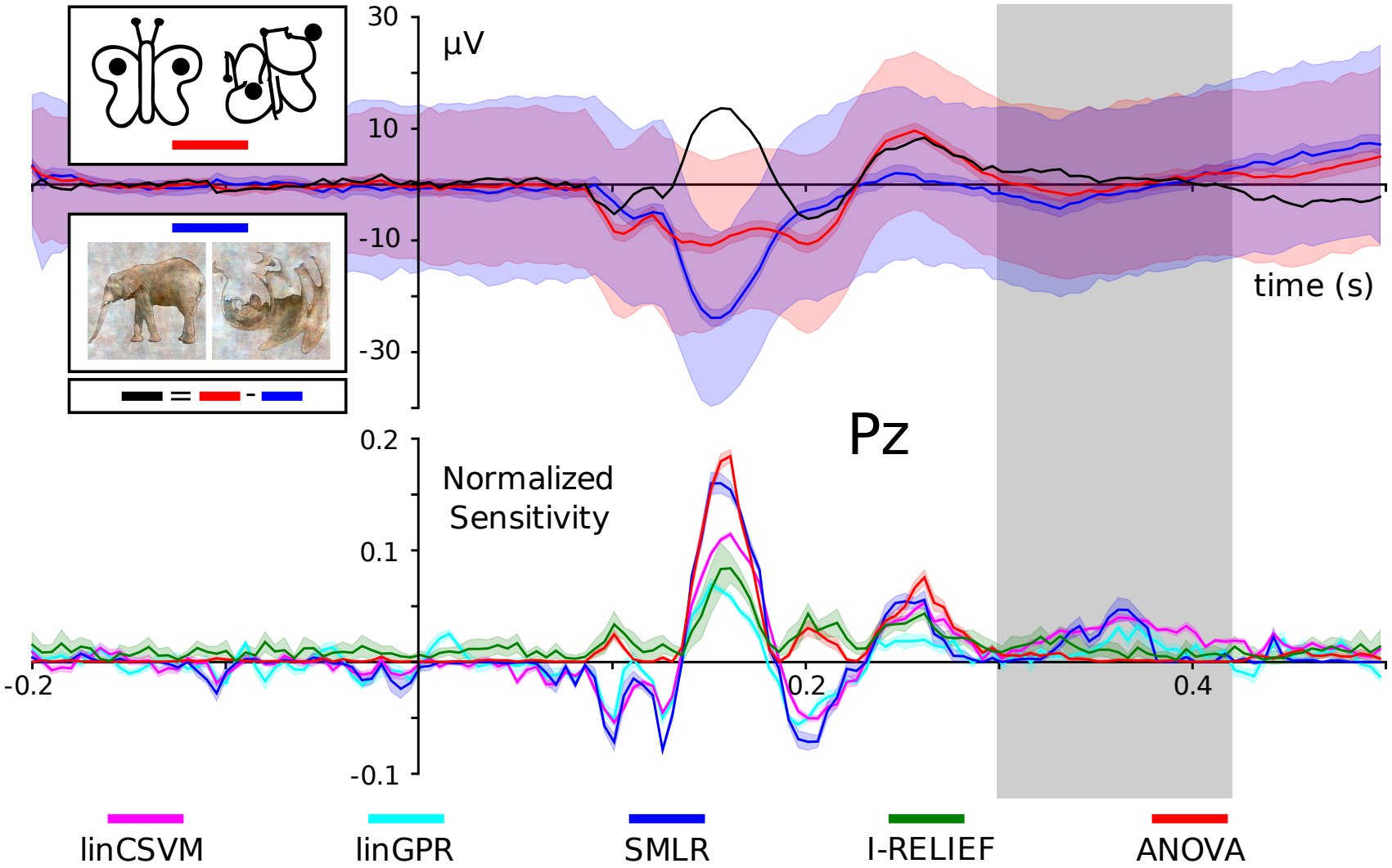
Giessen 2014

Modality agnostic

sensitivity analysis

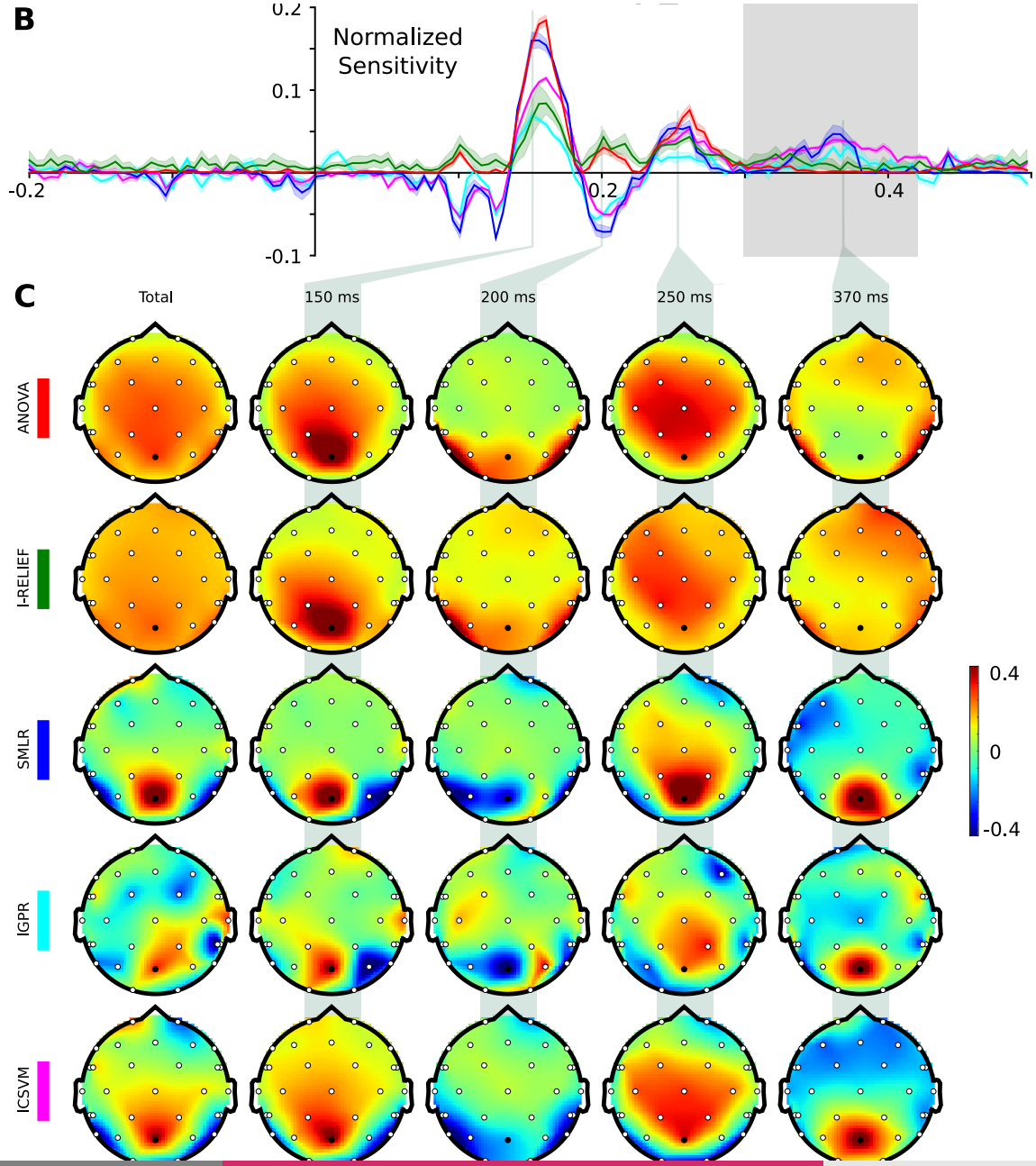
Modality-independent: EEG



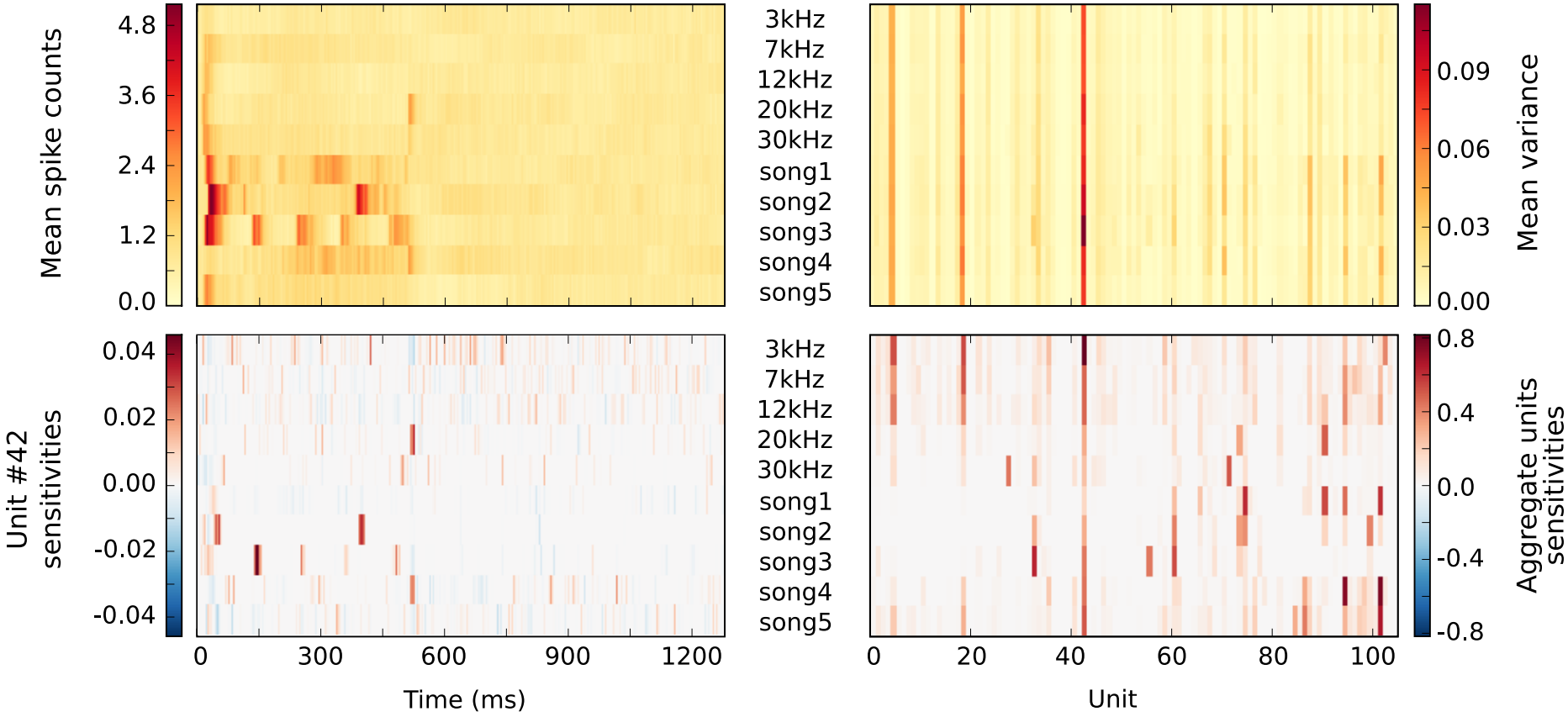
86.2% 89.6% 91.8%

Hanke et al. (2009) (Daten: Fründ et al., 2008)

Modality-independent: EEG Temporal Profile

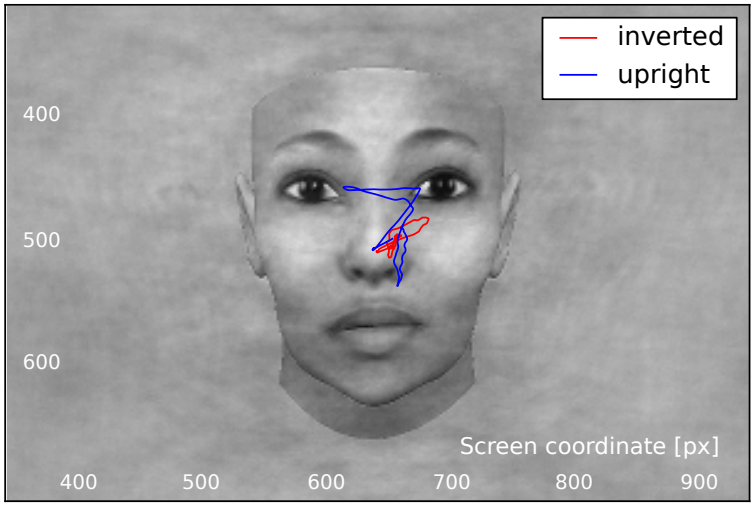


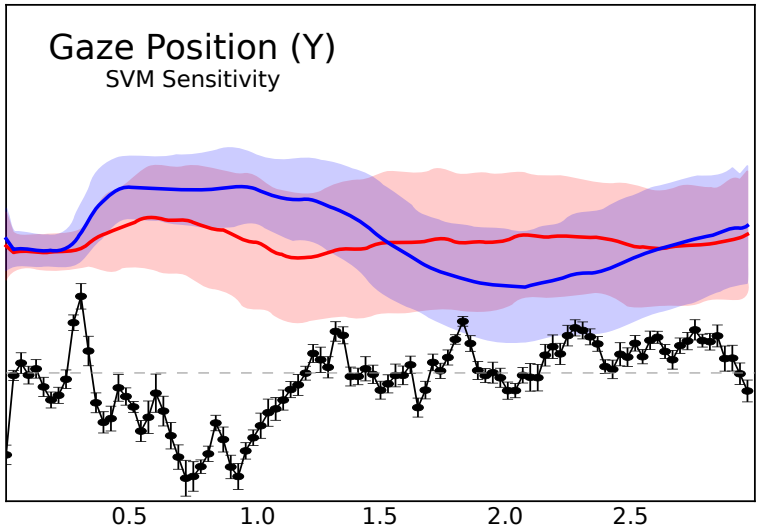
Modality-independent: Spikes

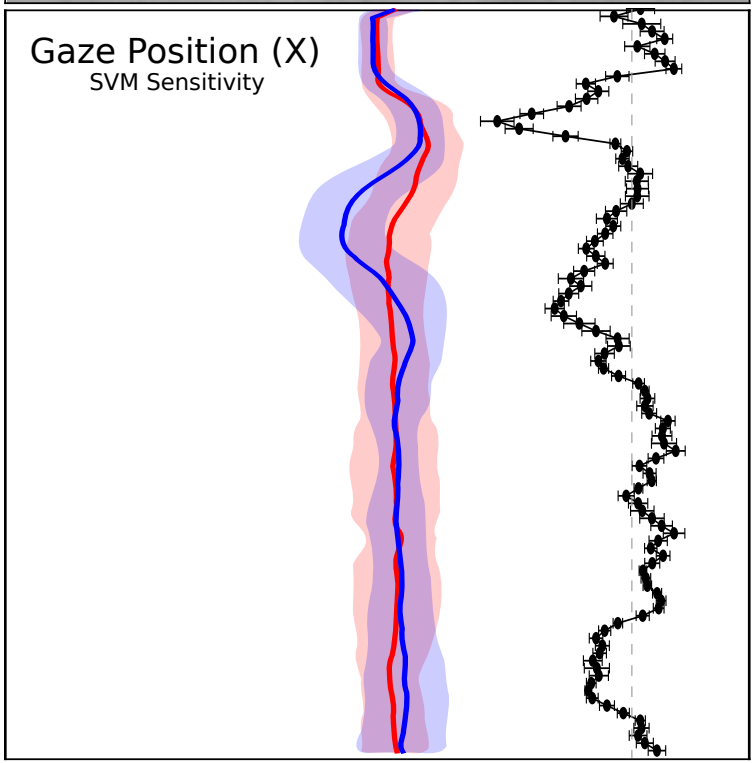


Hanke et al. (2009)

Modality-independent: Eye movements



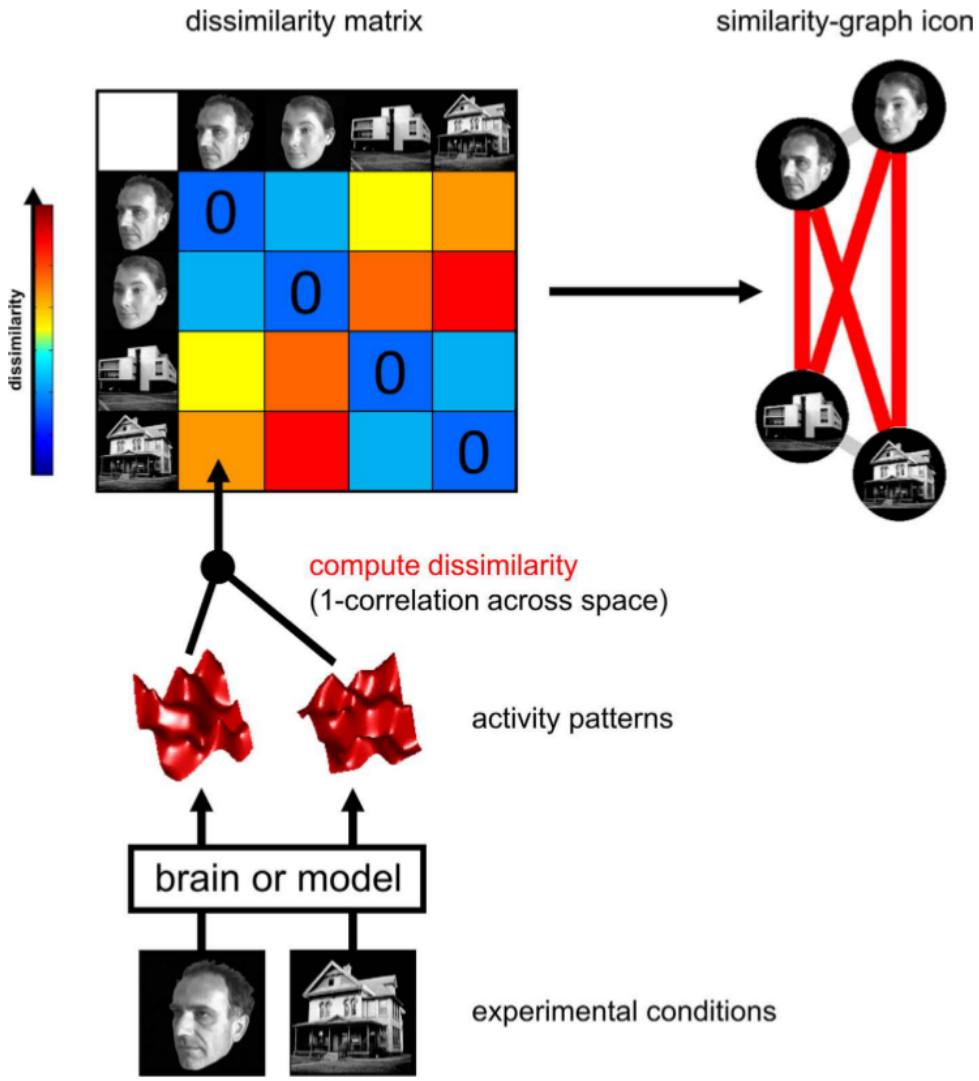




Similarity structure analysis

2nd-order isomorphism

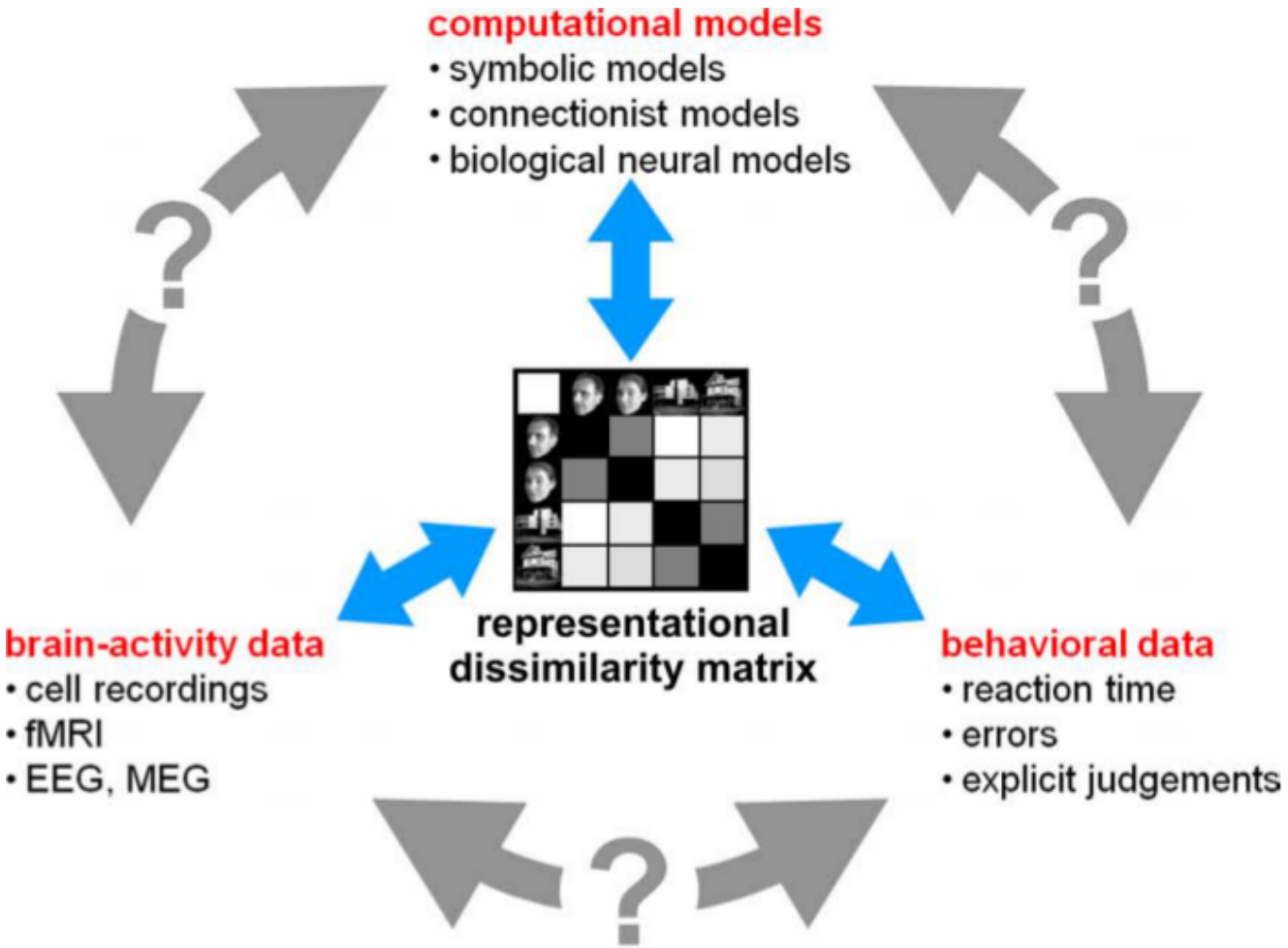
similarity of similarity structure



Kriegeskorte et al., Frontiers in Systems Neuroscience, 2008

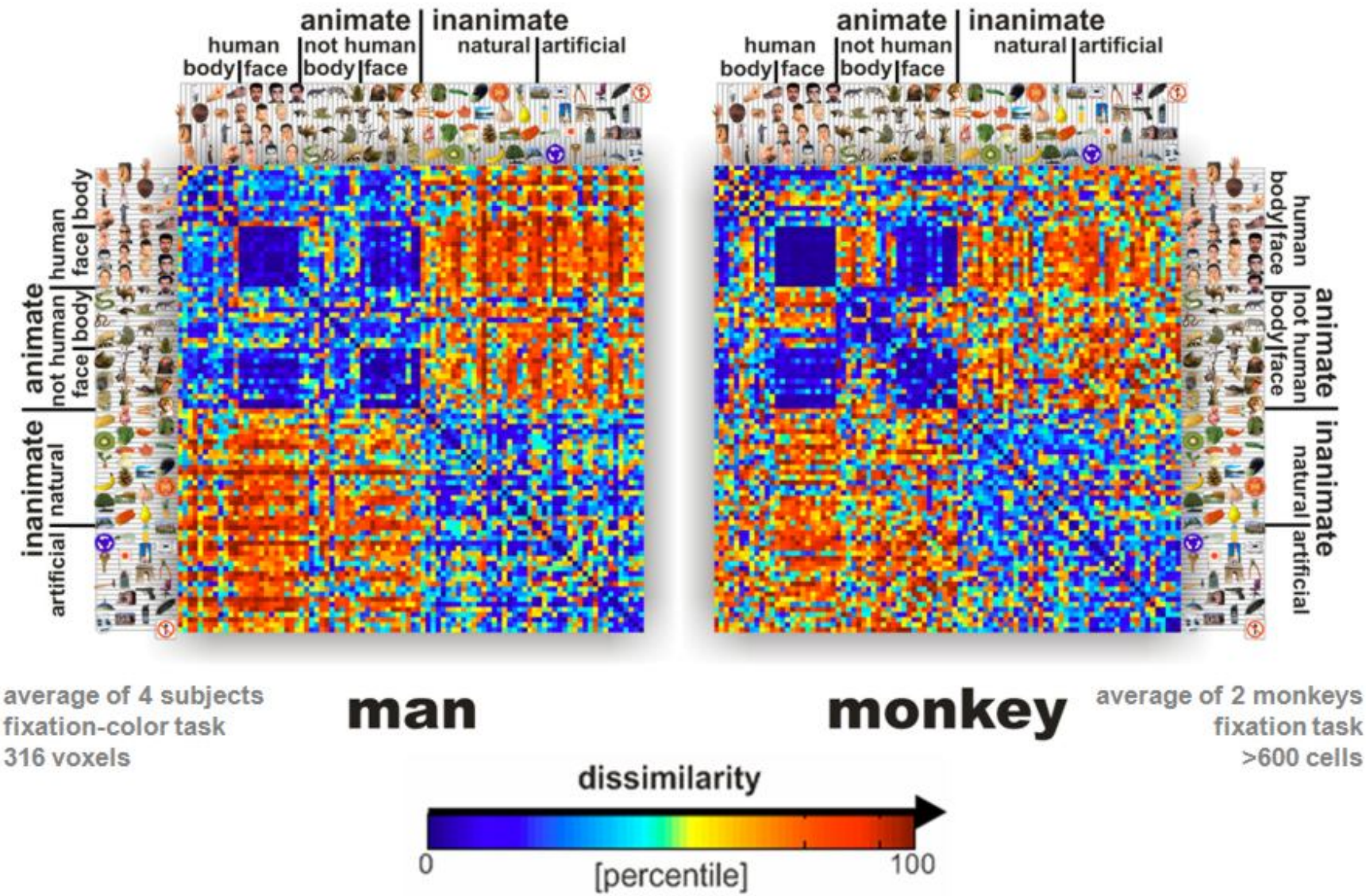
2nd-order isomorphism

similarity of similarity structure



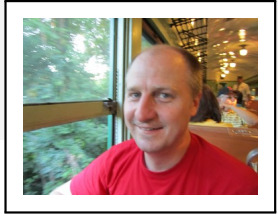
Kriegeskorte et al., Frontiers in Systems Neuroscience, 2008

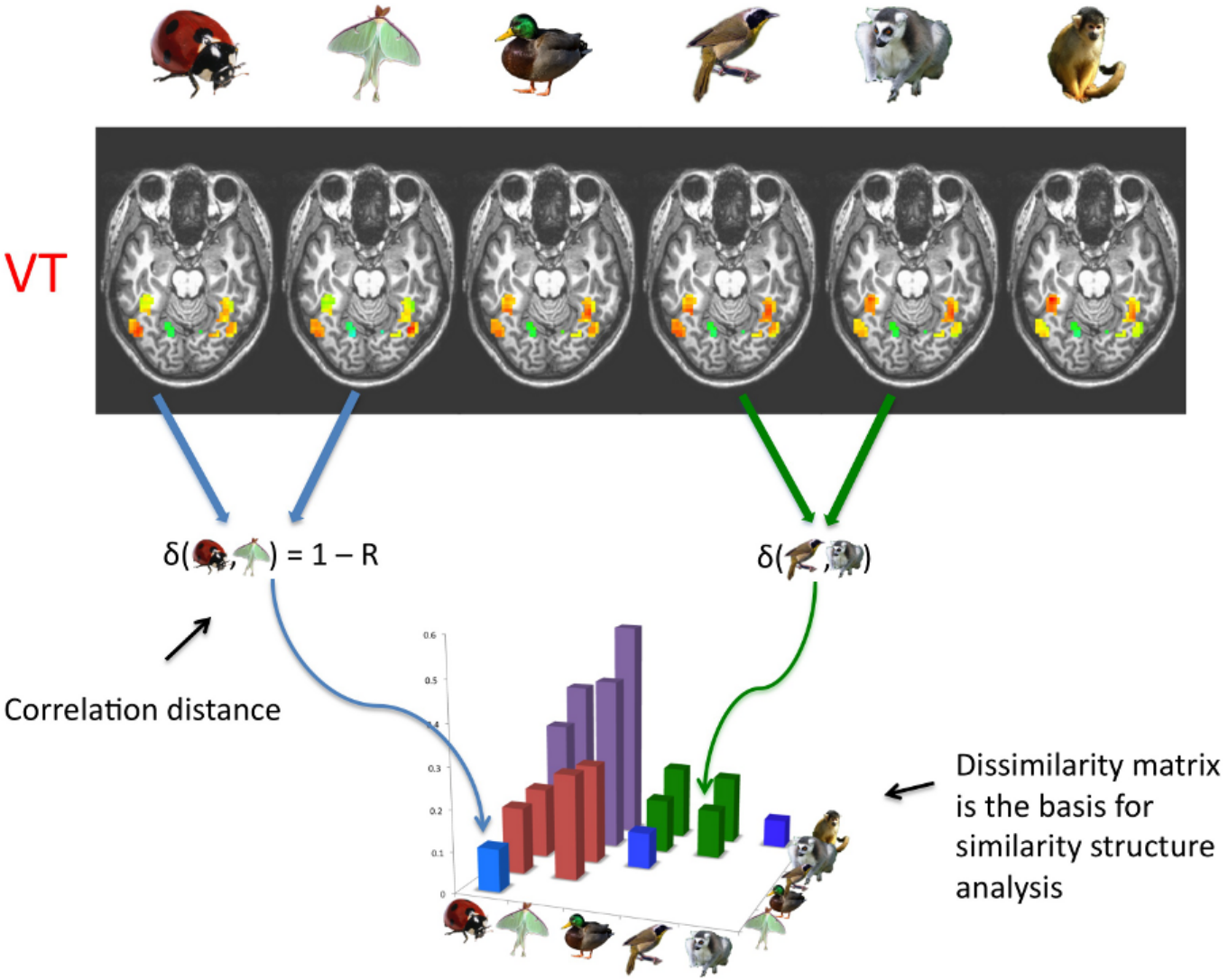
Representational spaces across species



Kriegeskorte et al., COSYNE, 2008

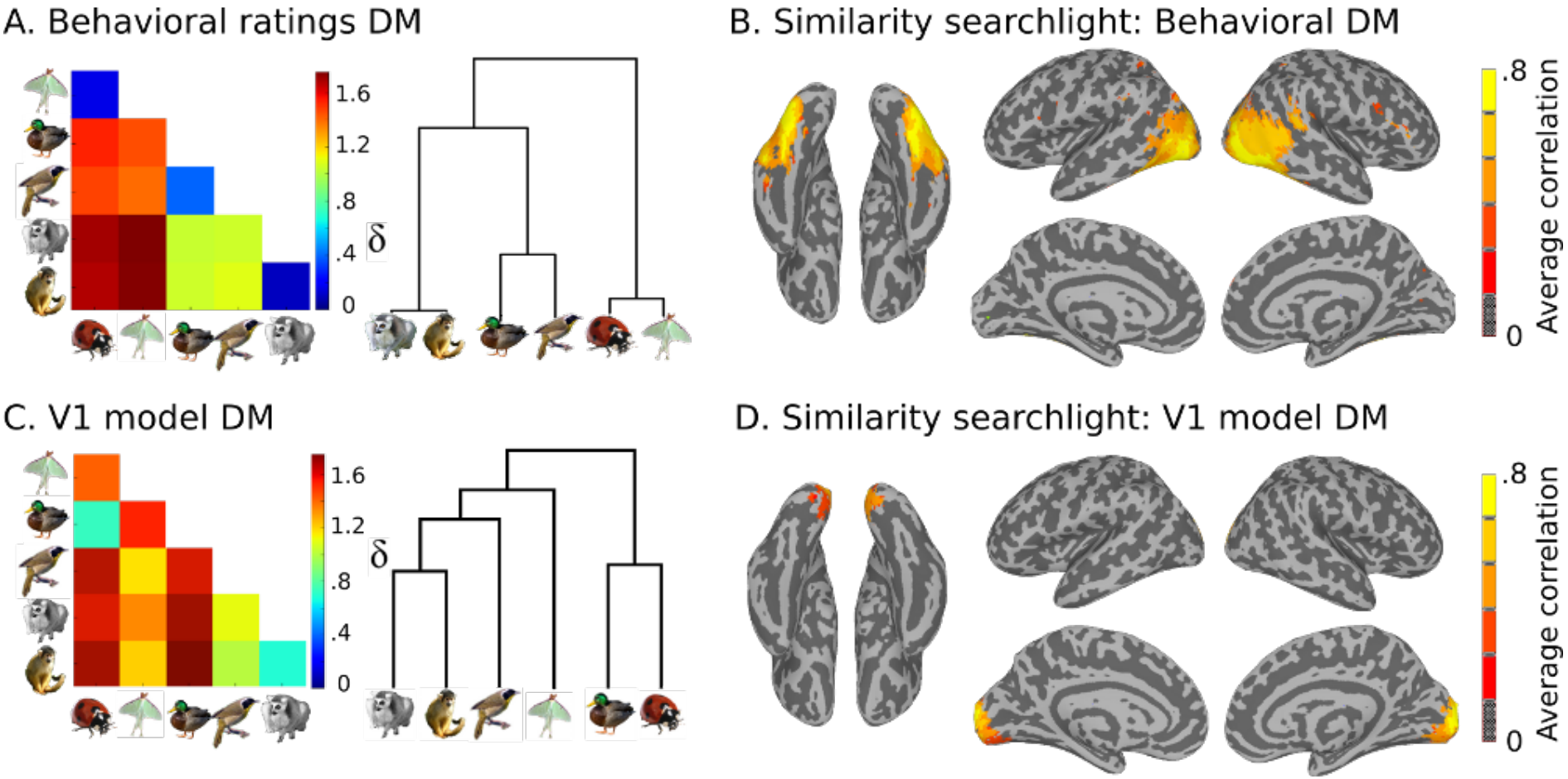
Similarity Analyses





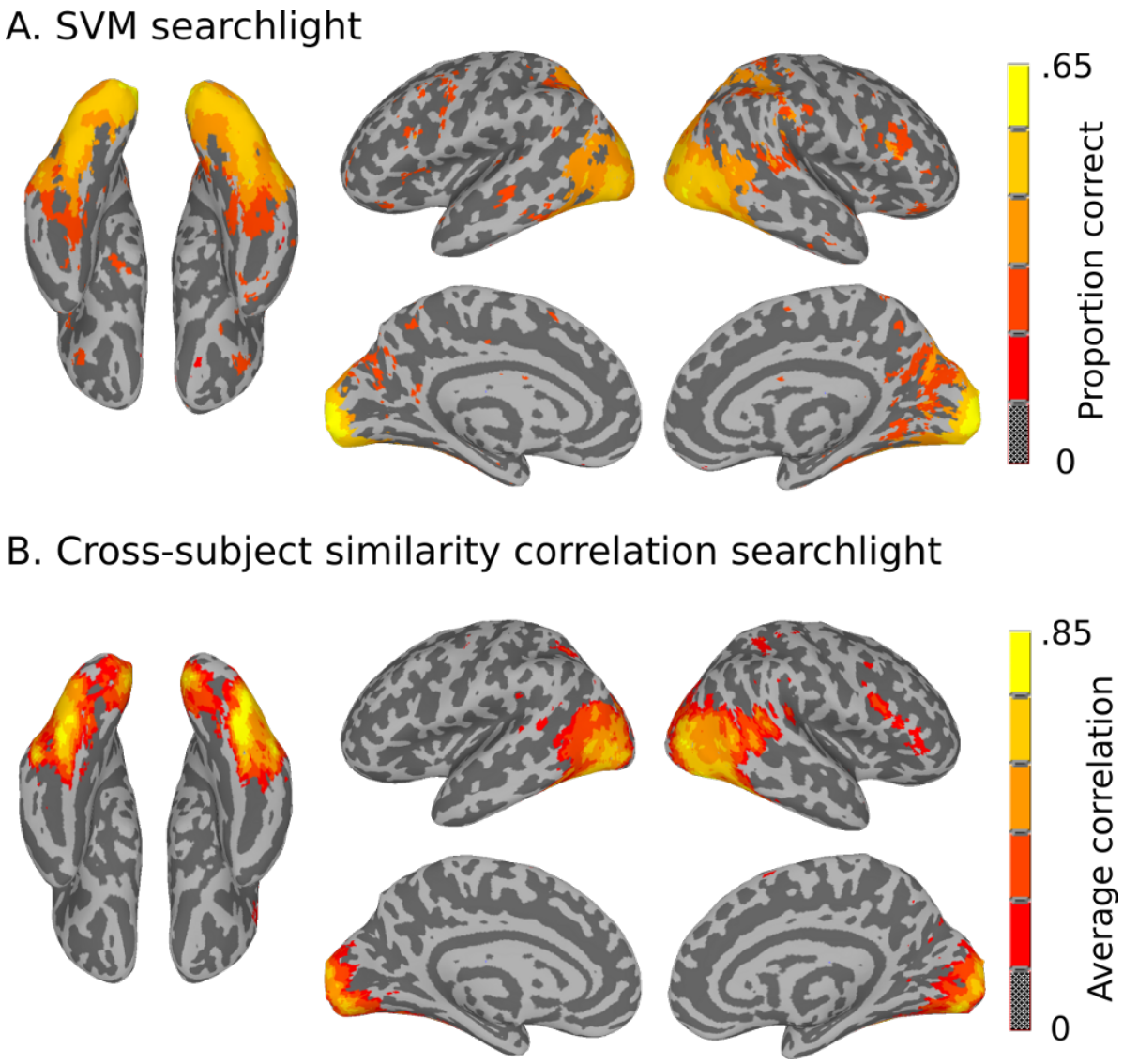
Connolly et al. (2012)

Similarity Analyses: V1 vs behavioral models



Connolly et al. (2012)

Similarity Analyses: Cross-subject agreement



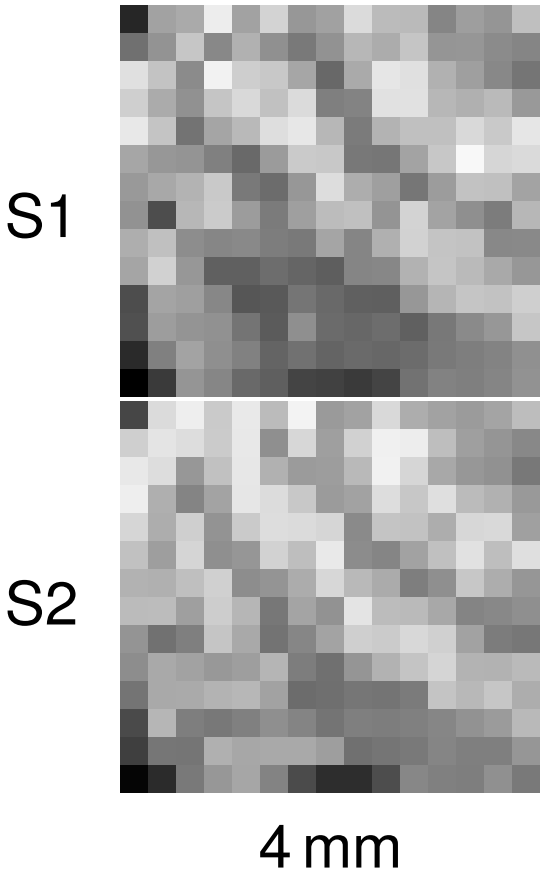
Connolly et al. (2012)

Take Home

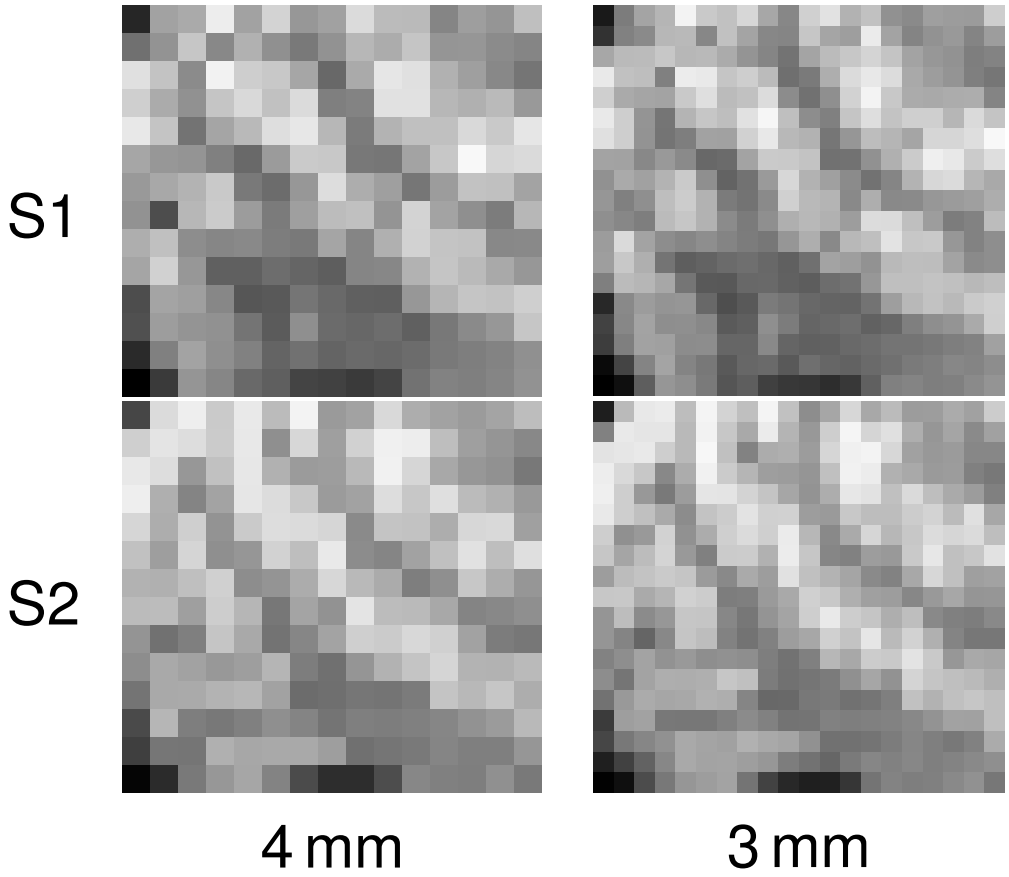
Similarity structure analysis works with **any kind of model** and **across data modalities**

But if 2nd-order is not enough?

Localization – the end is near!



Localization – the end is near!



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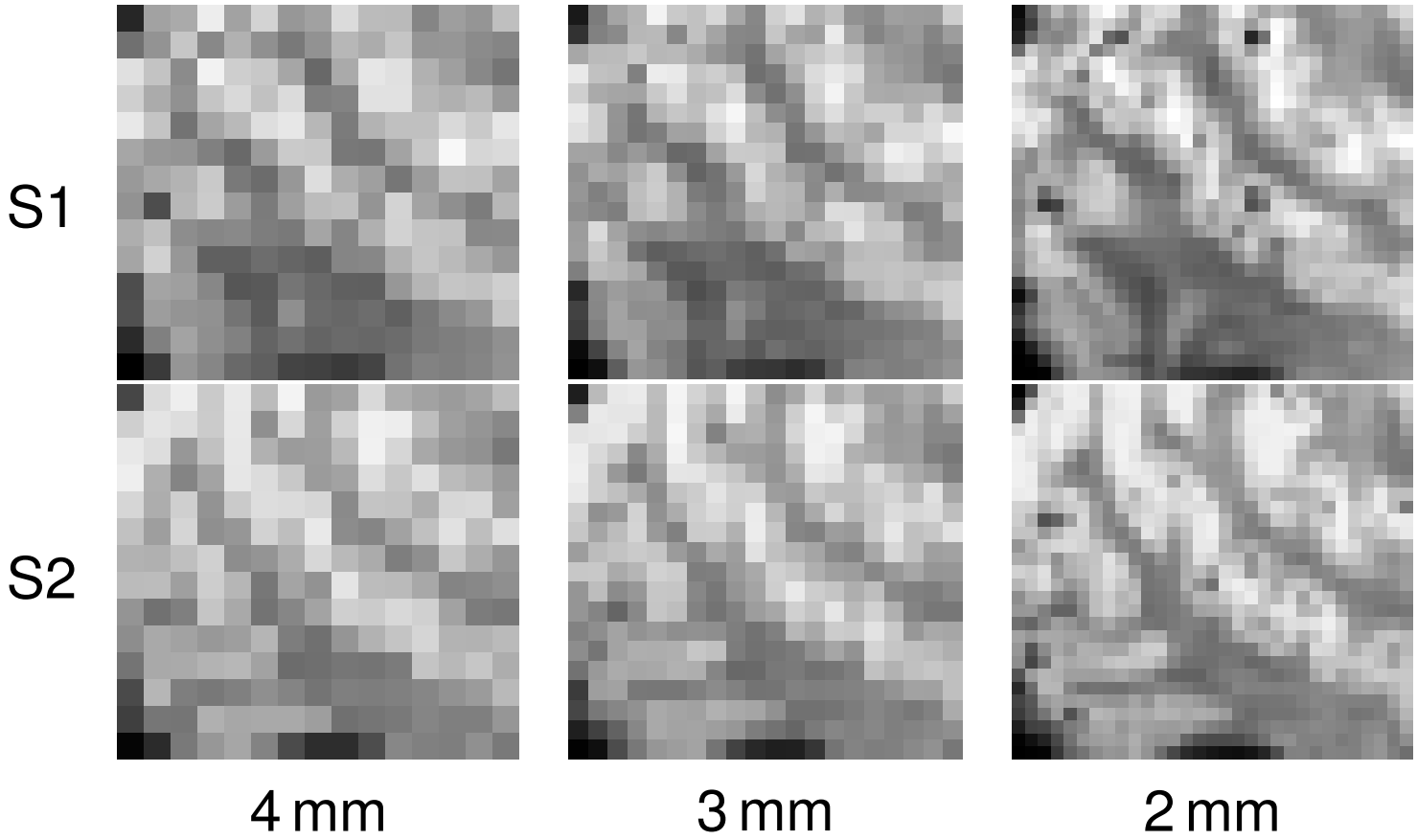

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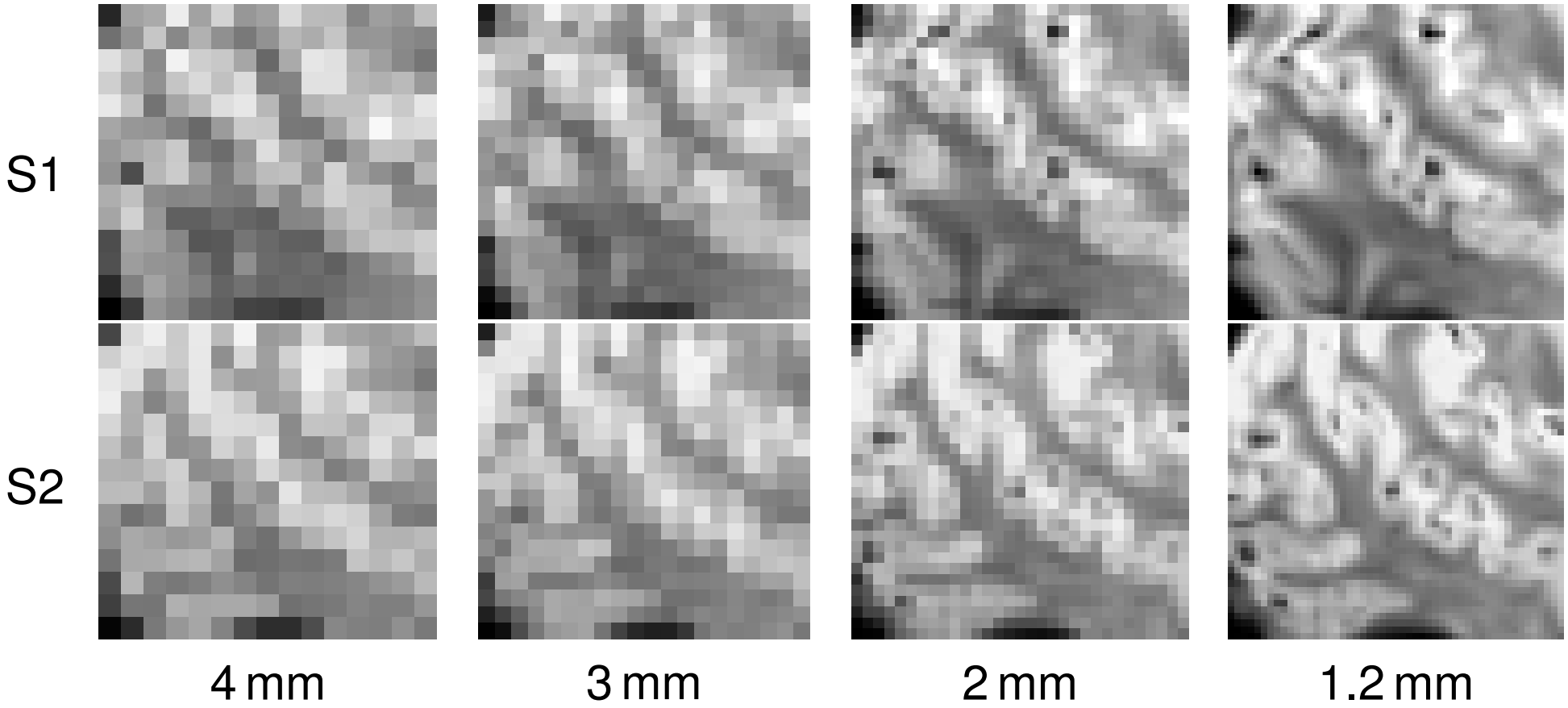
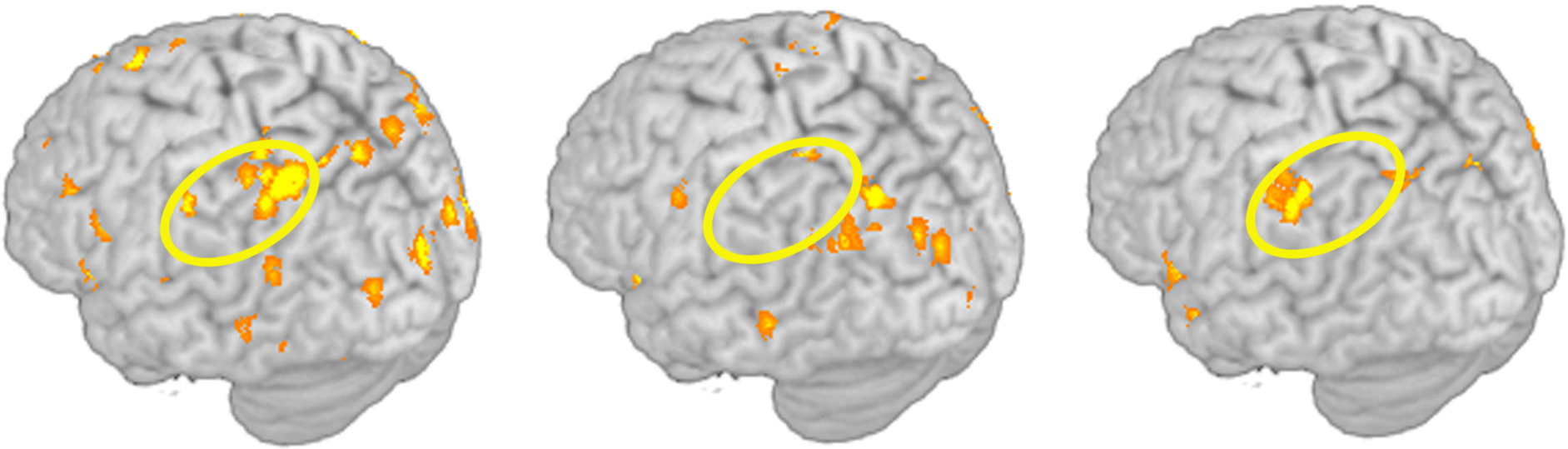


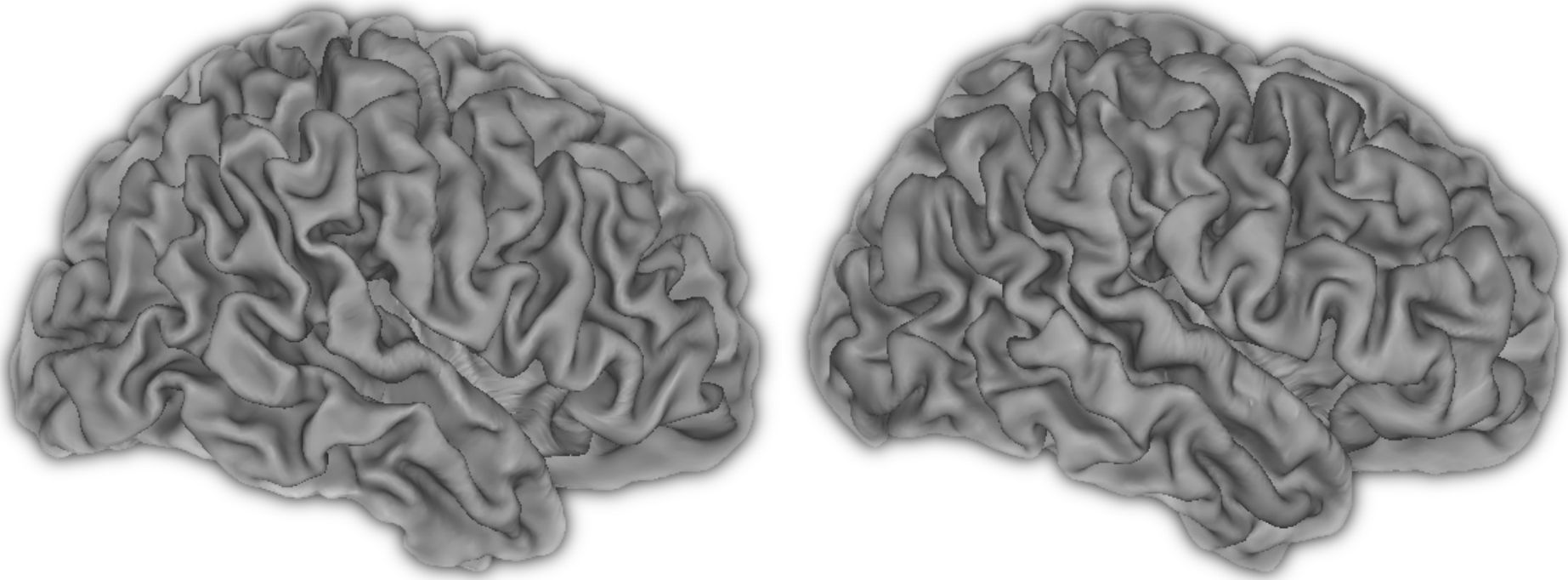
Challenge: Idiosyncratic brain activity patterns



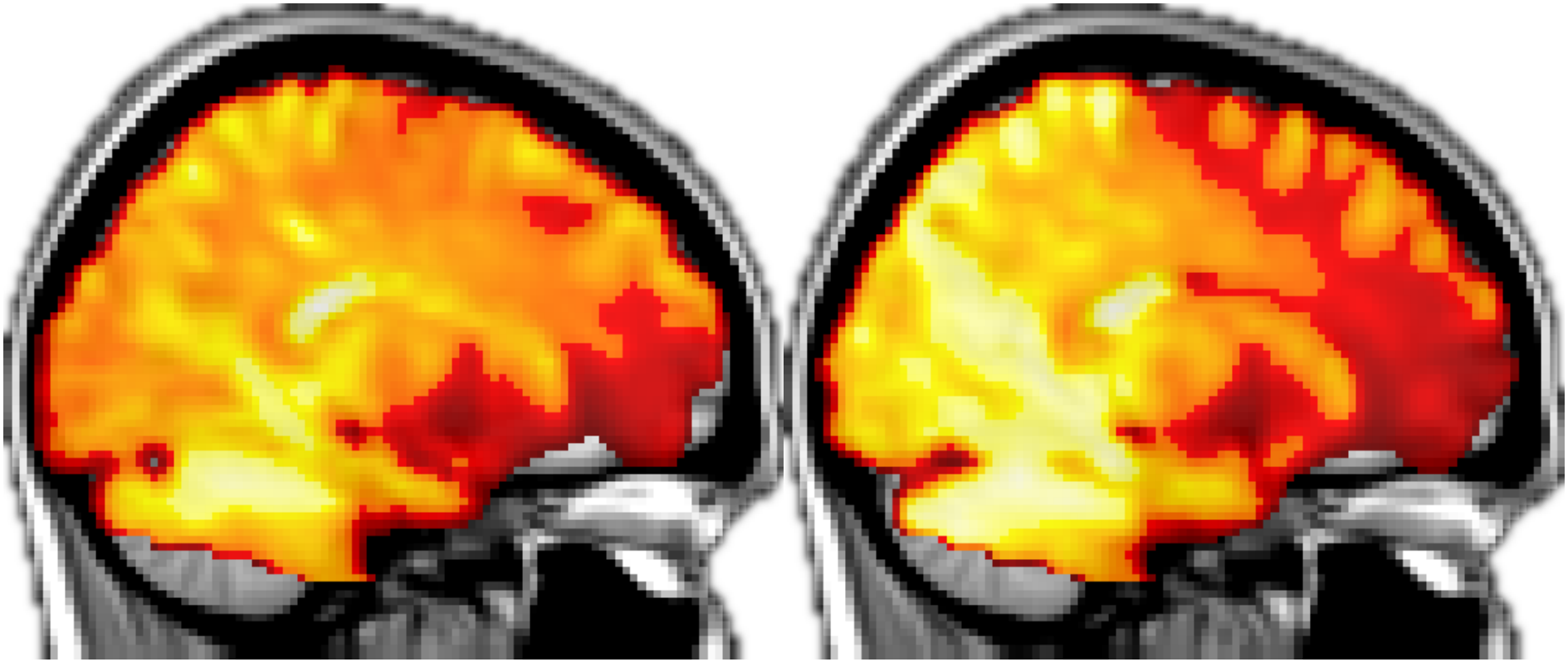
Example: Diagnostic voxels for perception of tools vs. dwellings

Mitchell et al. (2008)

Spatial alignment



Functional alignment



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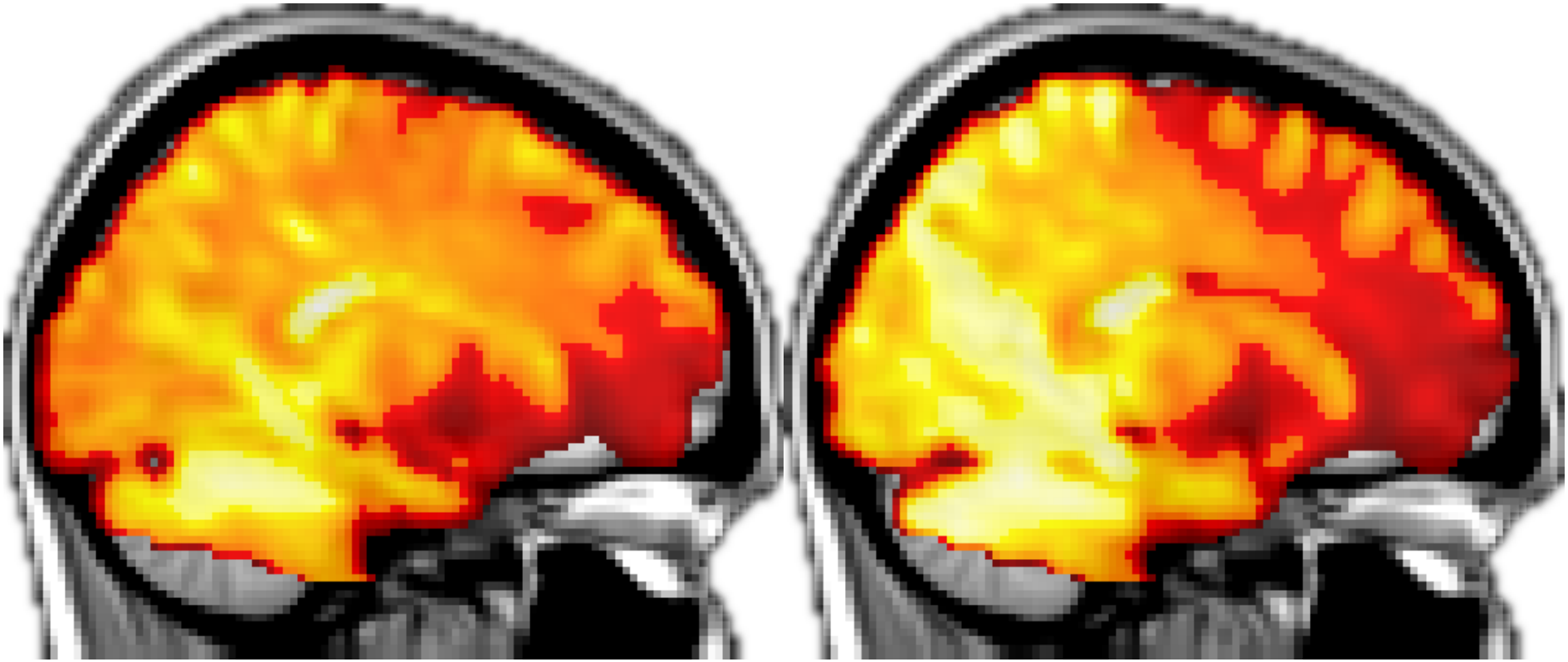


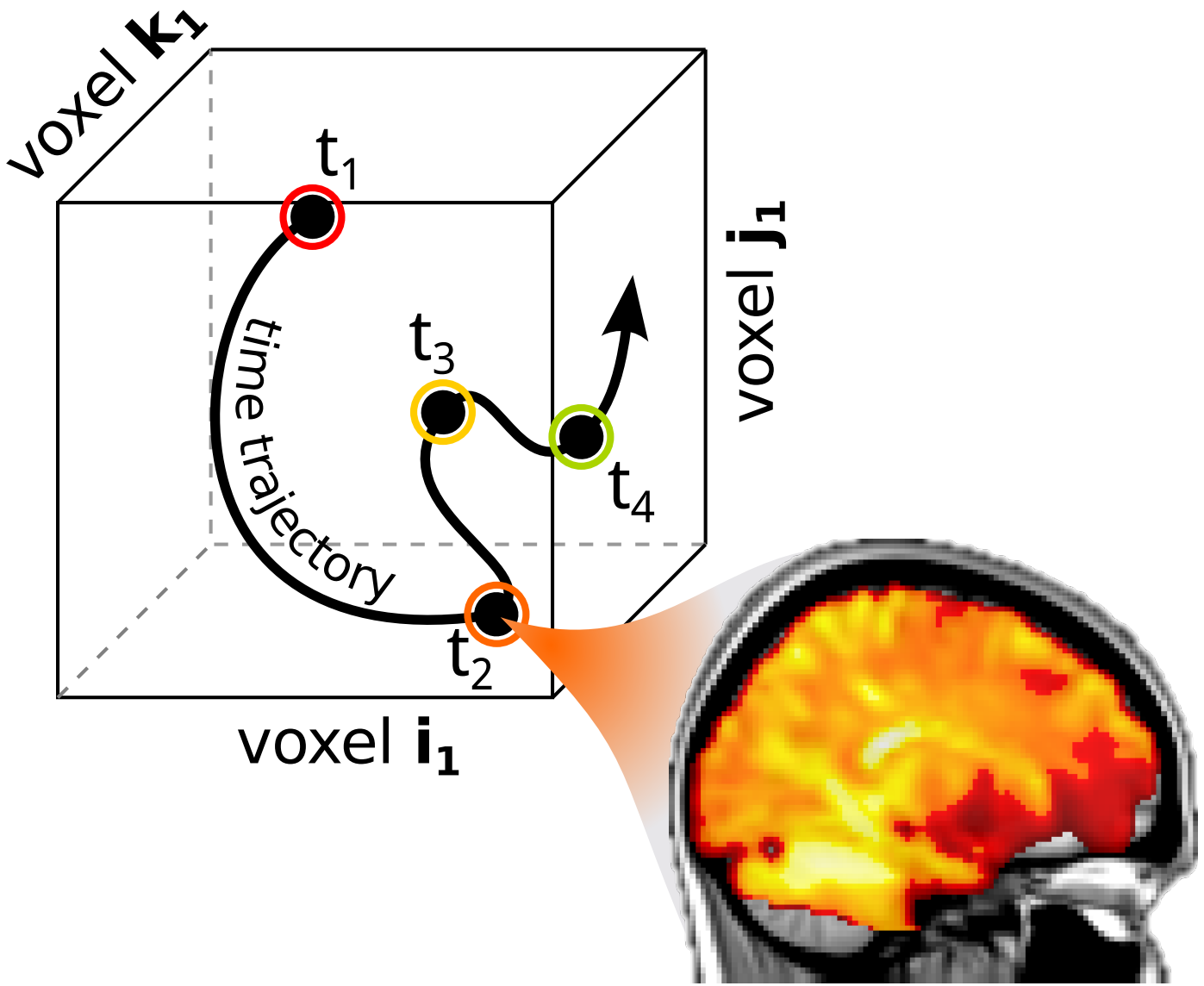
Reference space

Have: spatial/anatomical reference (MNI152; *3-dimensional*)

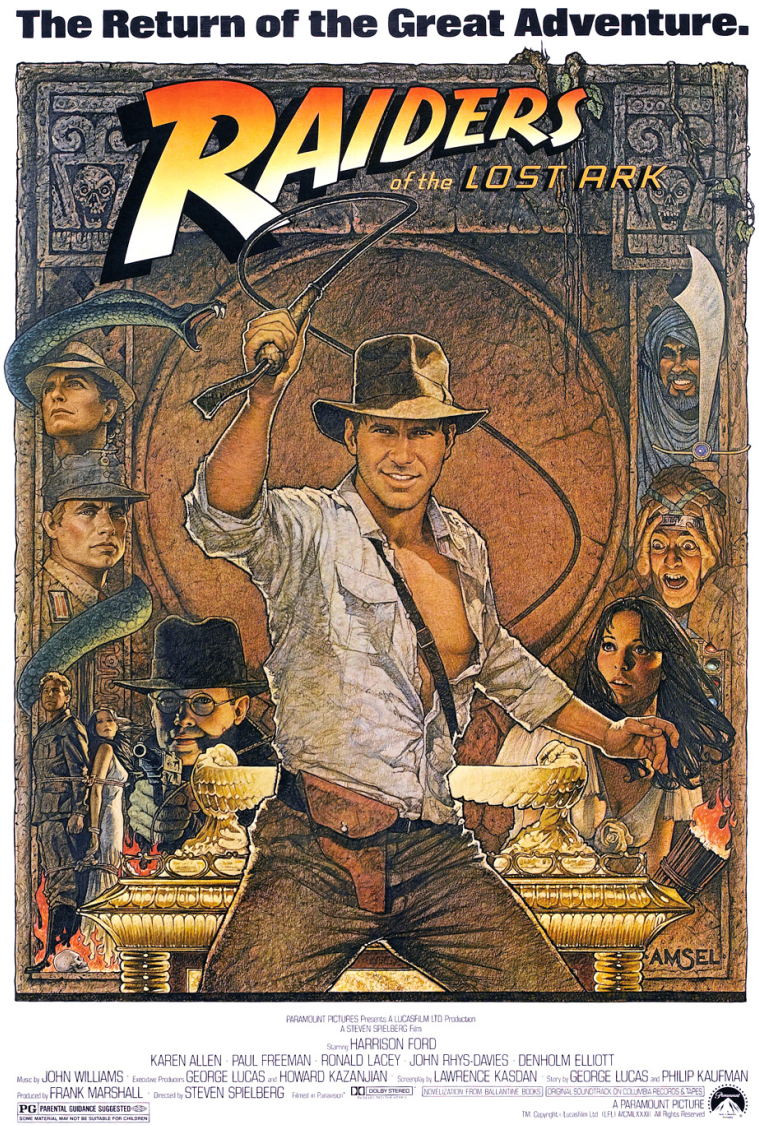
vs.

Want: functional/“brain state” reference (n-dimensional)

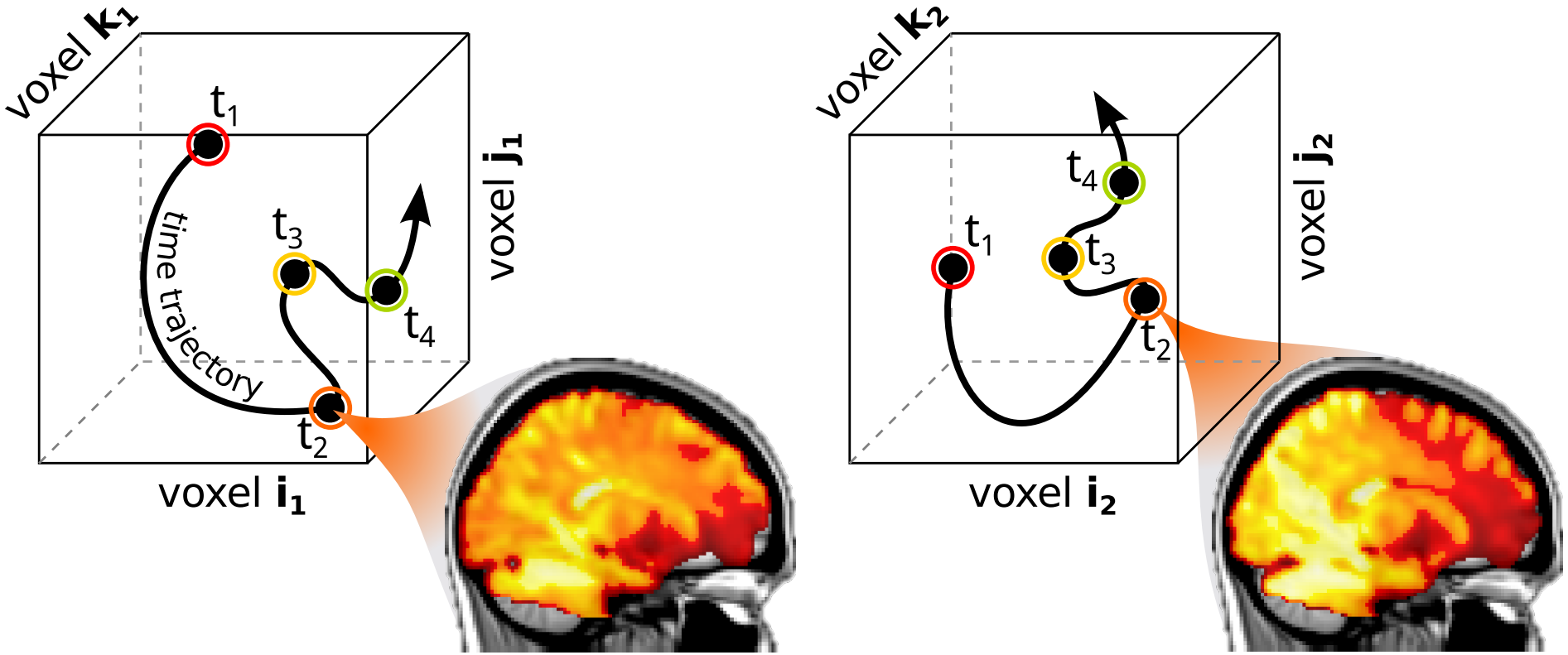
Concept: brain state space



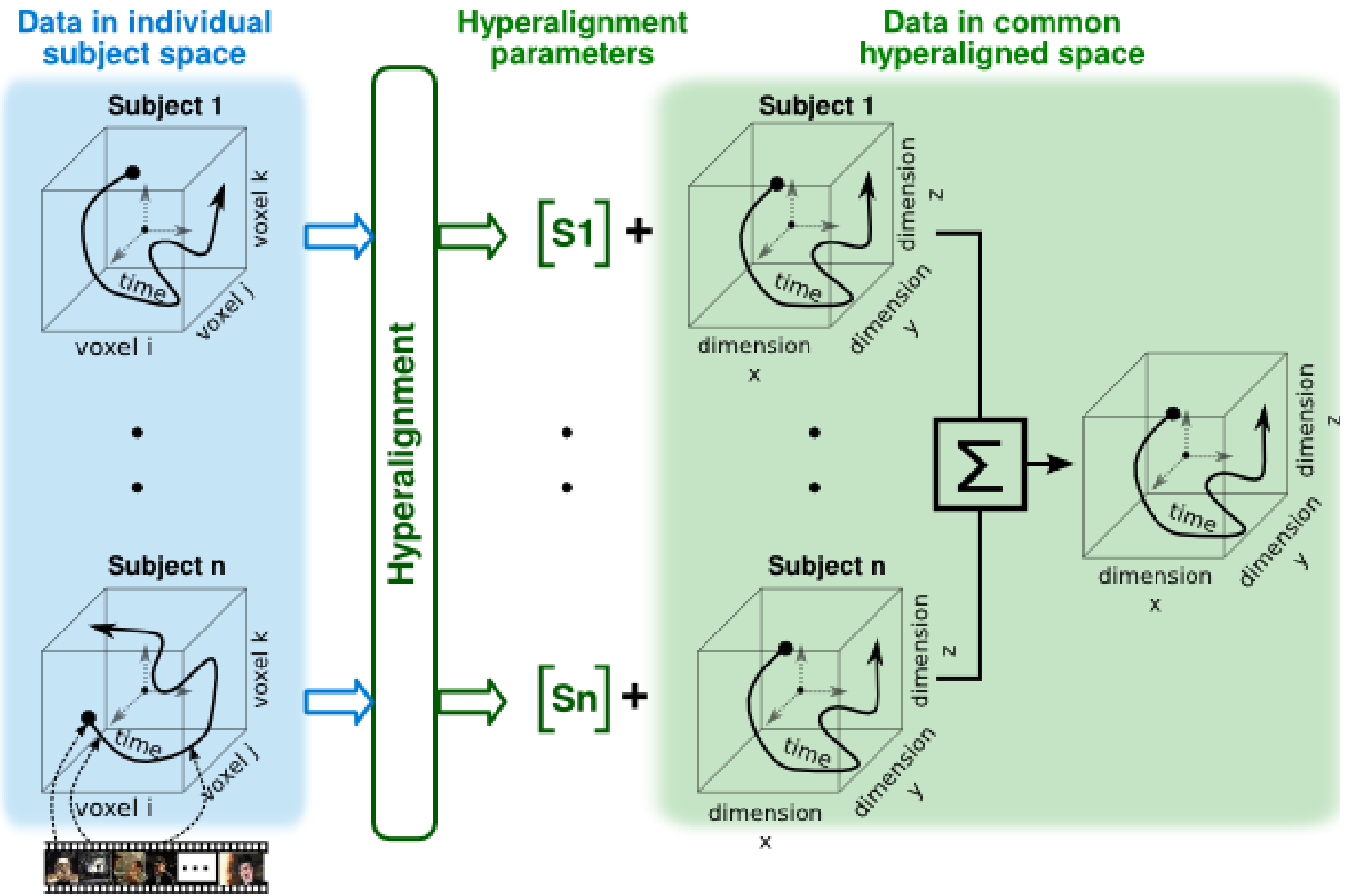
Natural stimulation



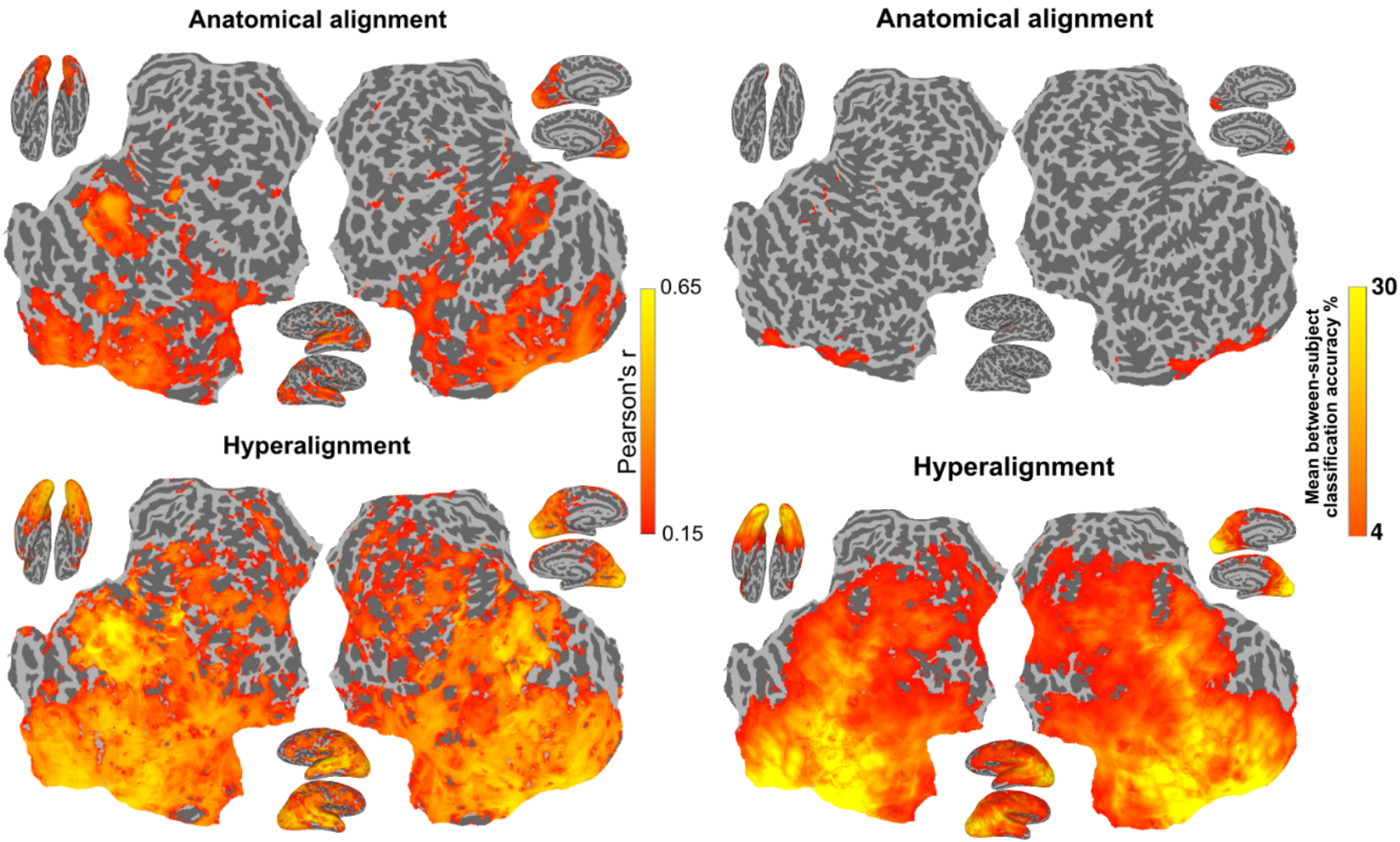
Approach: high-dimensional functional alignment



Hyperalignment: a common representational space

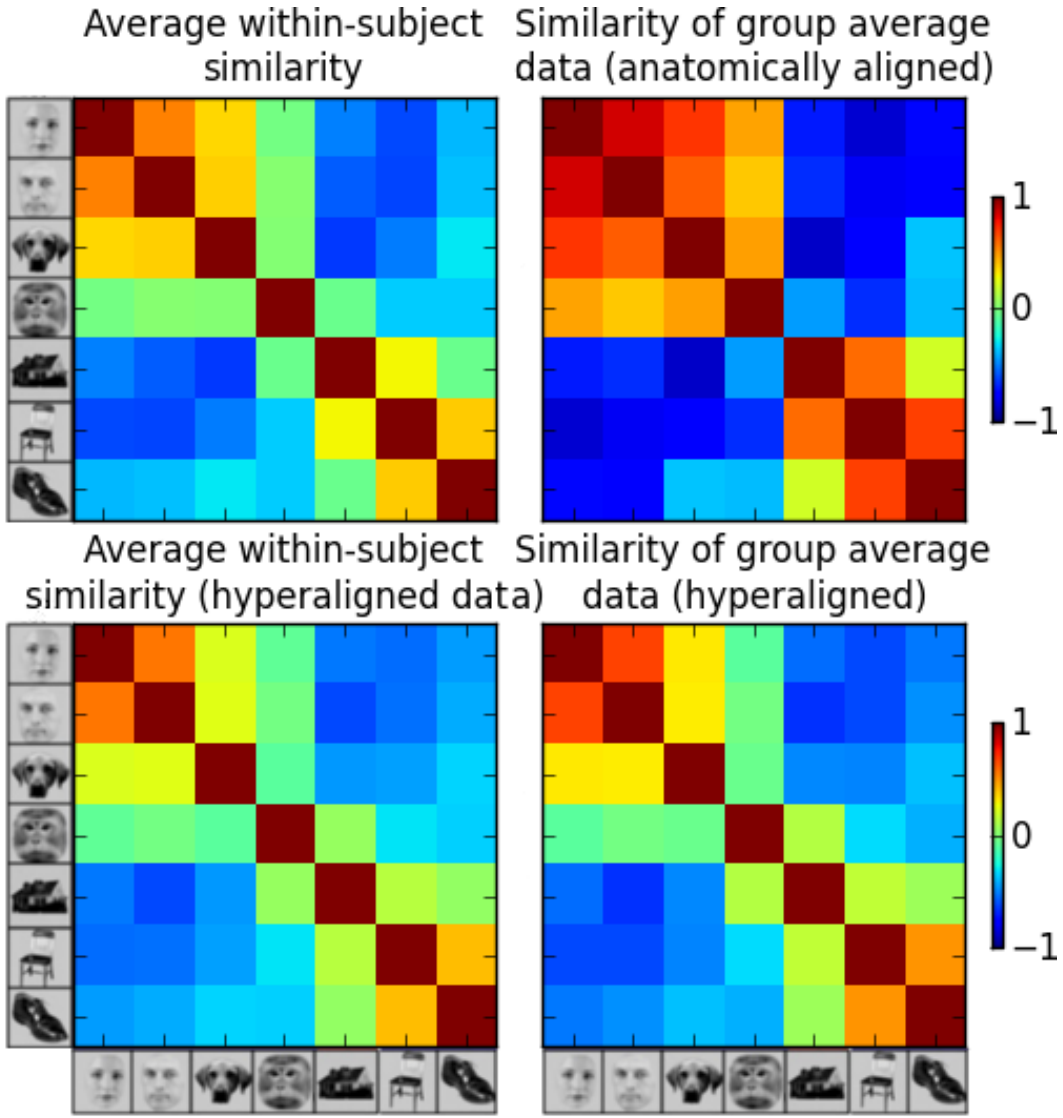


Movie time series similarity and pattern discriminability



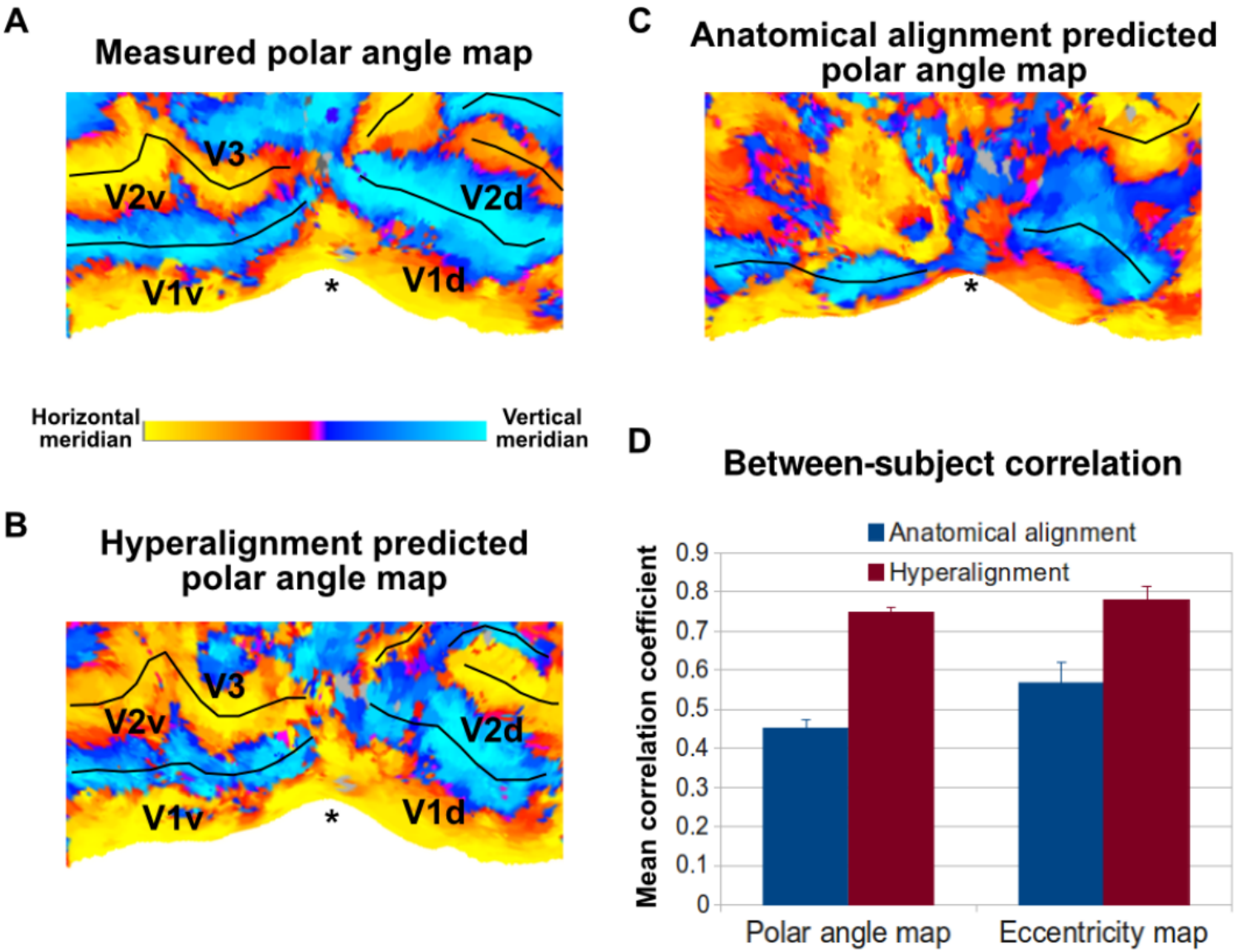
Guntupalli & Haxby, OHBM, 2013

Hyperalignment: object representation similarity in VT



Haxby et al., Neuron, 2011

Hyperalignment: pattern normalization



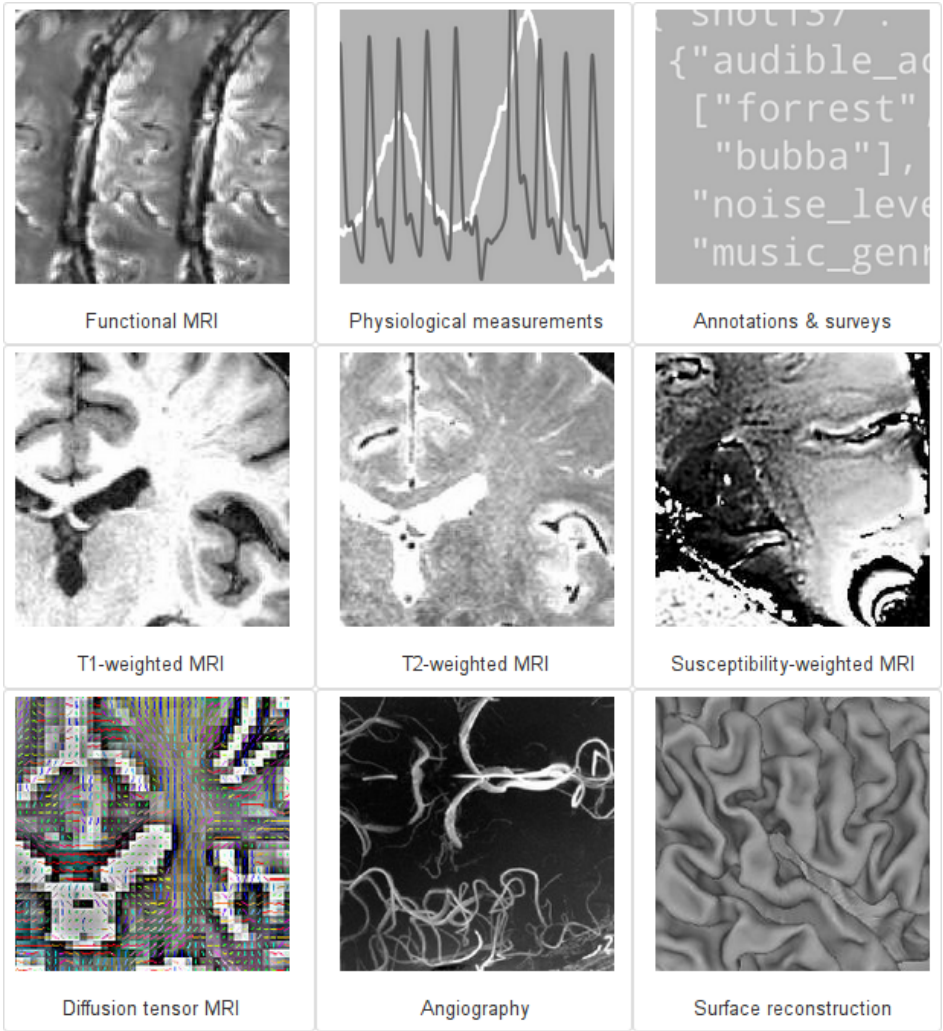
Guntupalli & Haxby, OHBM, 2013

Starting point: auditory representational spaces

- 2 h audio movie
- story narration
- verbal scene descriptions
- "'shared memory"'
- wide spectrum of music
- real emotions

Real-life cognition challenge

- 20 participants (plus phantom)
- 2 hours of fMRI (7 Tesla Siemens Magnetom, 2 s TR, 1.4 mm)
- 0.3 mm ToF angiography
- simultaneous physiological data (respiratory, cardiac)
- 0.7 mm T1w, T2w, DWI, SWI (Philips Achieva)
- reproducible stimulus
- 12-page methods description



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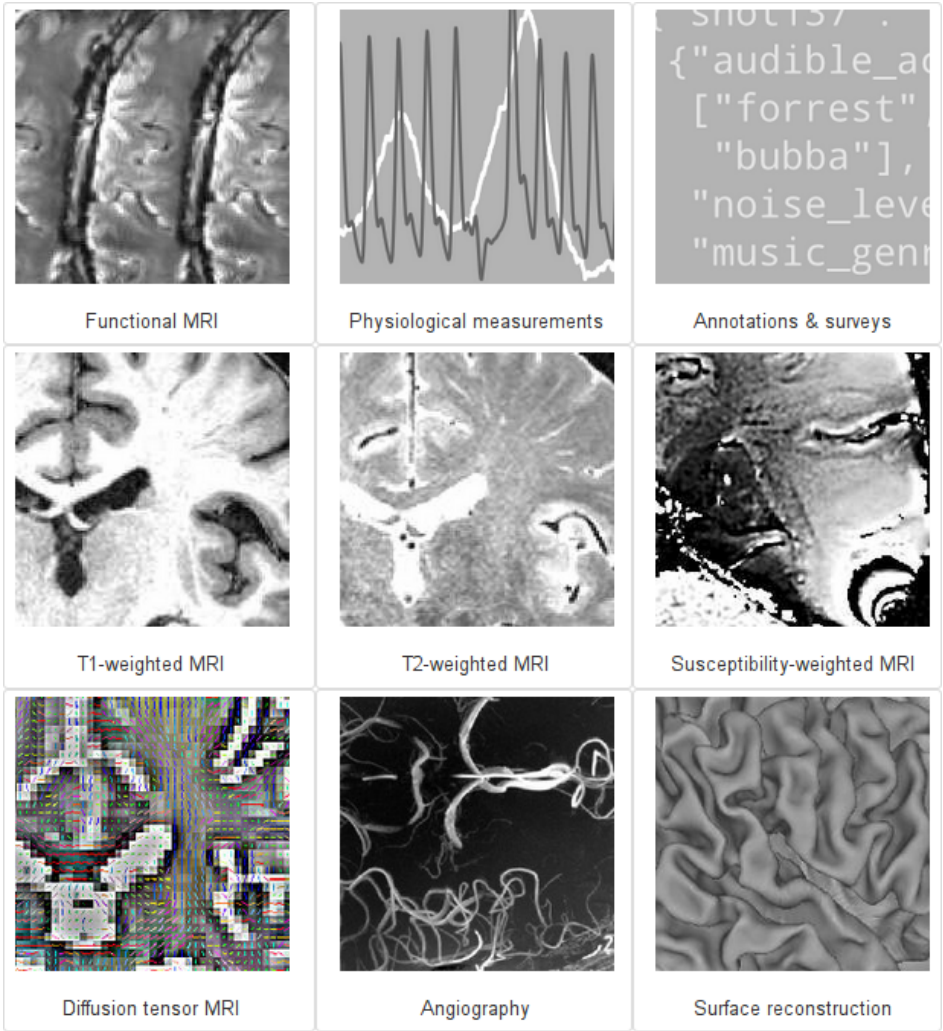
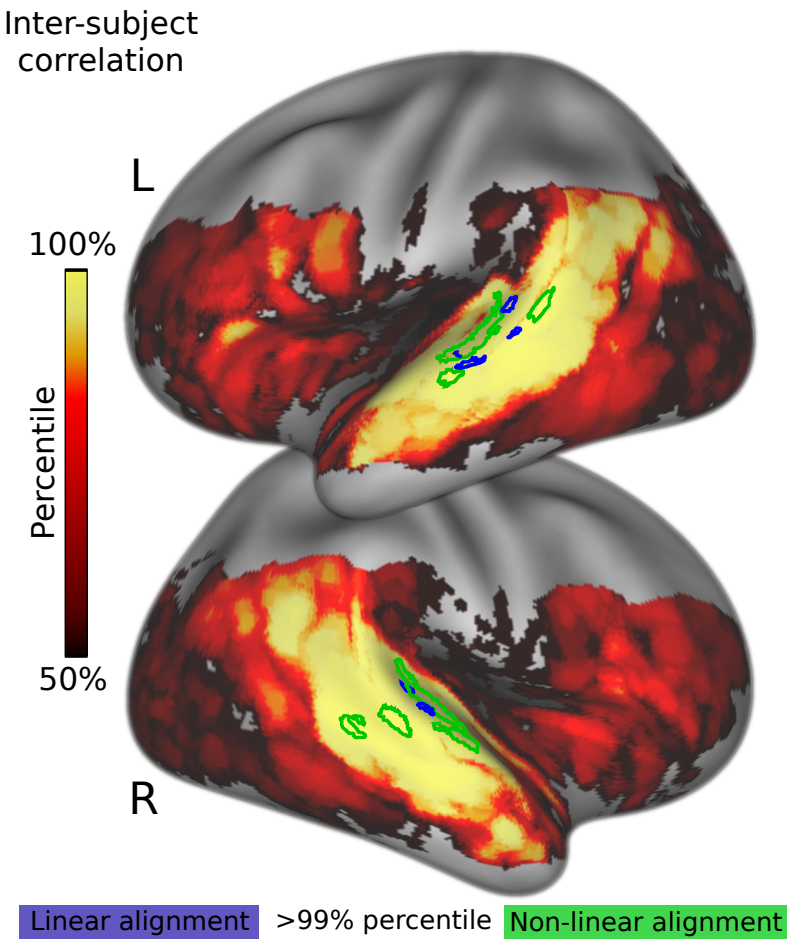


Everything available at

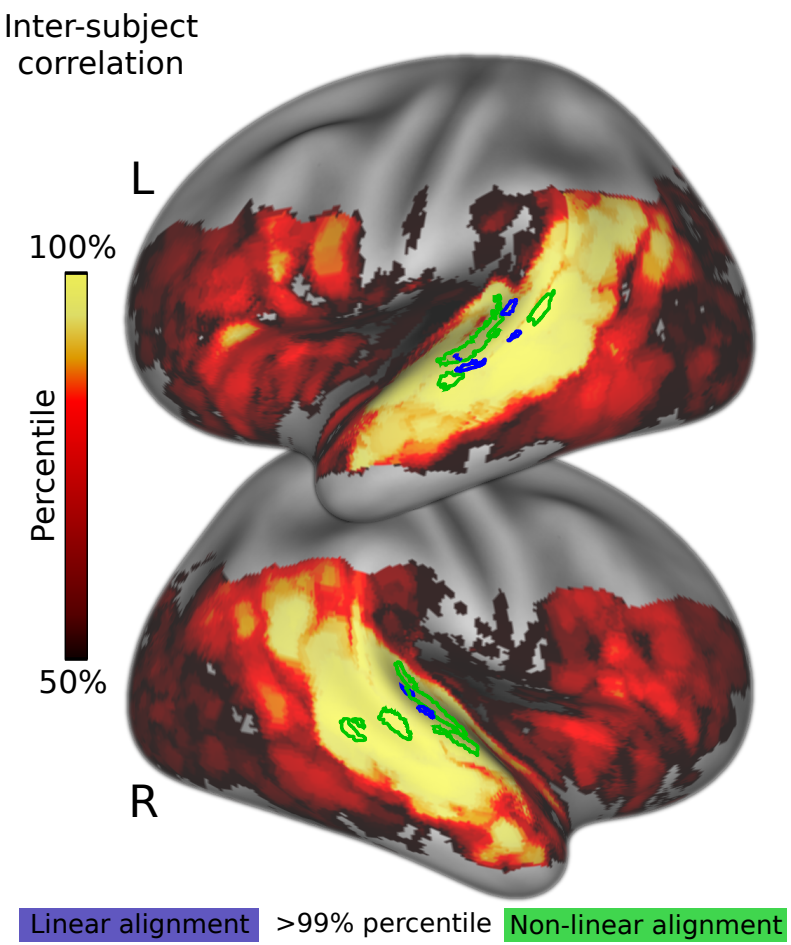
http://studyforrest.org
and 5000 EUR on top!

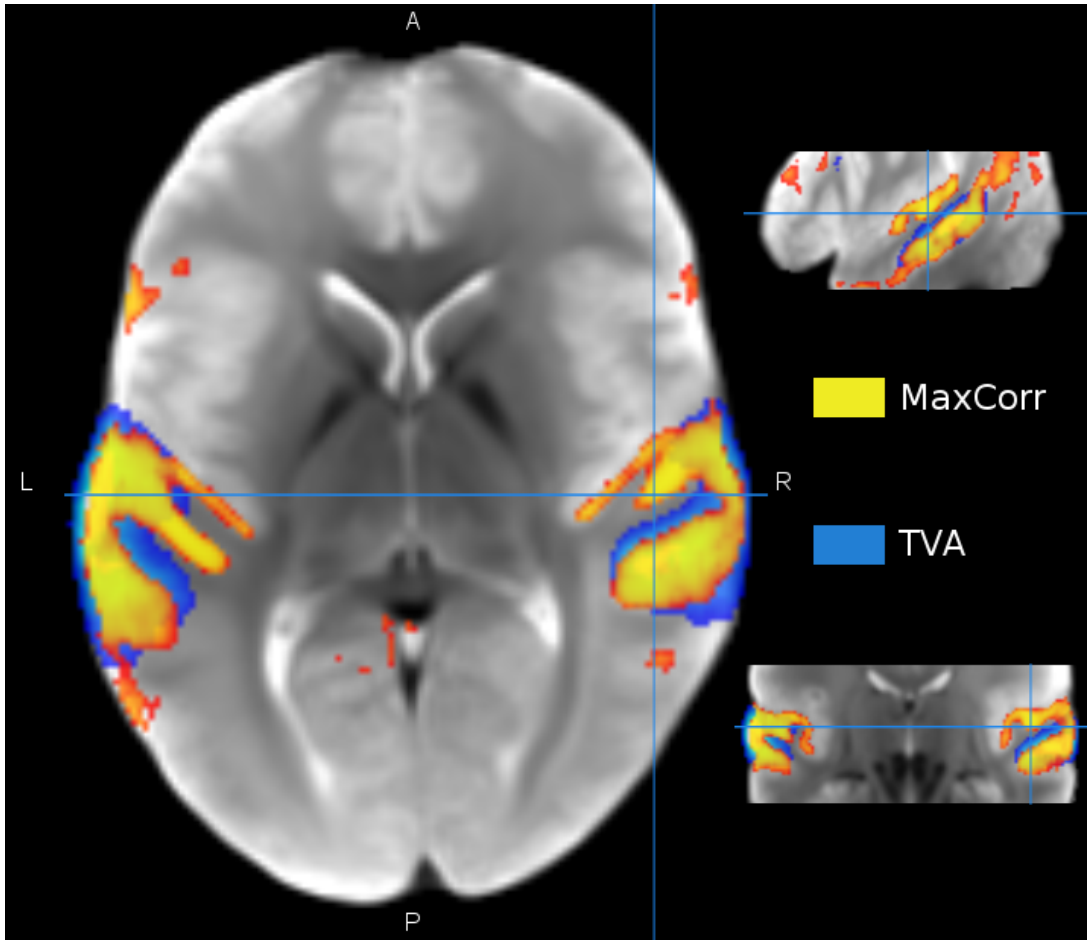
Data QA



Hanke et al., Scientific Data, 2014

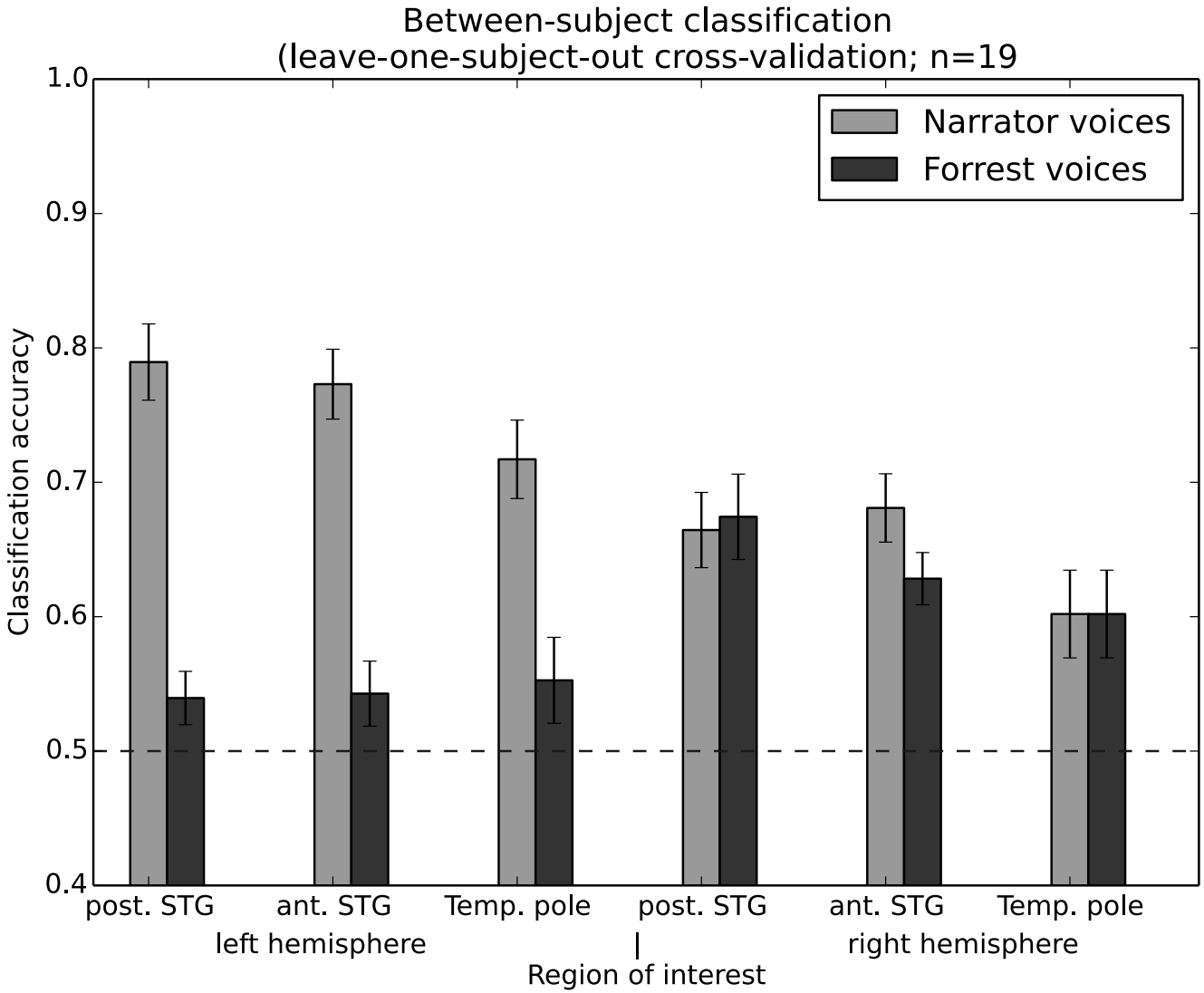
Data QA





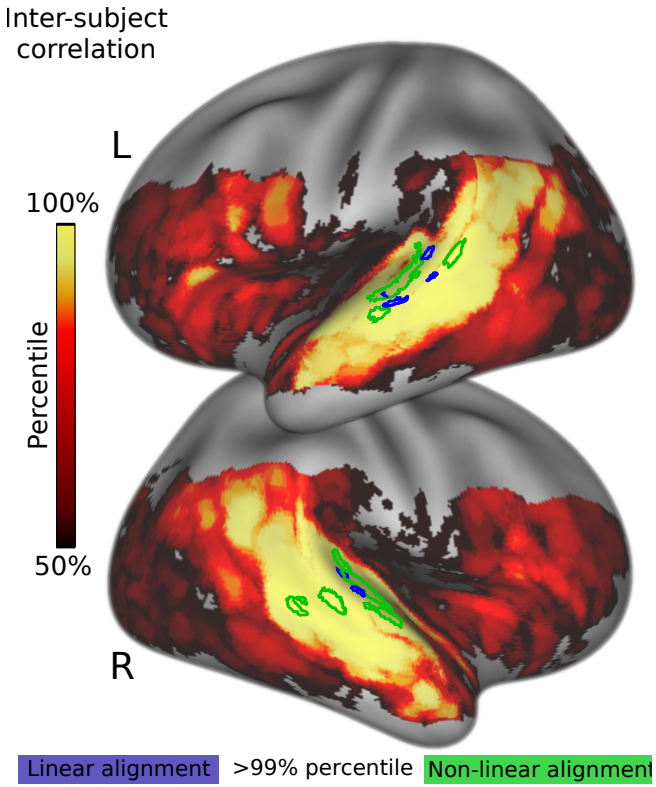
Hanke et al., Scientific Data, 2014 Pernet et al., submitted; avail. at NeuroVault.org

Exploration: Using the movie itself for analysis

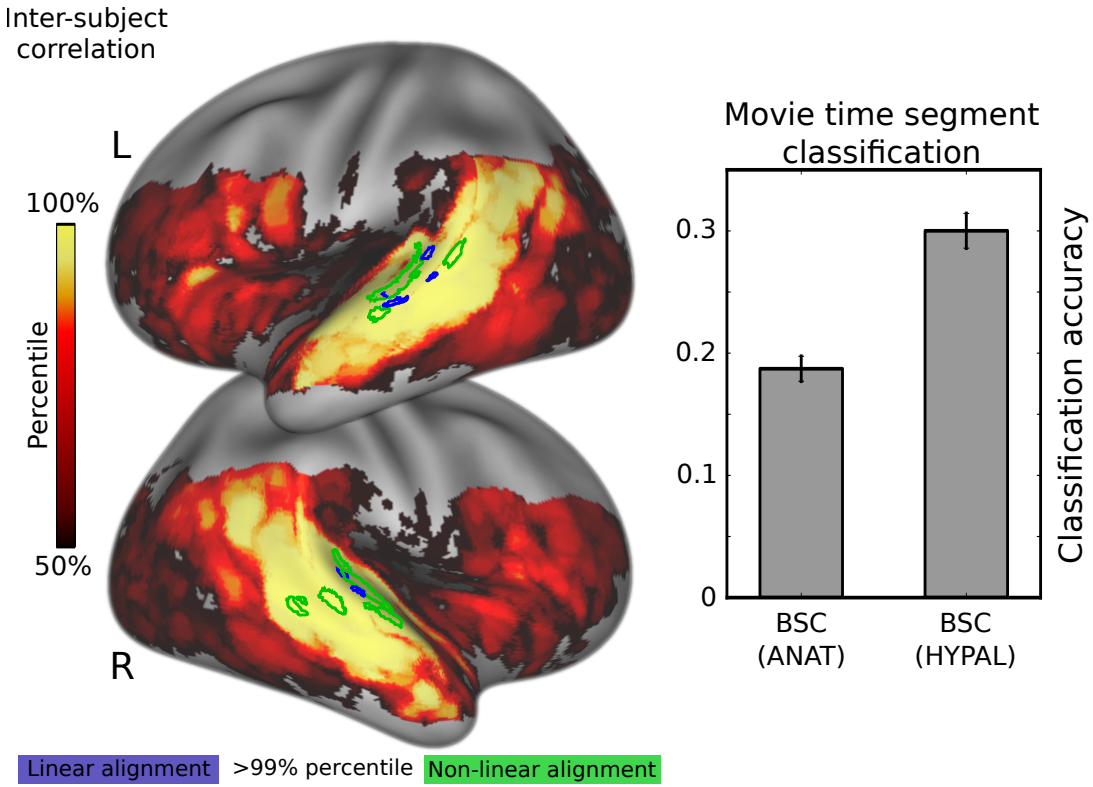


Complete dialog annotation will be published

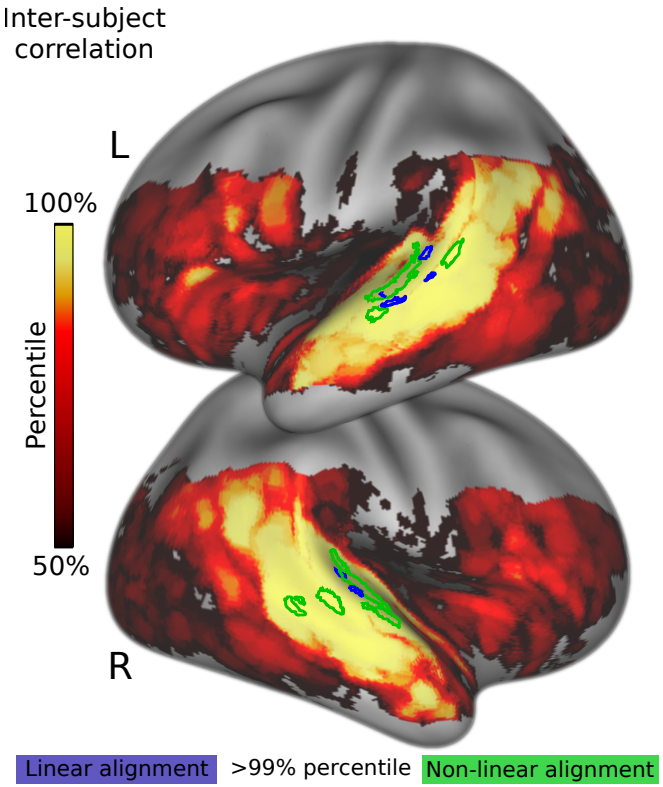
Hyperalignment test

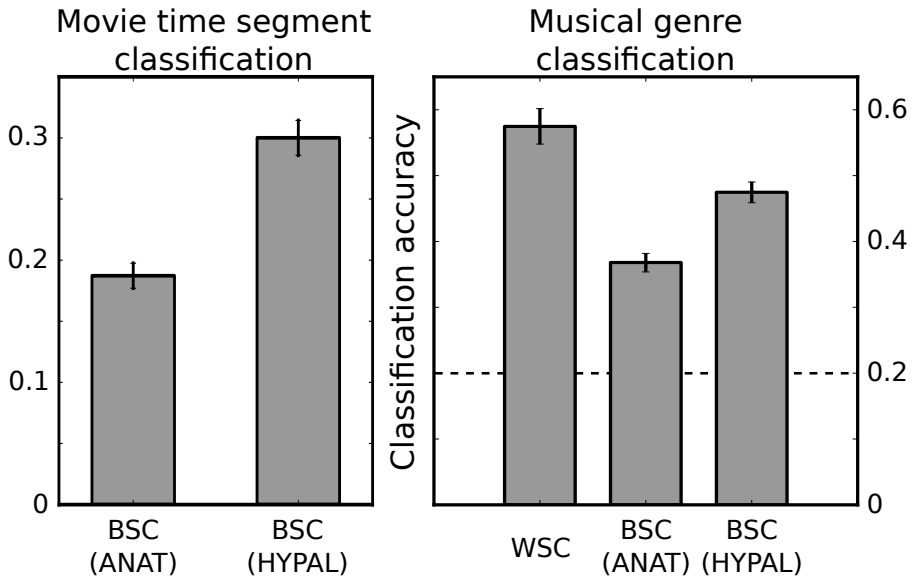


Hyperalignment test



Hyperalignment test

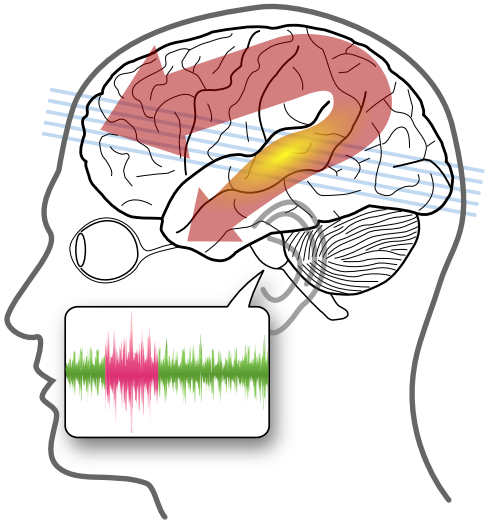




Task fMRI is scheduled for release Q4/2014

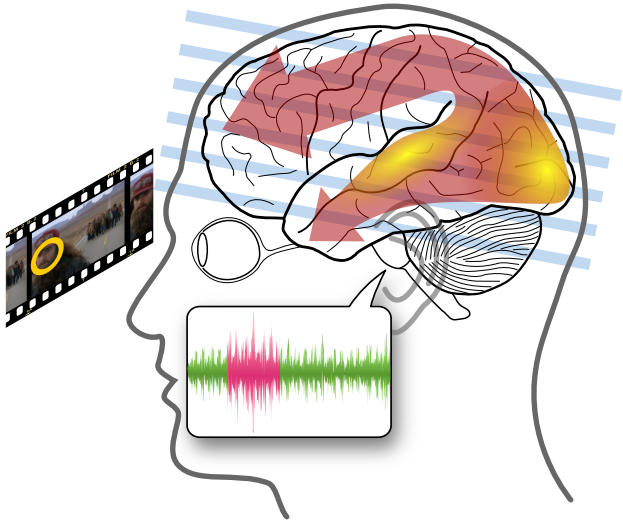
More public data

Phase 1
(complete)



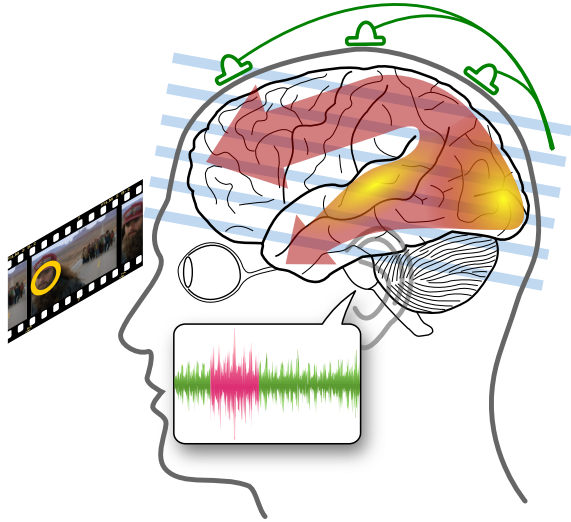
7T
auditory

Phase 2
(in progress)



3T
audio-visual
eye-tracking

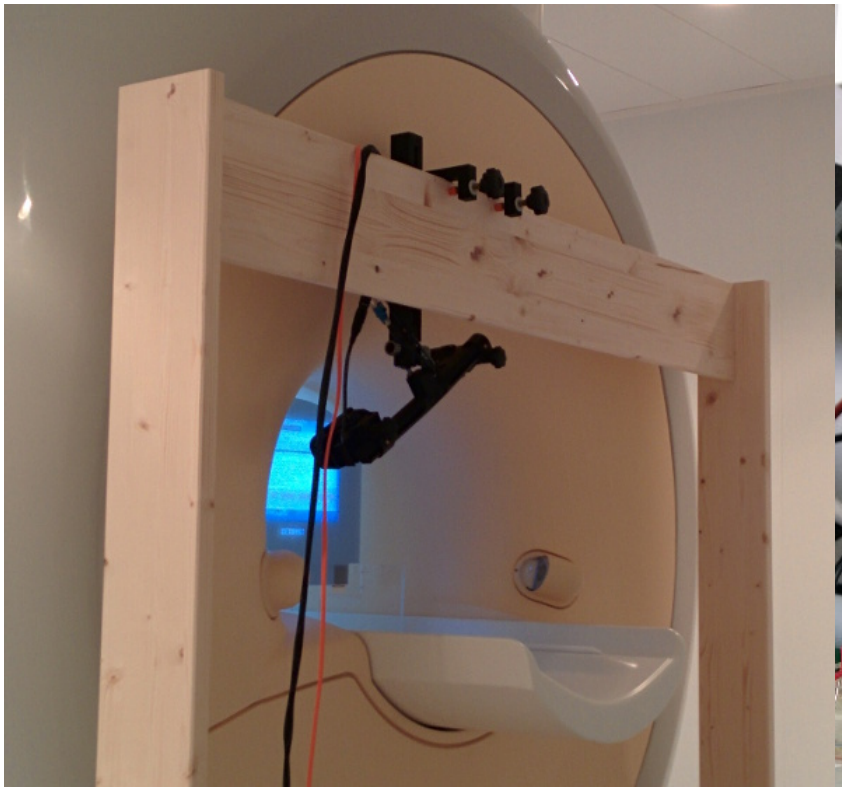
Phase 3
(est. Oct. 2014)

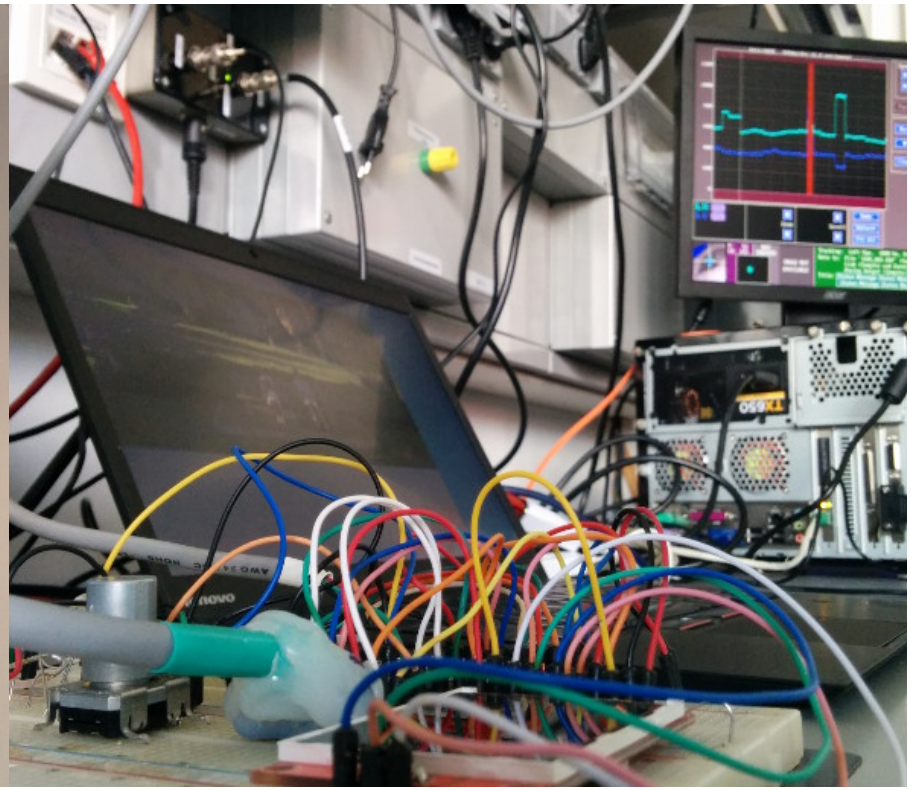


3T
audio-visual
eye-tracking, EEG

Dedicated eye-tracking with GSR and facial expressions is in the works.

Simultaneous 3T fMRI and 1000 Hz eye-tracking

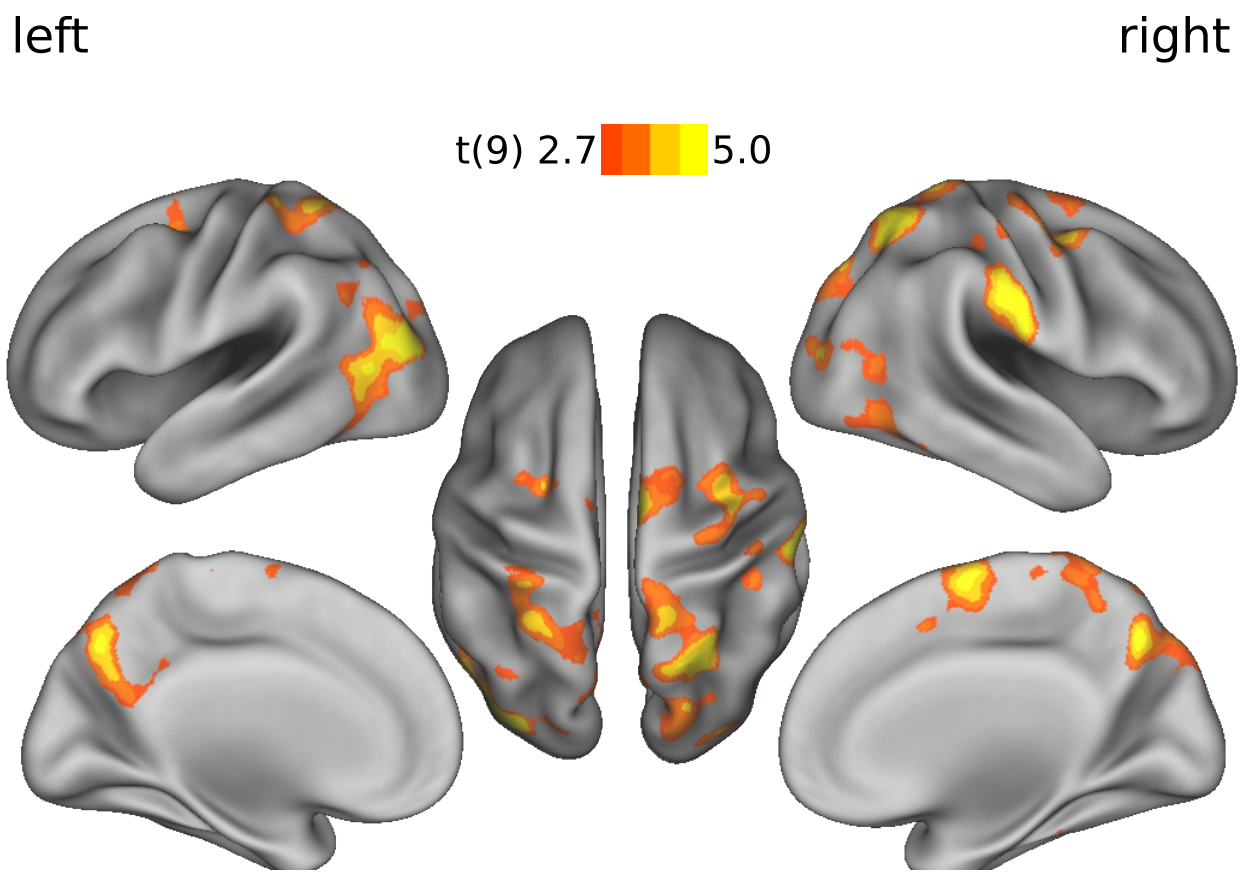




Watch data preview. . .

14 participants overlap with phase 1 data; watch data preview

RSA analysis for temporal eye-gaze synchronicity



"'where is fMRI signal more similar when subjects' eye-gaze is synchronous"'

$\rightarrow$ large parts of the fronto-parietal attention network

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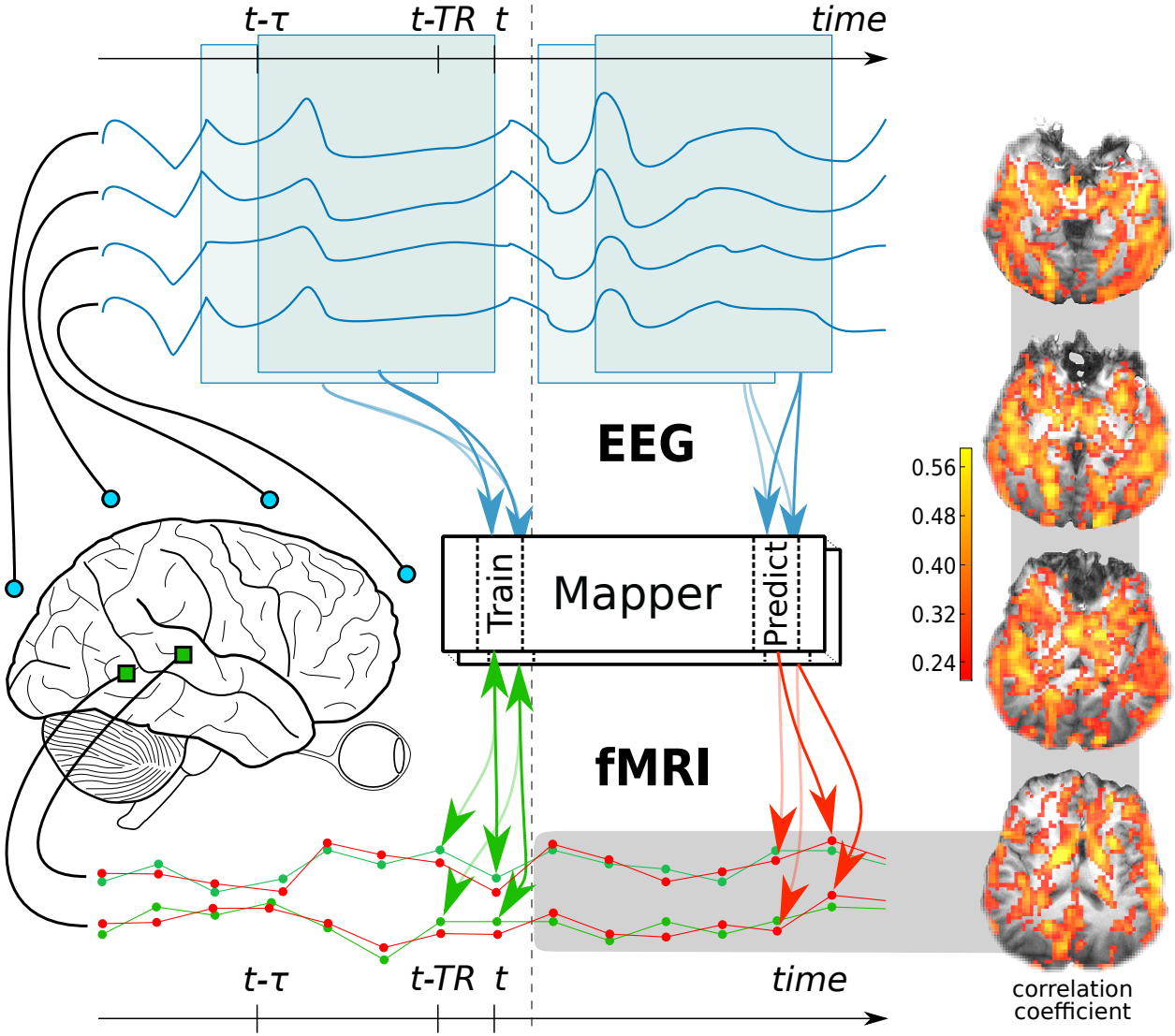
n=10; cluster threshold (t=2.7, p=.05): FEF, SEF, IPS, hMT+, Precuneus

EEG/fMRI



Halchenko, Y. O. and Hanke, M. (2010). Advancing Neuroimaging Research with Predictive Multivariate Pattern Analysis (MVPA). *The Neuromorphic Engineer*

Datamanagement

- sizable dataset: initial release ≈10000 files; 355Gb
- longitudinal changes: currently at post-publication-revision 3; three more major additions planned
- multiple hosting locations: OvGU, OpenFMRI, NITRC-IR, . . .

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DataGit*

- version control for data: track everything
- distributed: obtain, modify, re-publish – without a central gatekeeper
- a tool, not a service – built atop of git-annex
- facilitate incremental research on a data-level

Name needs to change because of people with lawyers. . .

References

Connolly, A. C., Guntupalli, J. S., Gors, J., Hanke, M., Halchenko, Y. O., Wu, Y.-C., Abdi, H., and Haxby, J. V. (2012). Representation of biological classes in the human brain. *Journal of Neuroscience*, 32:2608–2618. PMC3532035.

Halchenko, Y. O. and Hanke, M. (2010). Advancing Neuroimaging Research with Predictive Multivariate Pattern Analysis (MVPA). *The Neuromorphic Engineer*.

Hanke, M., Halchenko, Y. O., Sederberg, P. B., Olivetti, E., Fründ, I., Rieger, J. W., Herrmann, C. S., Haxby, J. V., Hanson, S. J., and Pollmann, S. (2009). PyMVPA: A unifying approach to the analysis of neuroscientific data. *Frontiers in Neuroinformatics*, 3(3). PMC2638552.