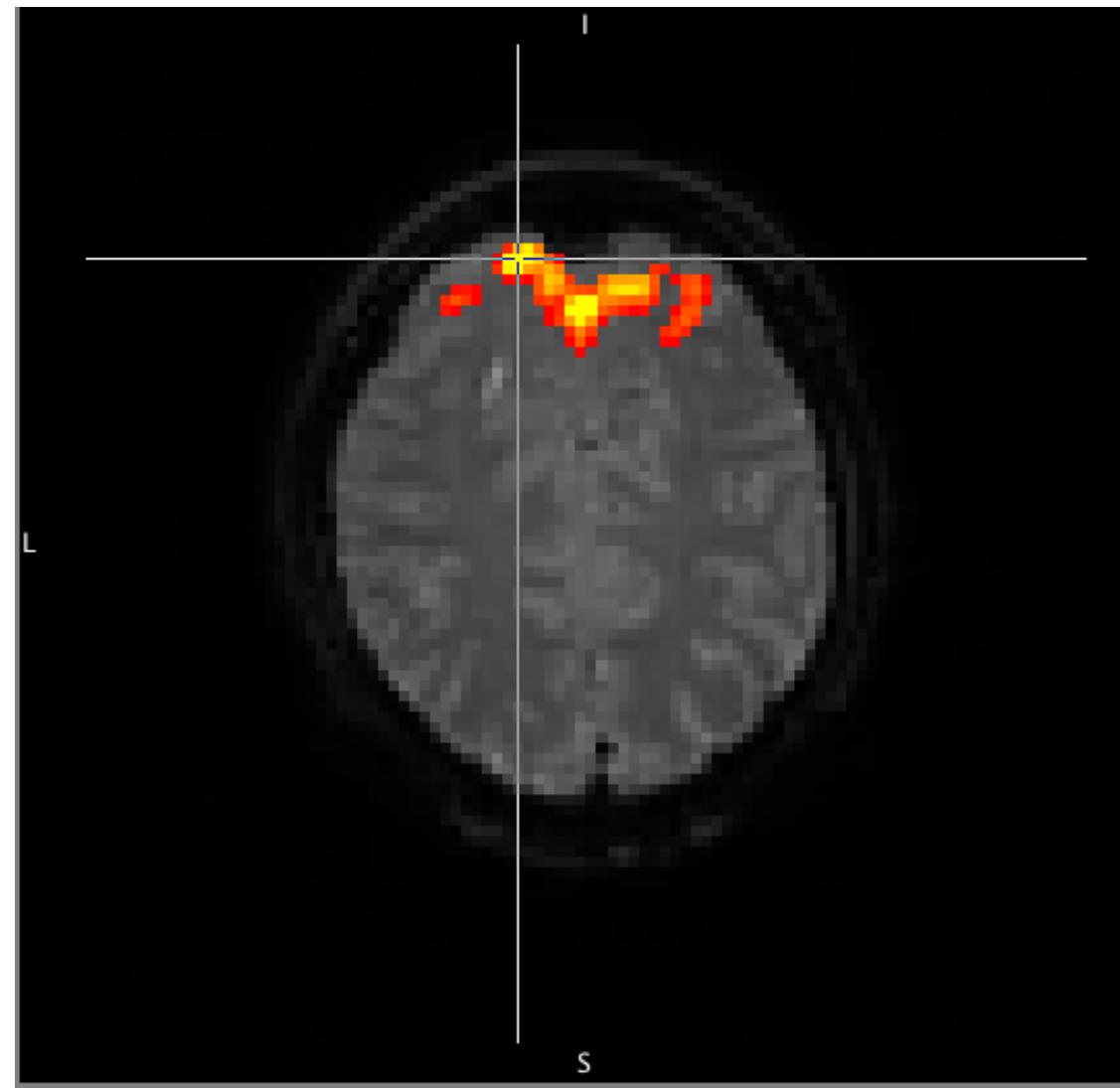


Patterns in time and space

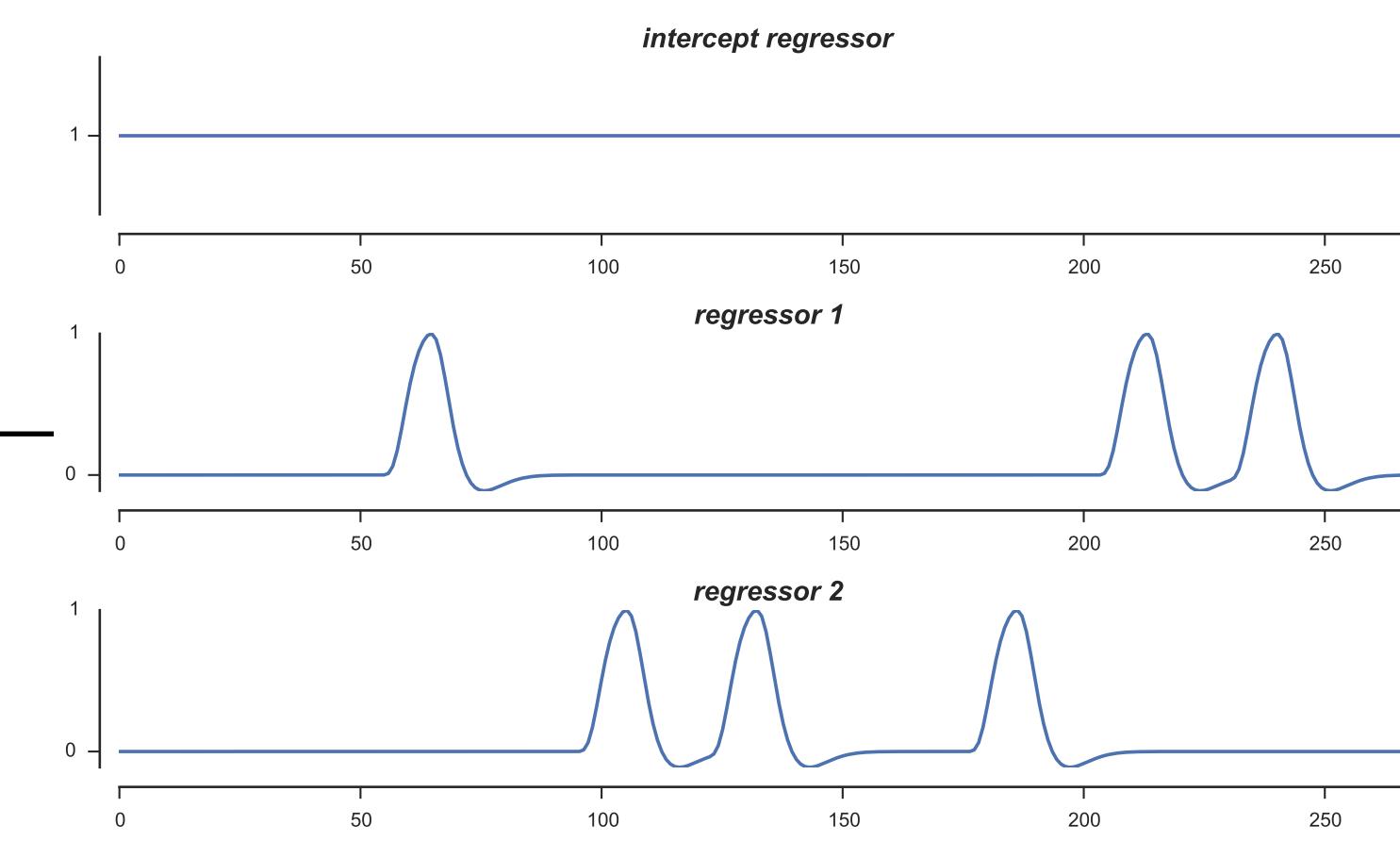
Connectivity and Pattern analysis



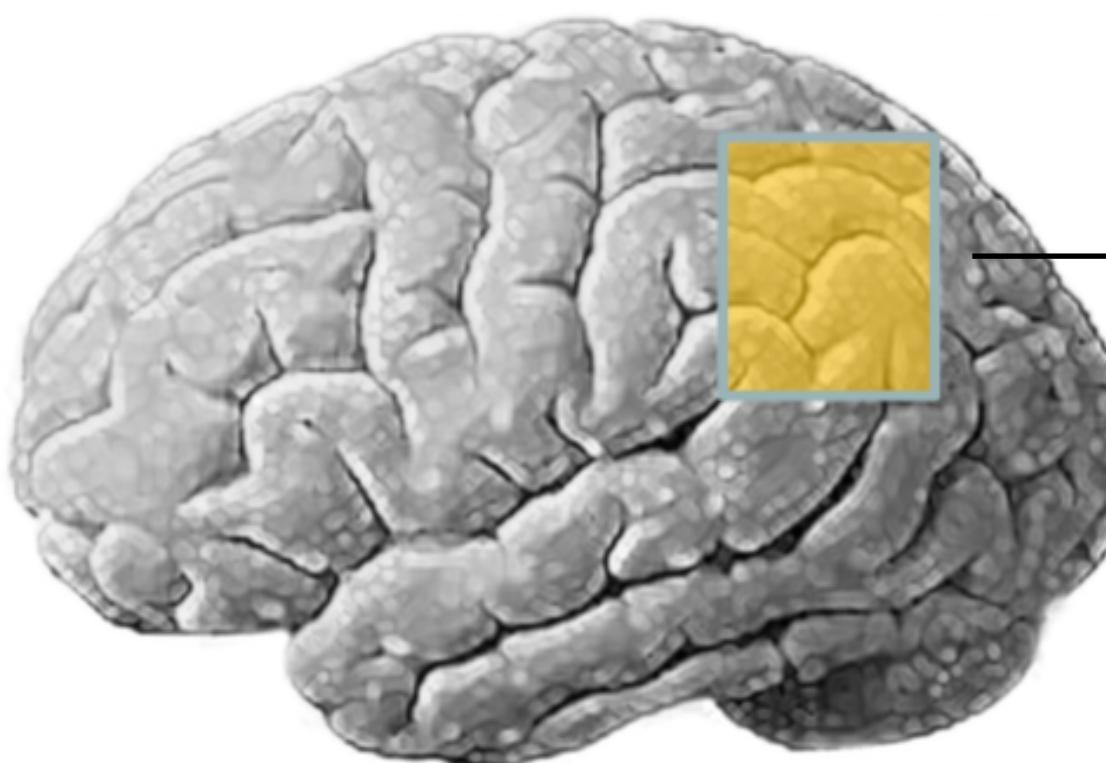
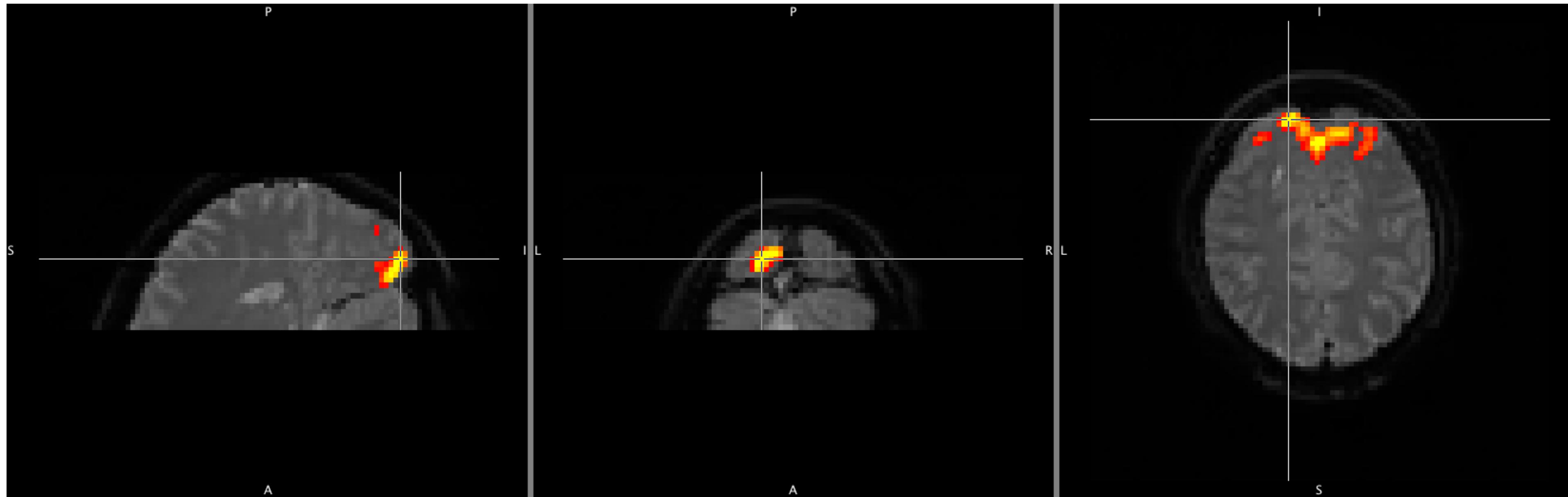
pre
processing



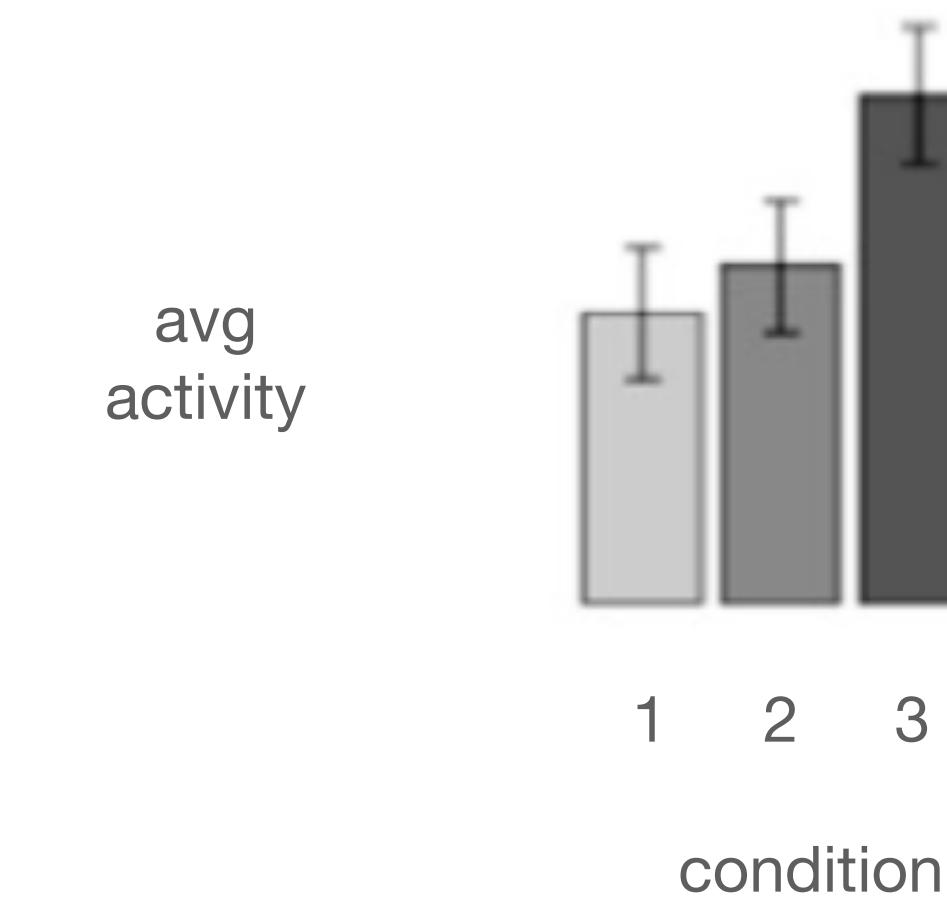
post-
processing



Univariate analysis a.k.a. ‘blobology’

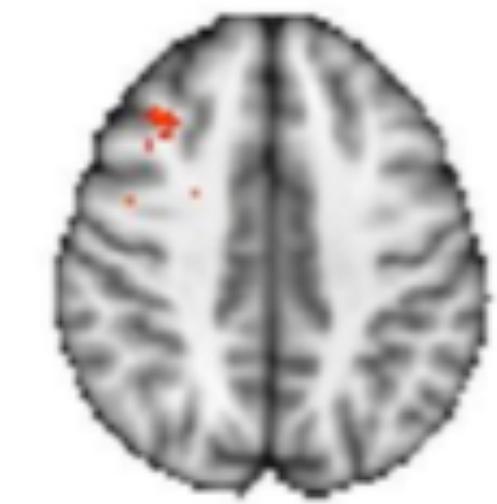
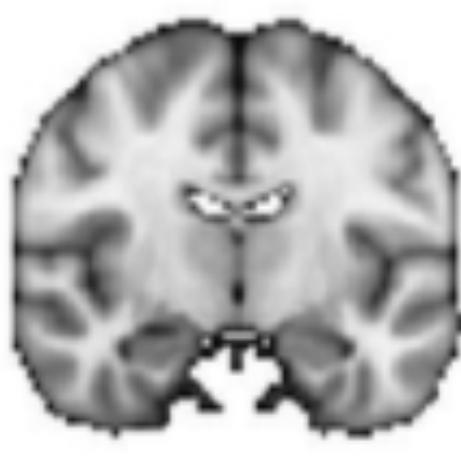


Region
Of
Interest



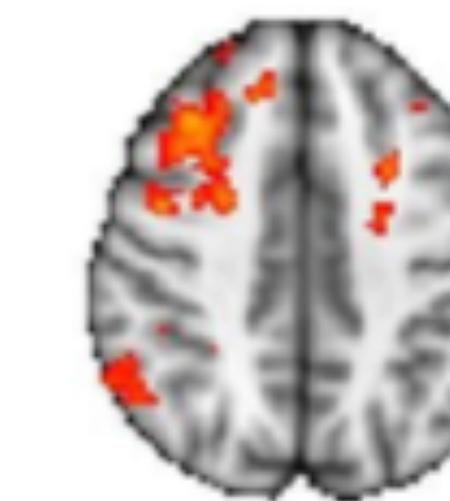
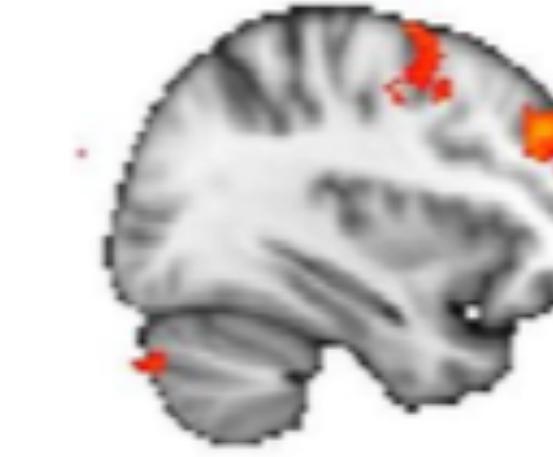
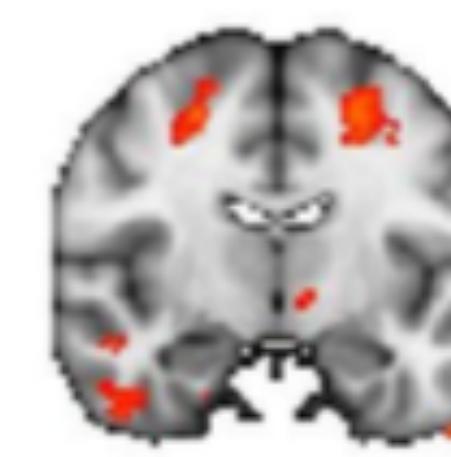
Thresholding problem

$t > 3$



"Concept X is **locally** represented in the left dorsolateral prefrontal cortex"

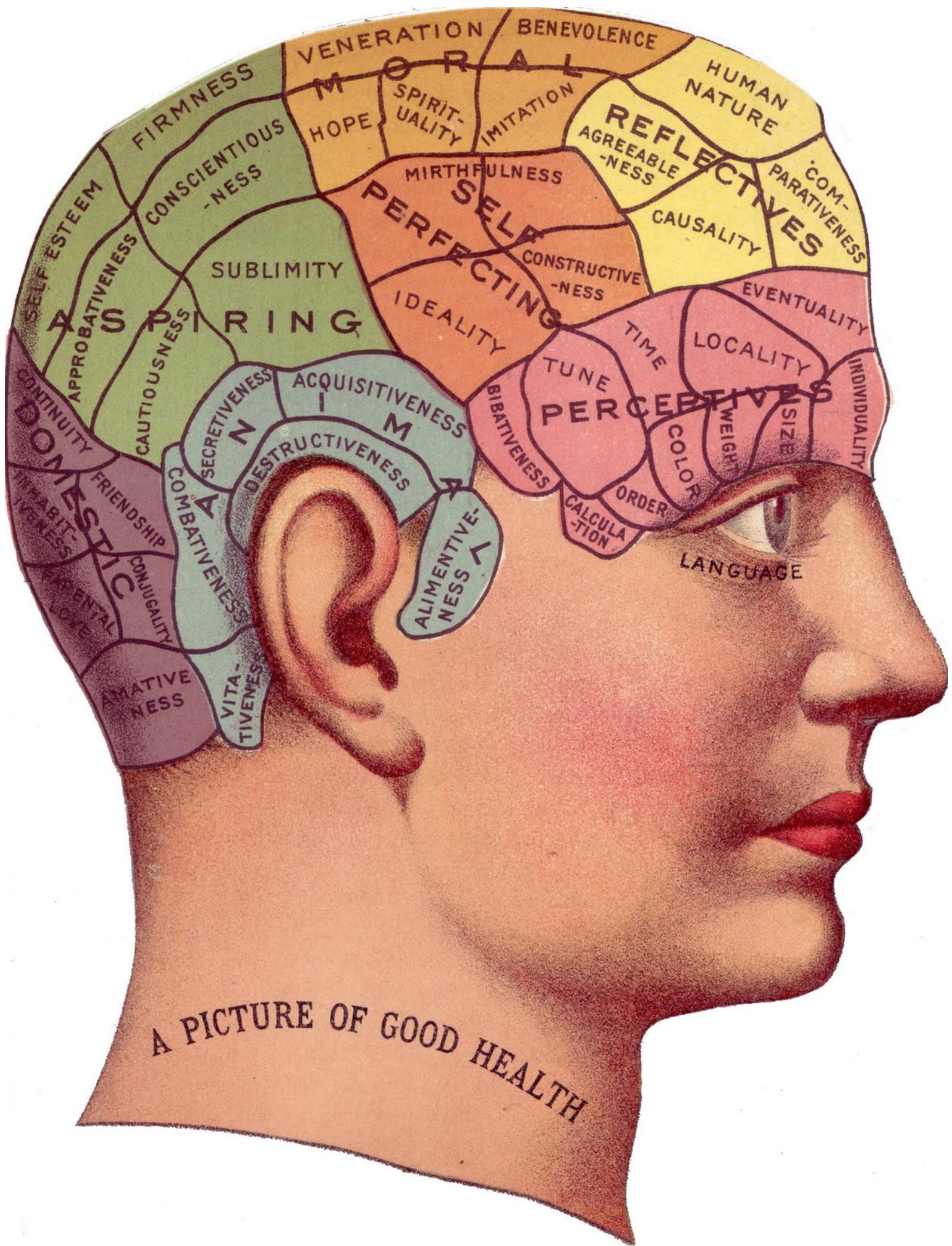
$t > 2.3$



"Concept X is **globally** represented in a **network** of the dorsolateral PFC, precentral gyrus, TPJ, and ATL"

function processed locally,
or in a network?

Neo-phrenology

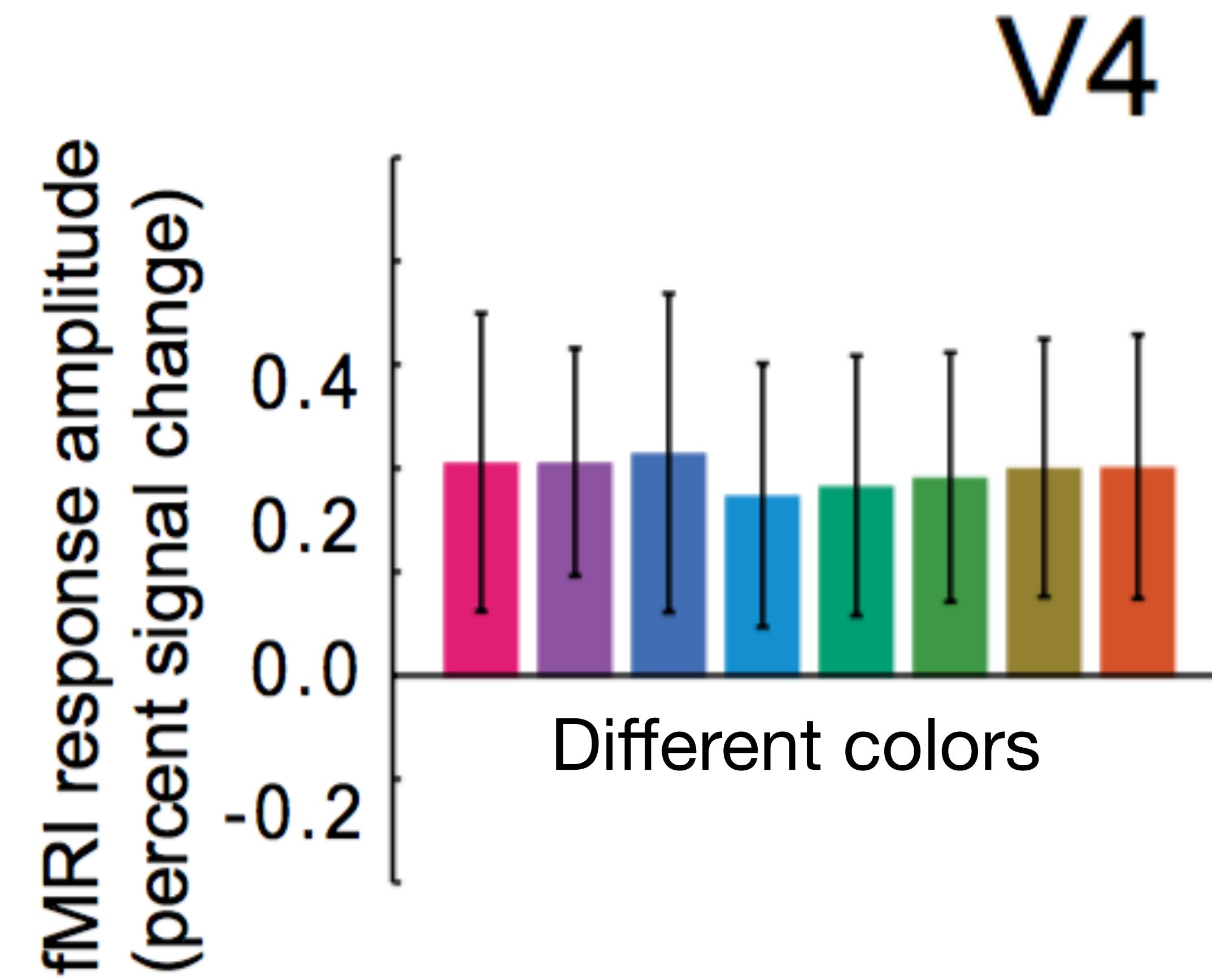


phrenology
localising functions
in the brain

phren = mind
logos = knowledge

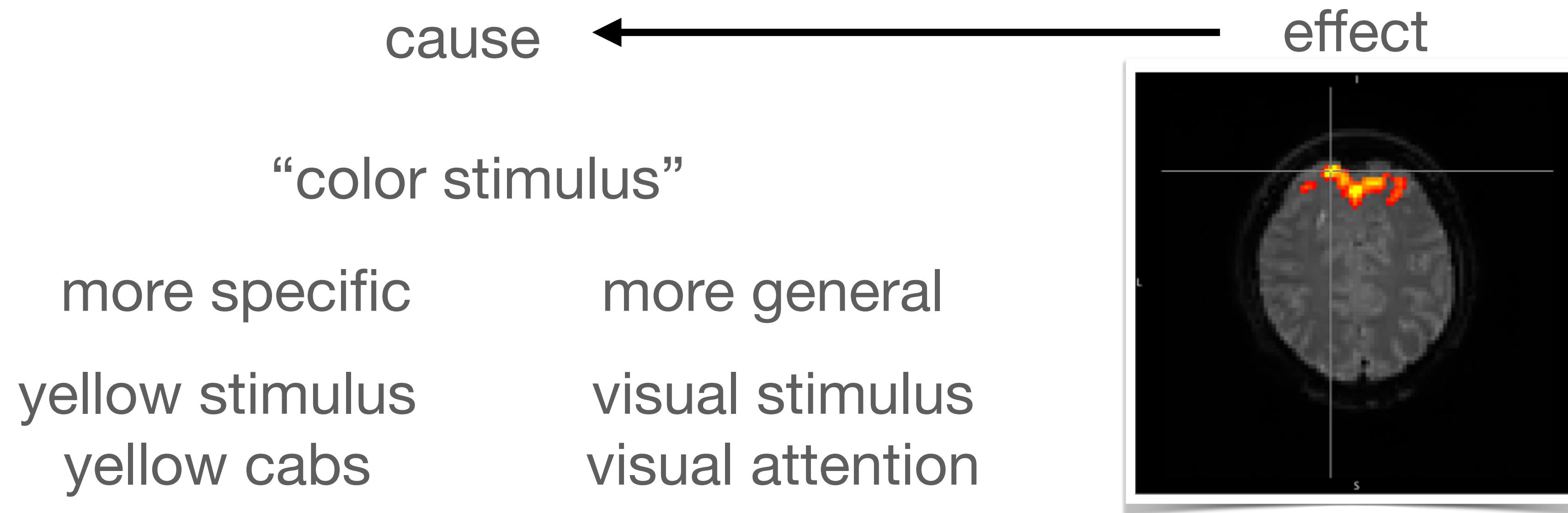
big overlap in
functions especially
in higher-order cortex

Per-ROI amplitude averages cannot distinguish between stimulus types within ROI



Reverse Inference Problem

- inverse inference problem



what is it about
your stimulus that
drives the effect?

Limitations of Univariate Analyses

- cannot distinguish stimulus types within ROI
- reverse inference: what is it about your stimulus that drives activity?

This Lecture

Pattern Classification

Other Lectures on
Receptive Field Models

Forward Models

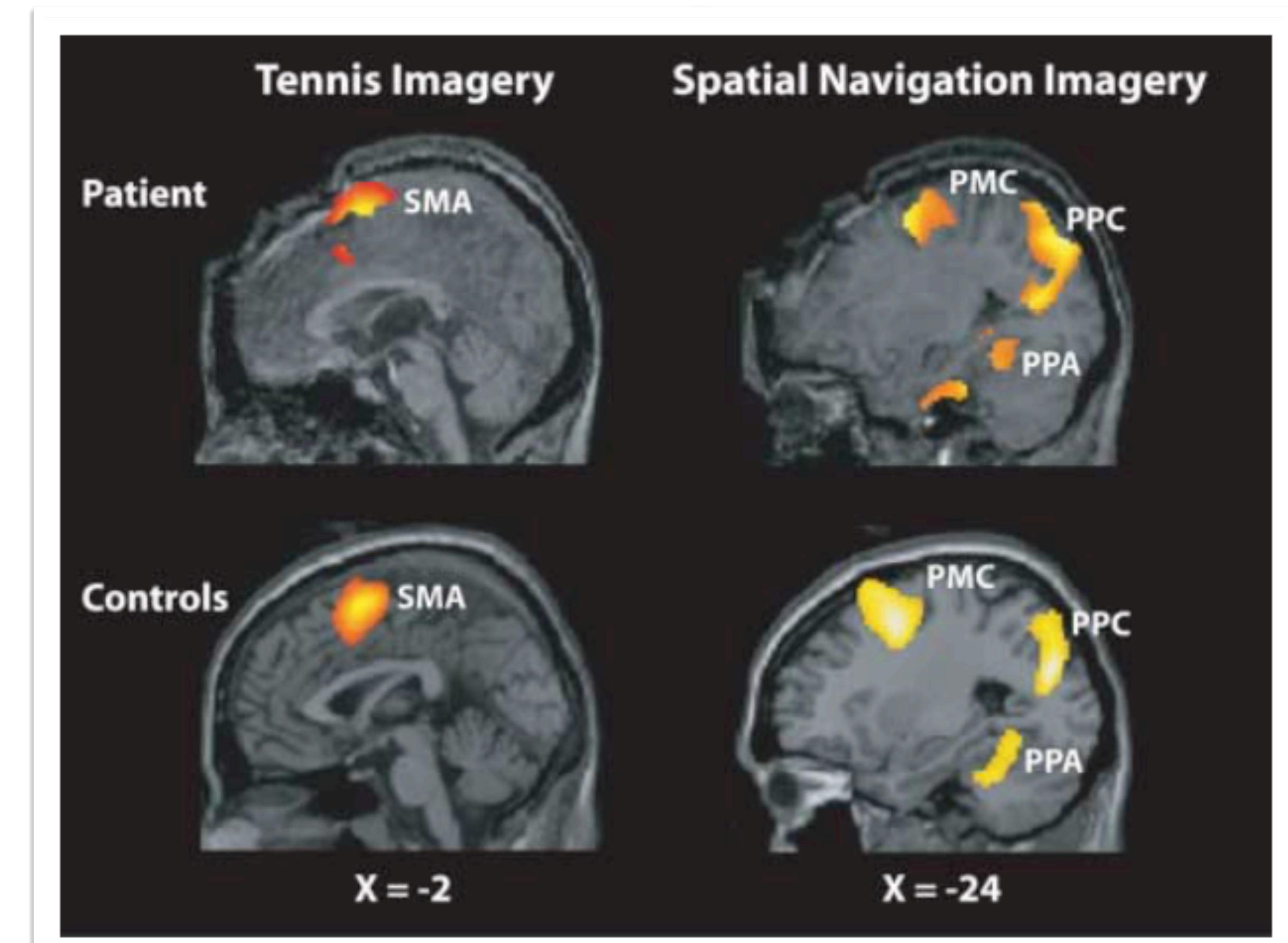
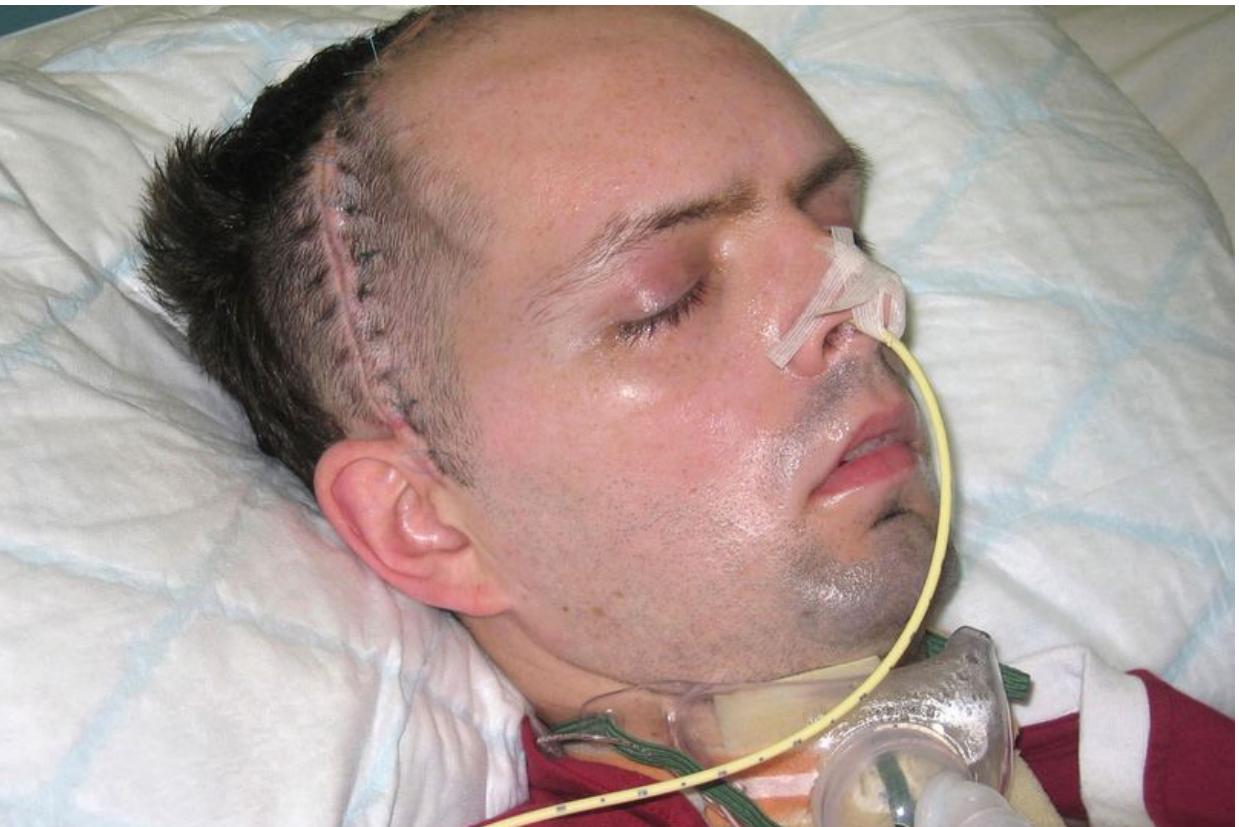
MVPA

Multivariate pattern analysis

Going Multivariate

Detecting Awareness in the Vegetative State

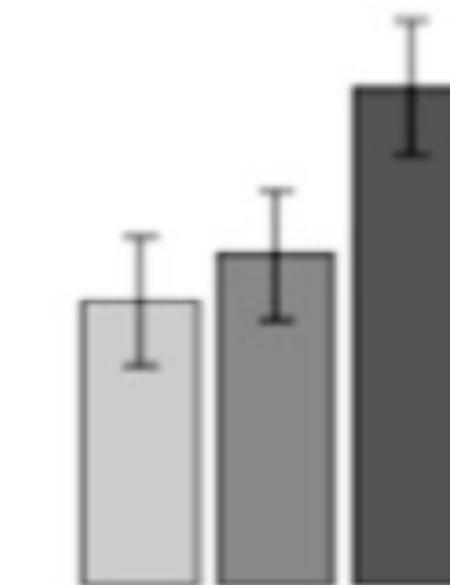
Adrian M. Owen,^{1*} Martin R. Coleman,² Melanie Boly,³ Matthew H. Davis,¹
Steven Laureys,³ John D. Pickard²



Distinguishing between stimulus types



Univariate
Region
Of
Interest → *average*
of activity

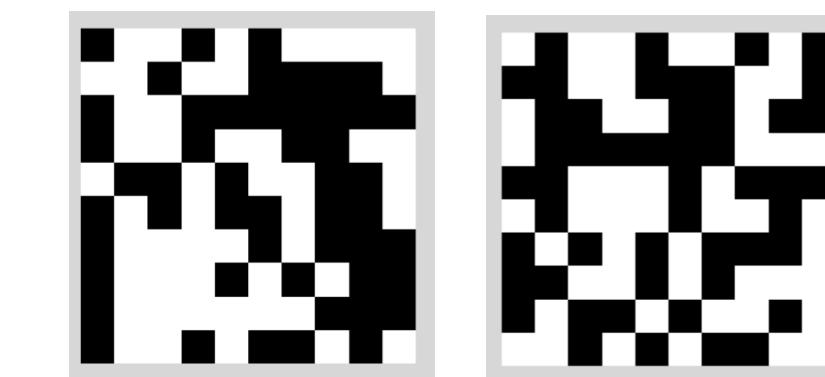


1 2 3

condition



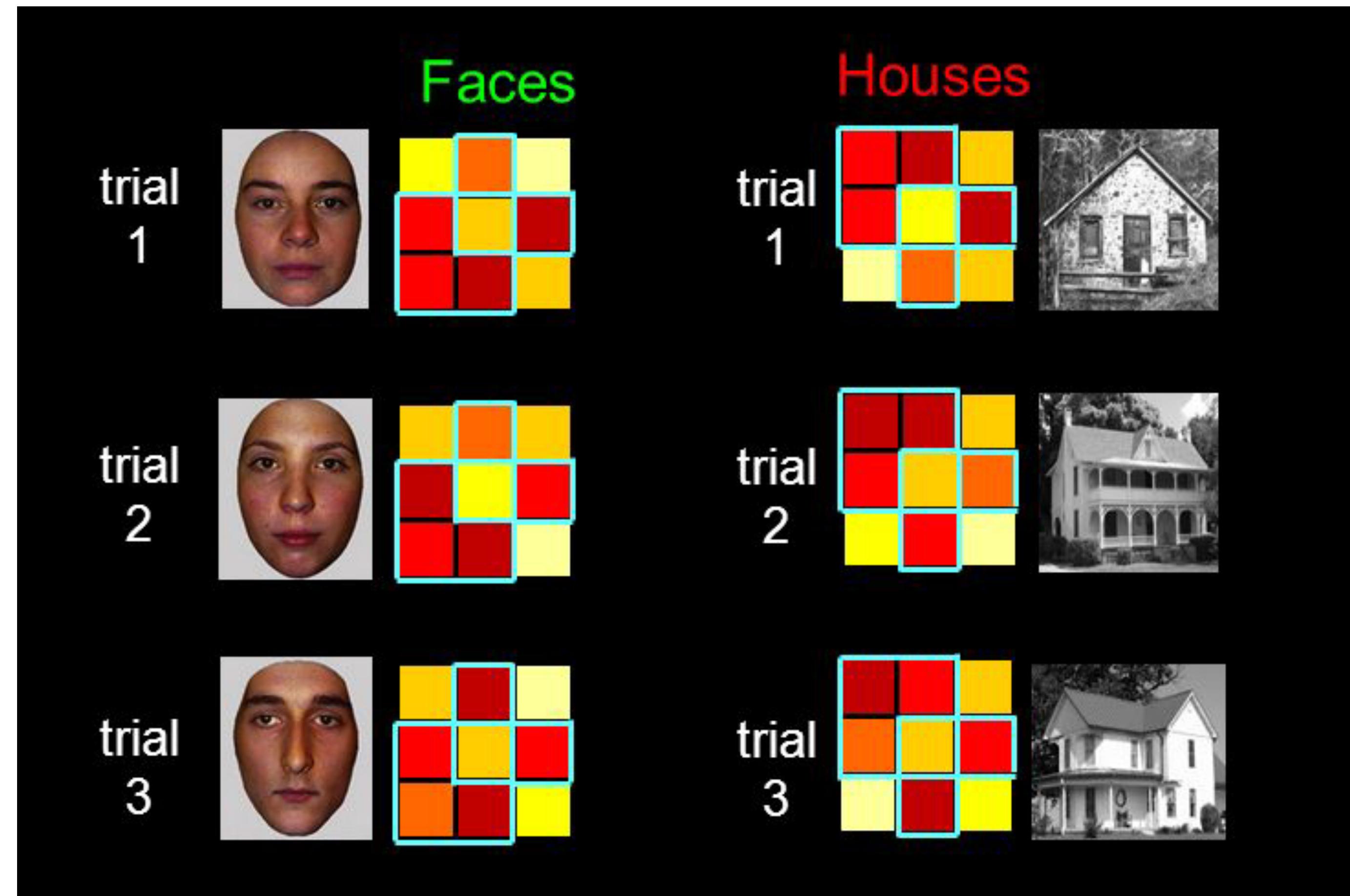
Multivariate (MVPA)
Region
Of
Interest → *pattern*
of activity
(β s)



1 2

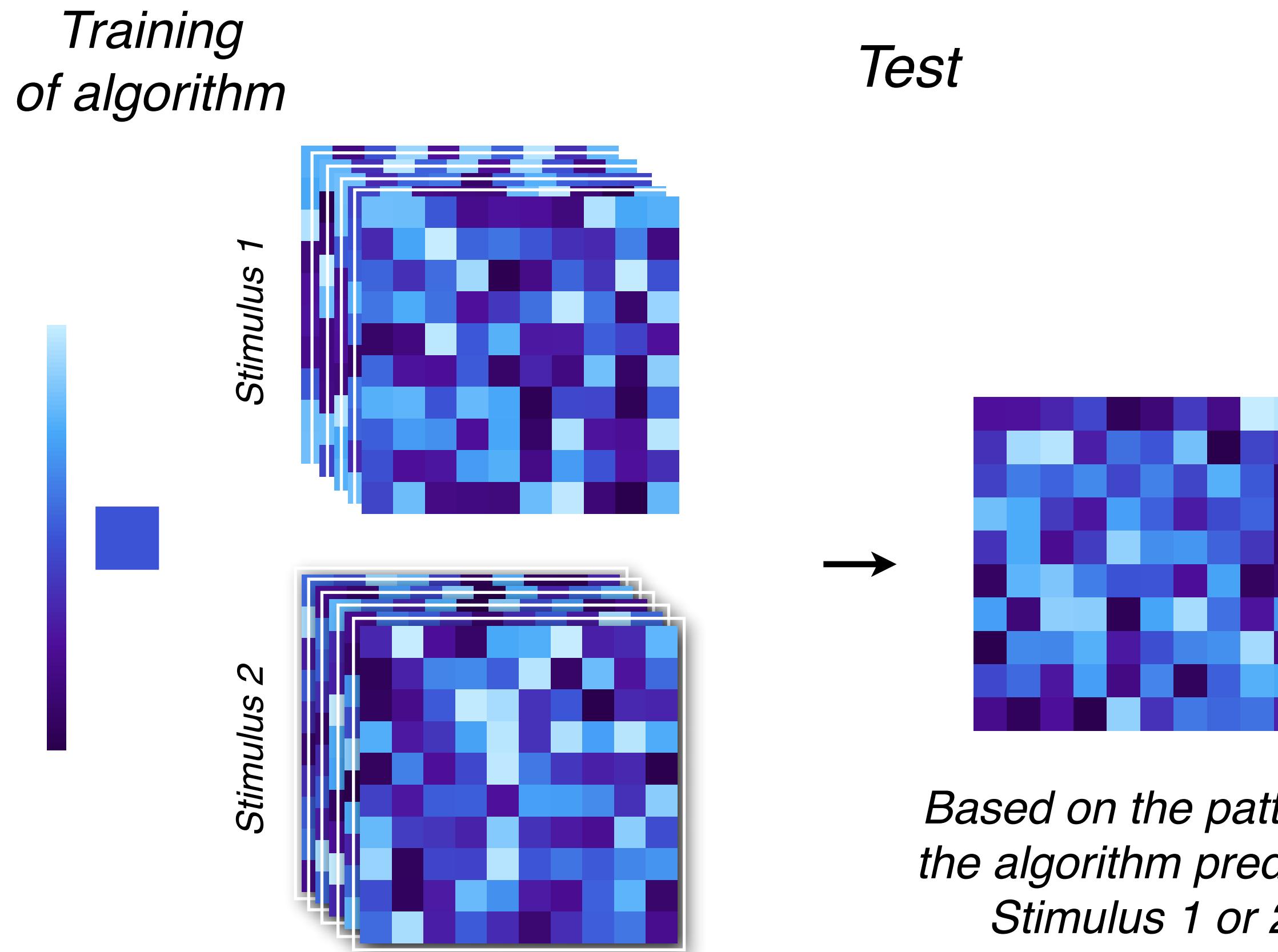
condition

Can we distinguish between stimulus types within ROI



Pattern classification

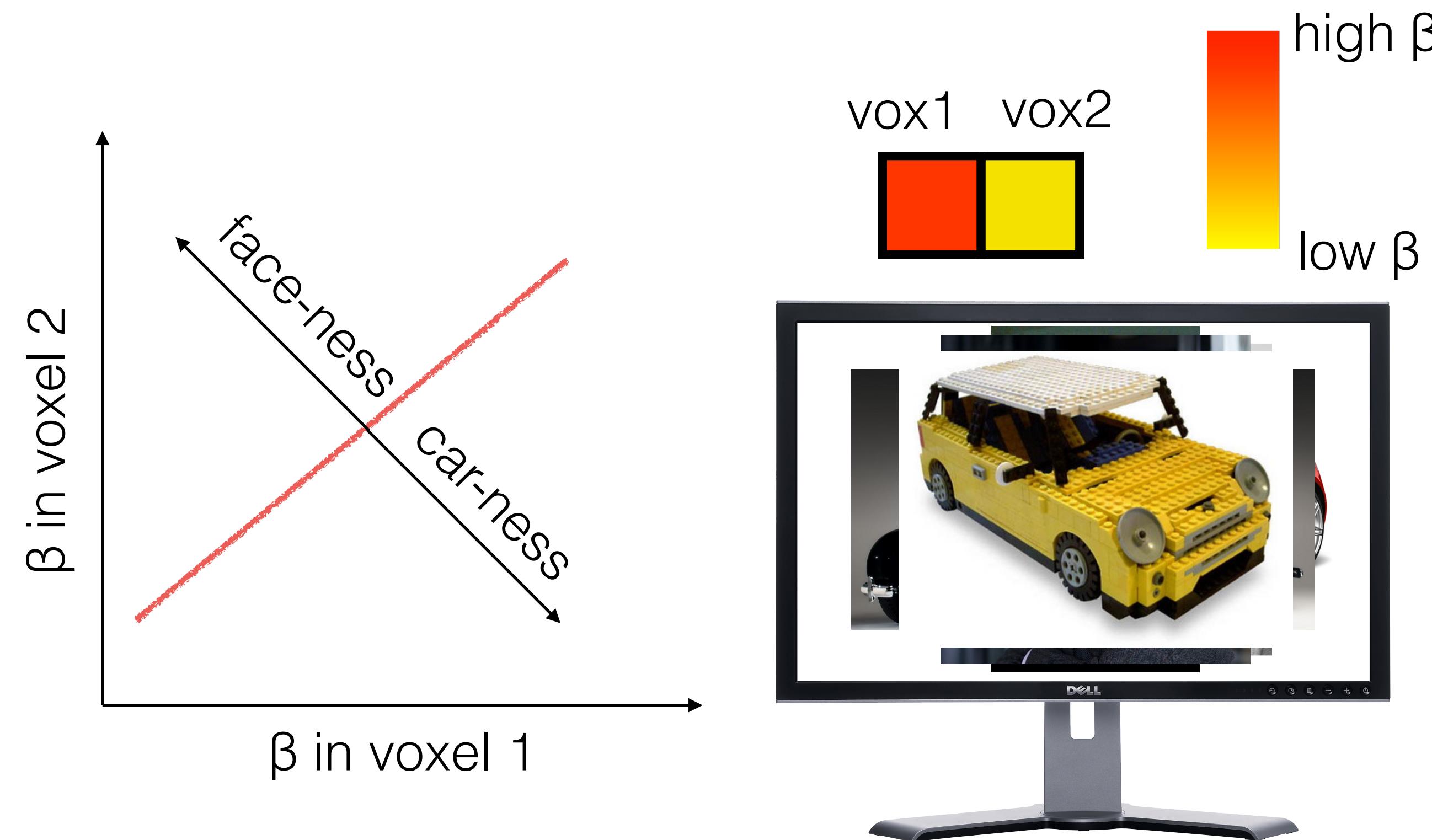
*Not mean signal intensity, but within-area **pattern** of activity, is used to classify what the brain state is.*



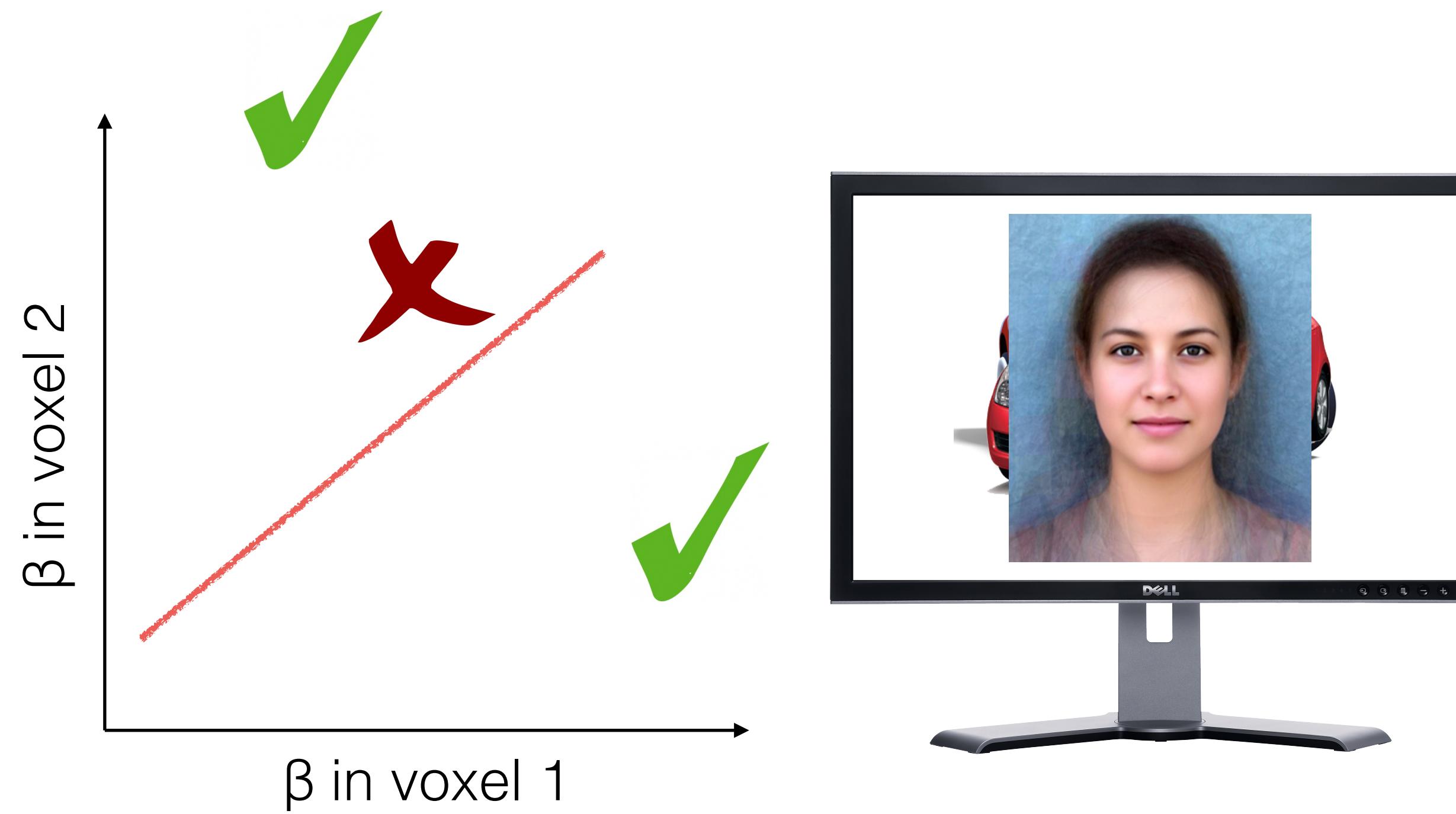
Performance of algorithm expressed as accuracy

- gauge on “information content” in a specific region of interest

Predicting stimulus type: training a classifier



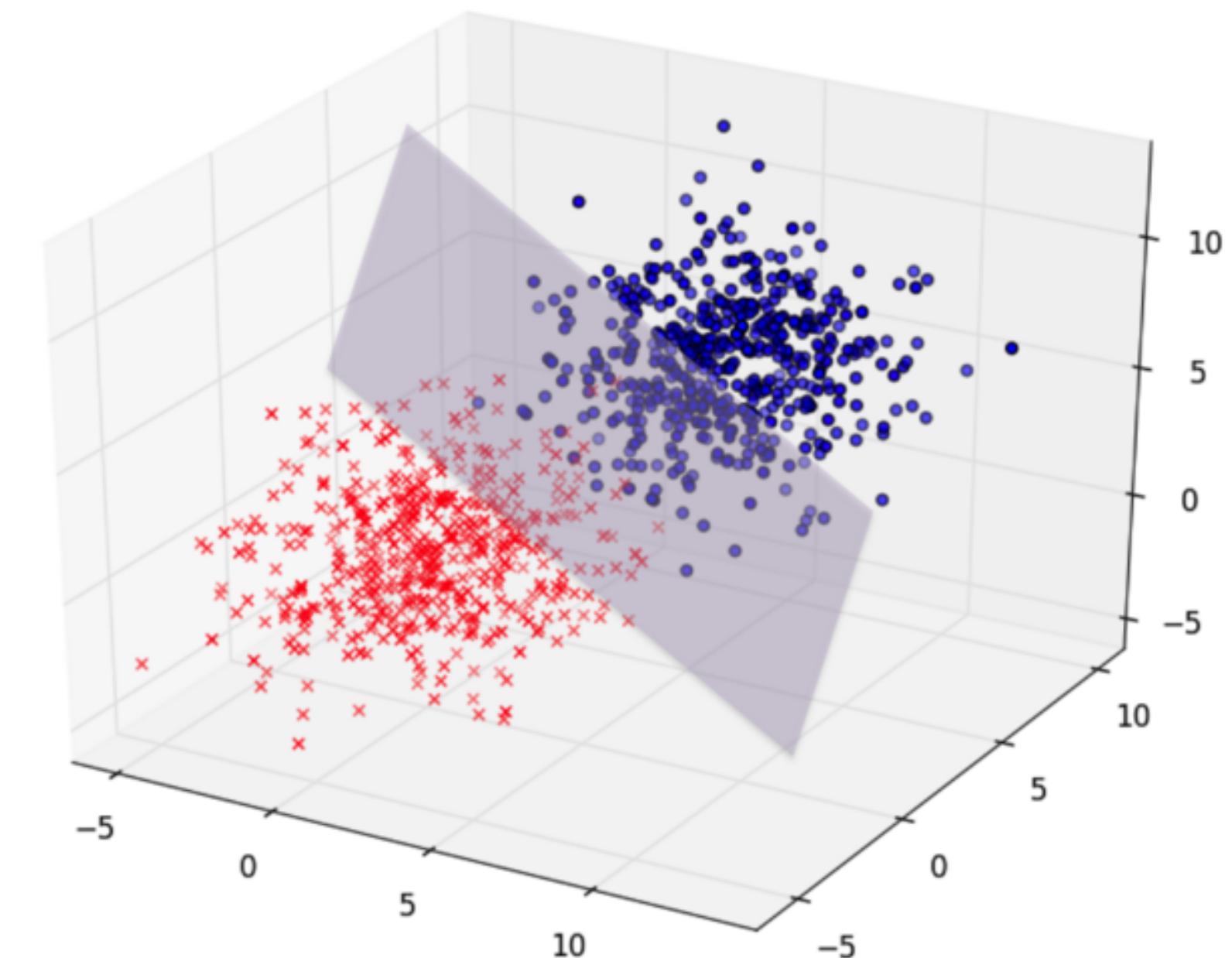
Predicting stimulus type: testing the classifier



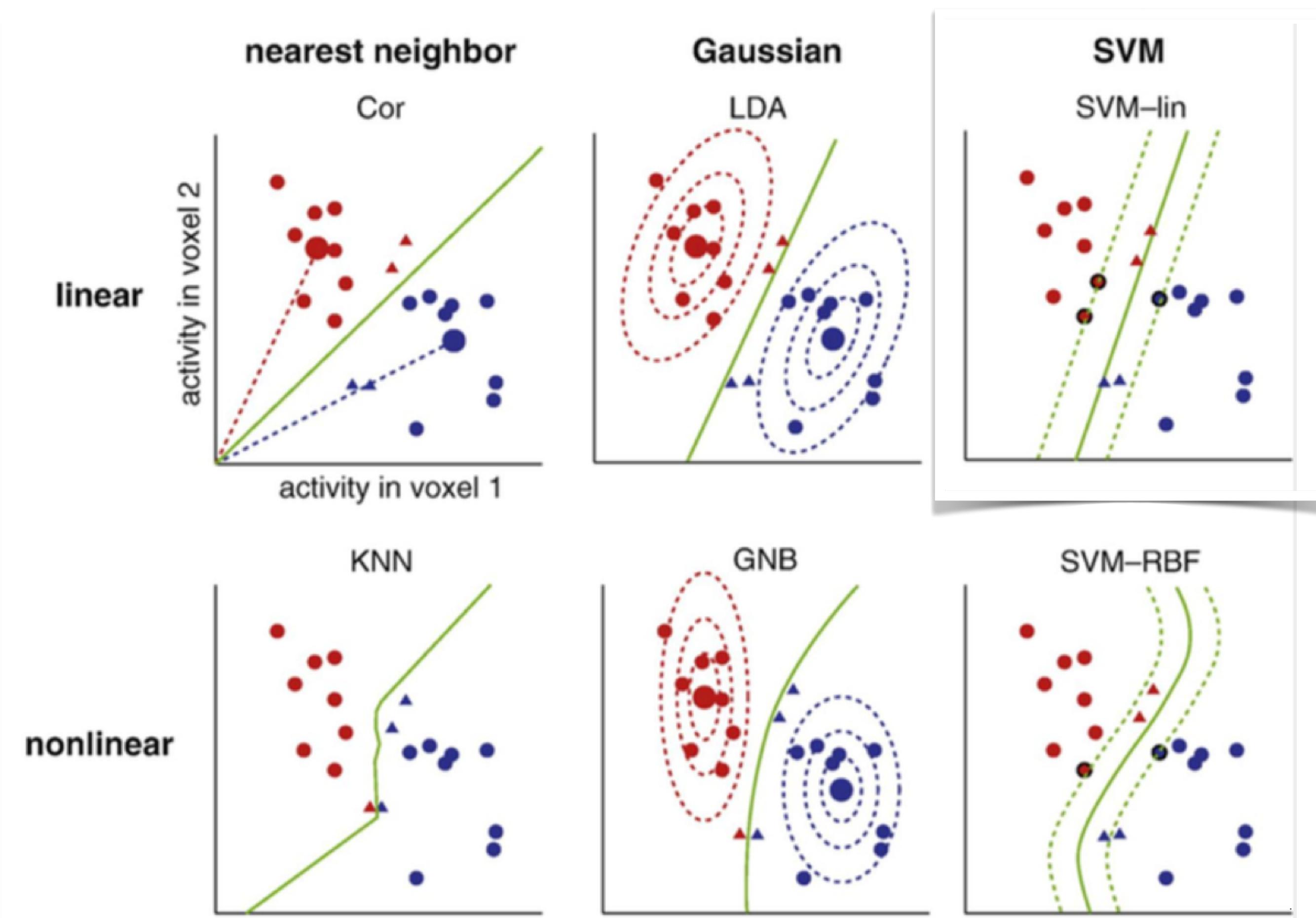
Extending to more voxels

- Finding the n-dimensional plane that separates patterns across n voxels

3 voxels



Machine Learning Algorithms: how to draw the line/plane?



Hint: Stanford Machine Learning Course on Coursera

Why separate training and test data?

*Training the algorithm finds predictive relations in the data.
Are these relations: 1. accurate, 2. sensitive, 3. consistent*

*Test on a separate test dataset: does the algorithm perform well on data it
hasn't seen before?*

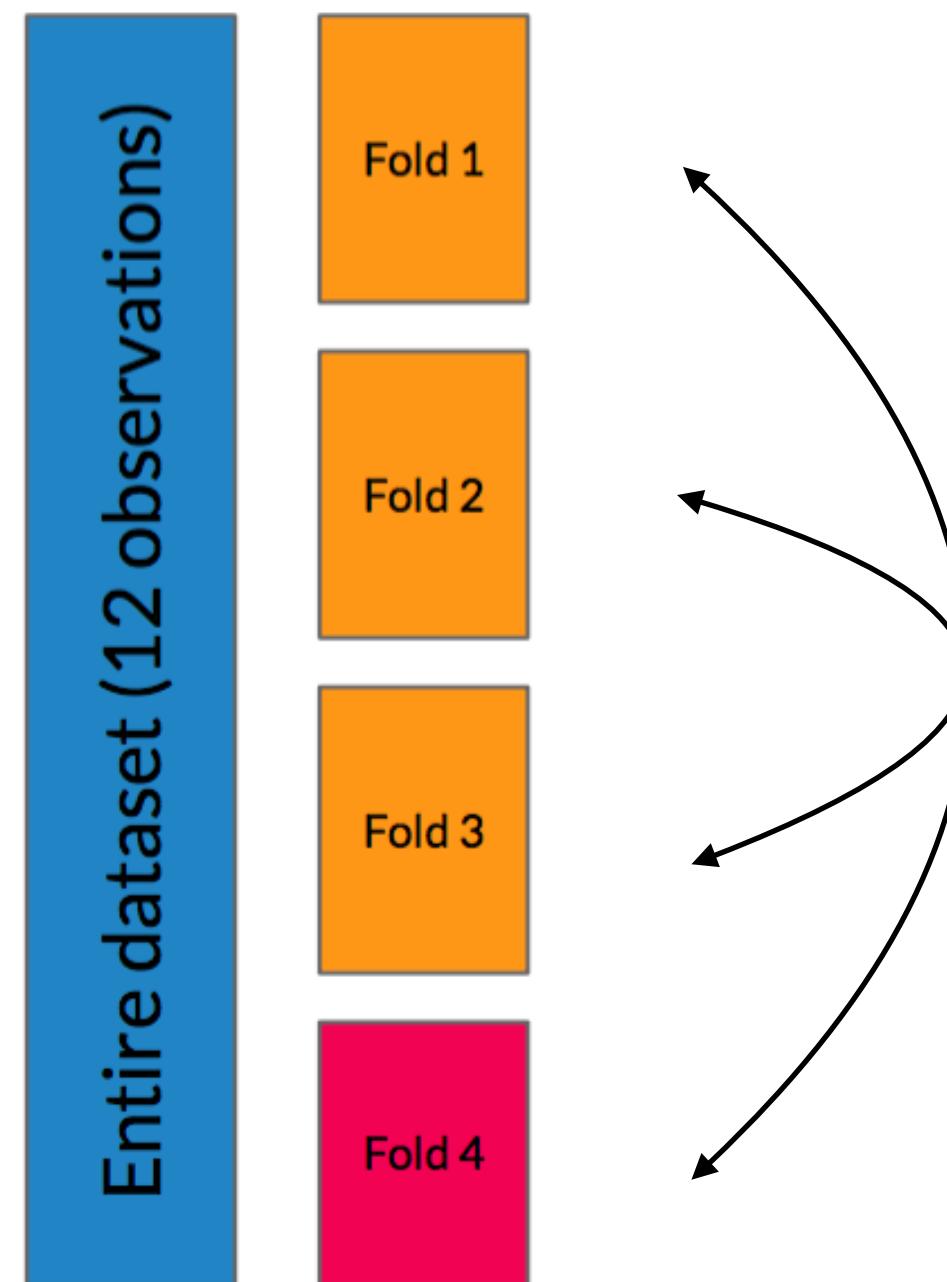
*What happens when you test using data that the algorithm has
been trained on?*

Circularity!

Predicting stimulus type: how to divide your data?

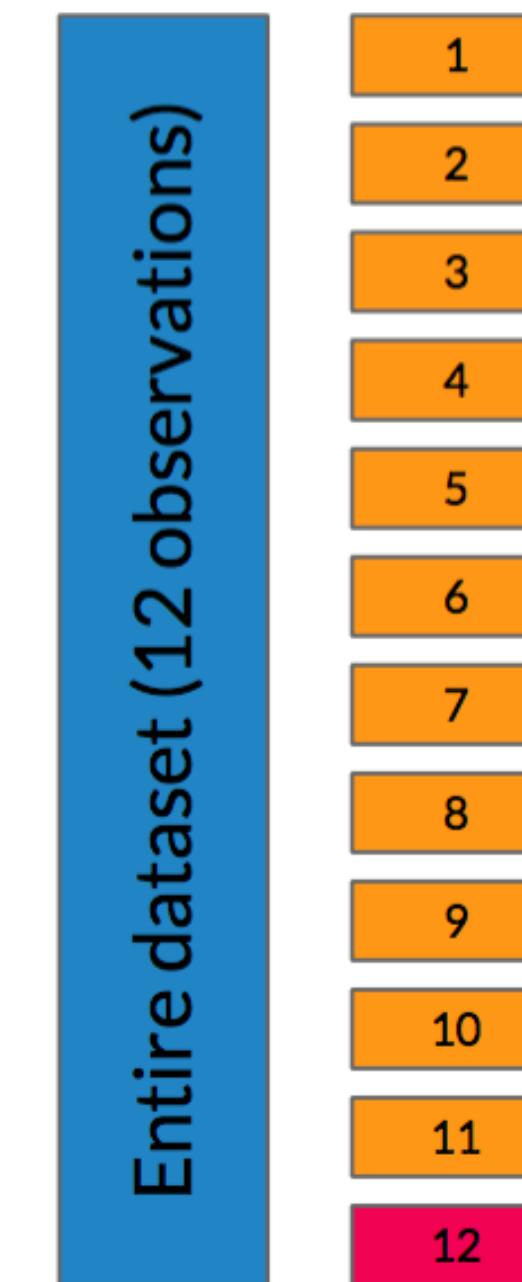
This is called ***cross-validation***

KFold



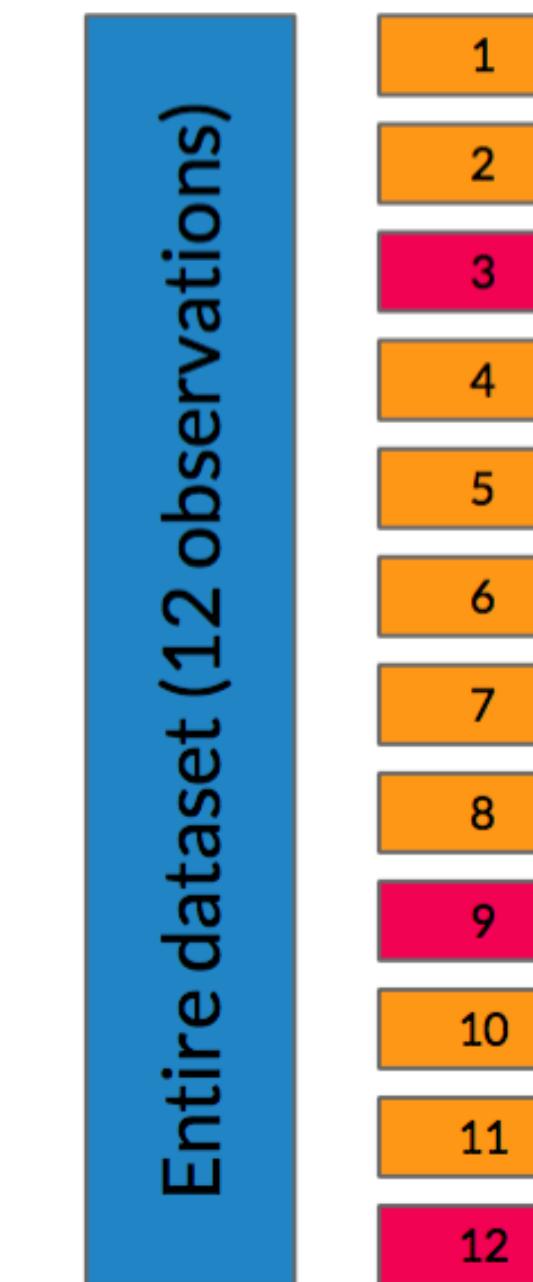
Every '**Fold**' is
the test set once

N-1 (leave-one-out)



Every **run** is
the test set once

Random subsampling



Many different test sets:
as many as you like

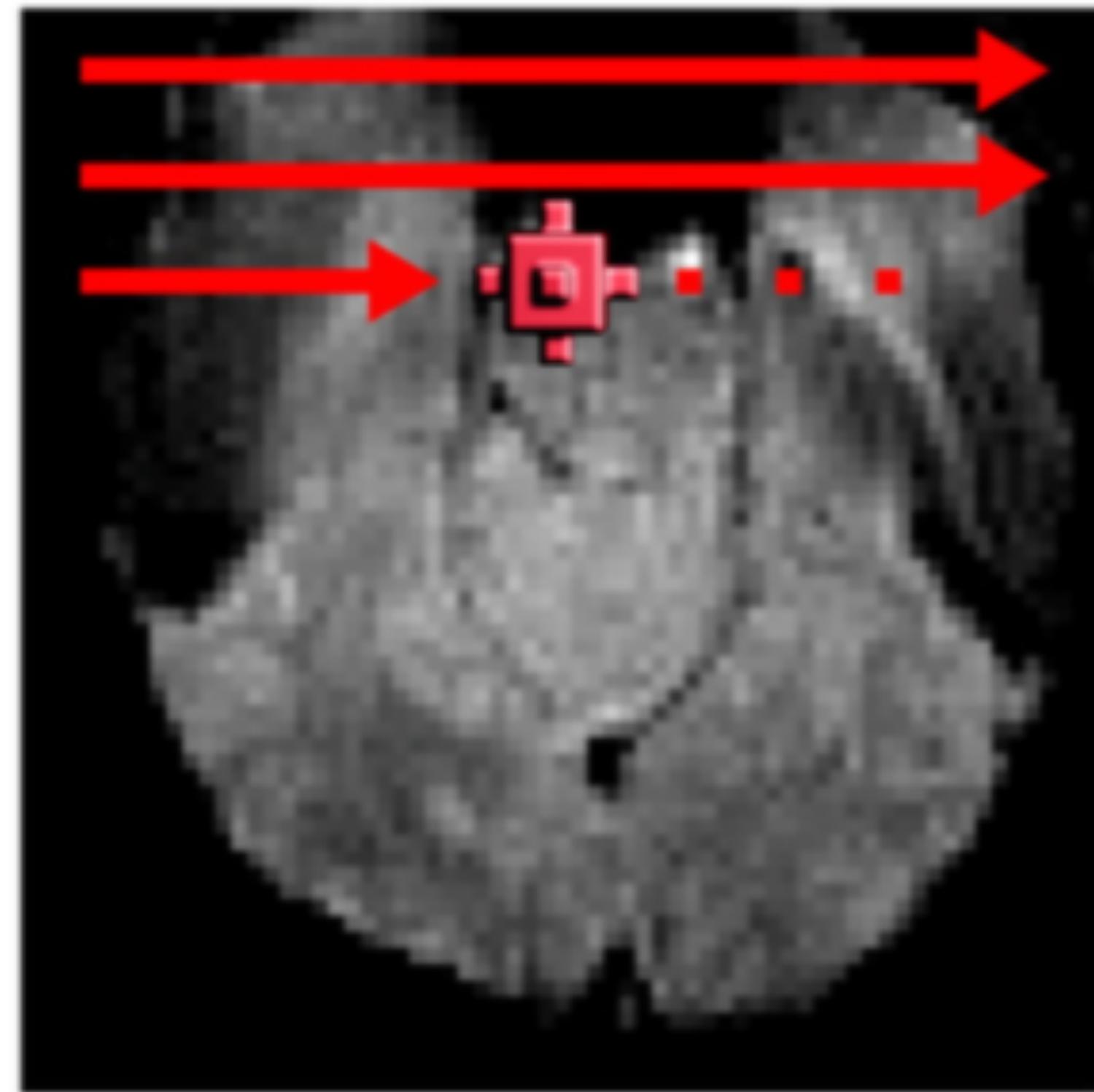
Searchlight Analysis

Flexible ROIs

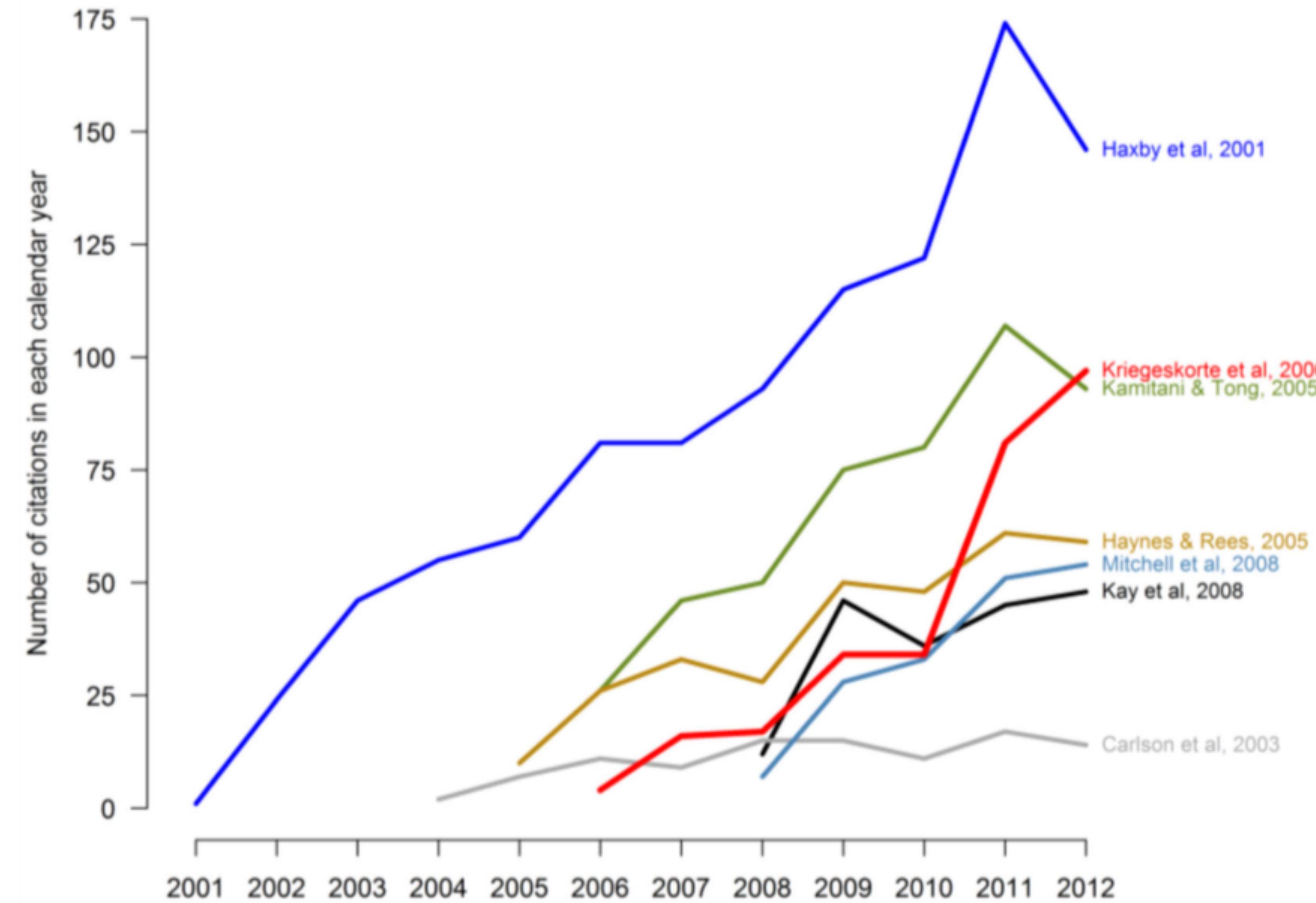
Find ‘information’ not in a region of interest,
but throughout the brain



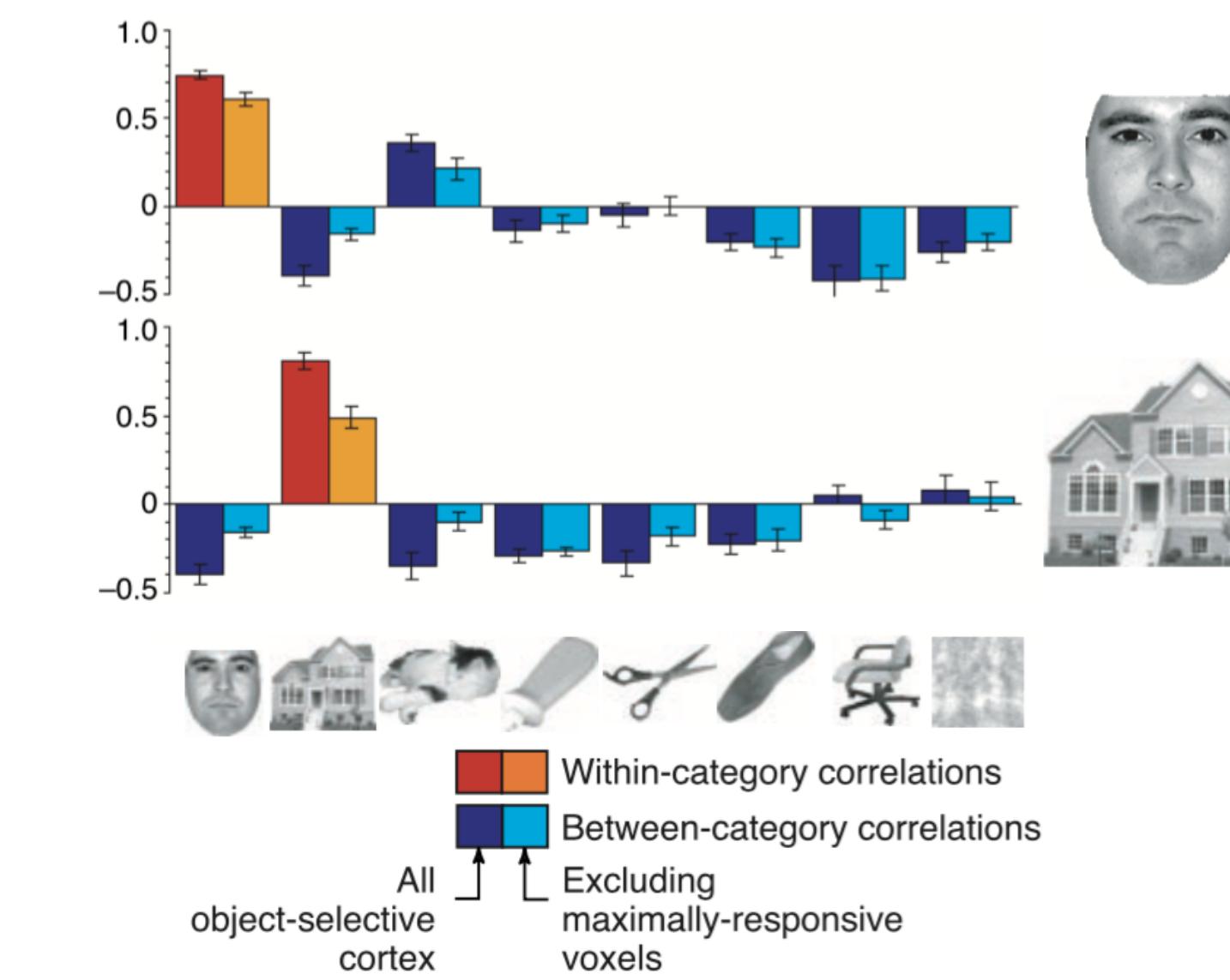
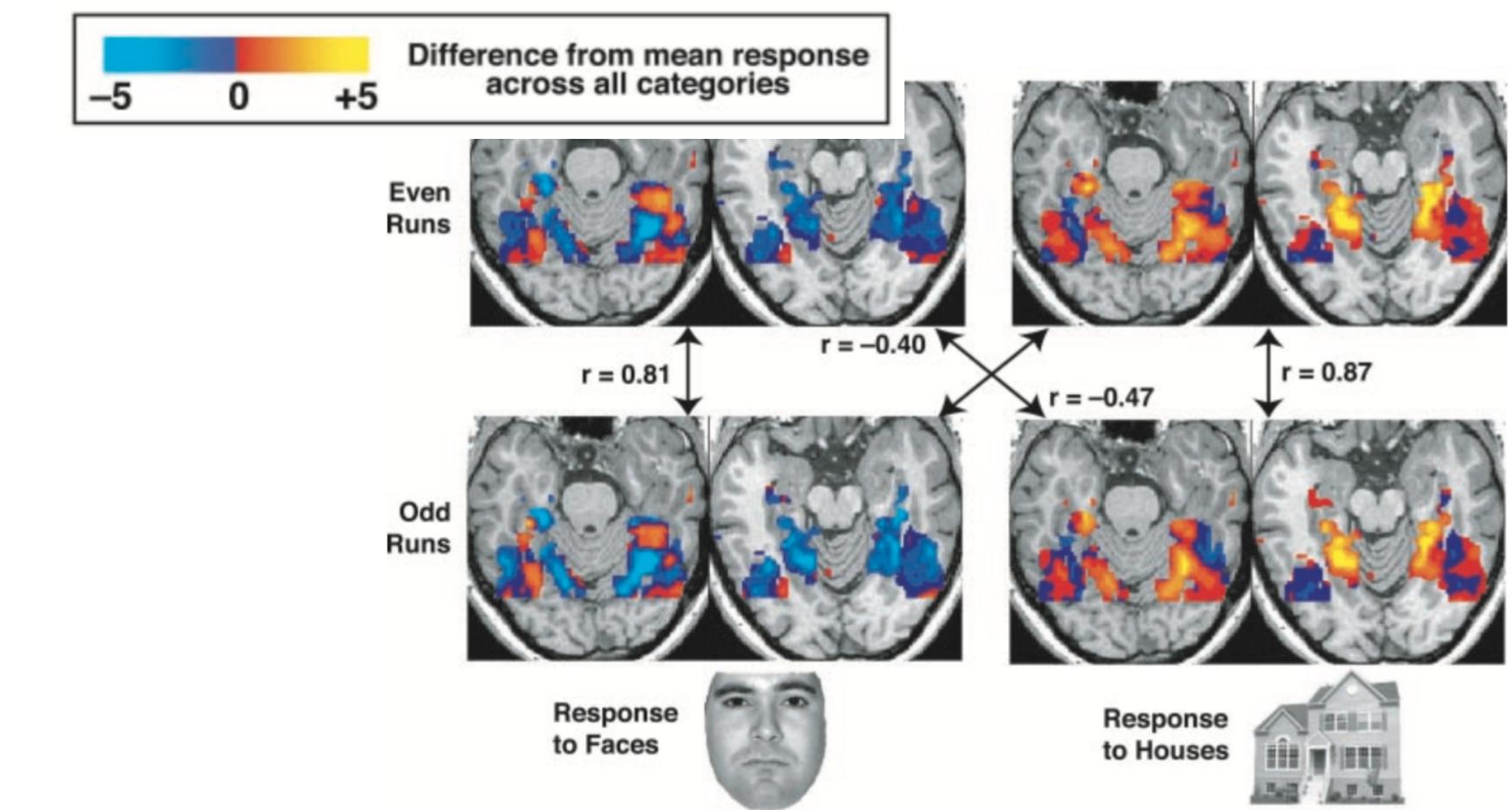
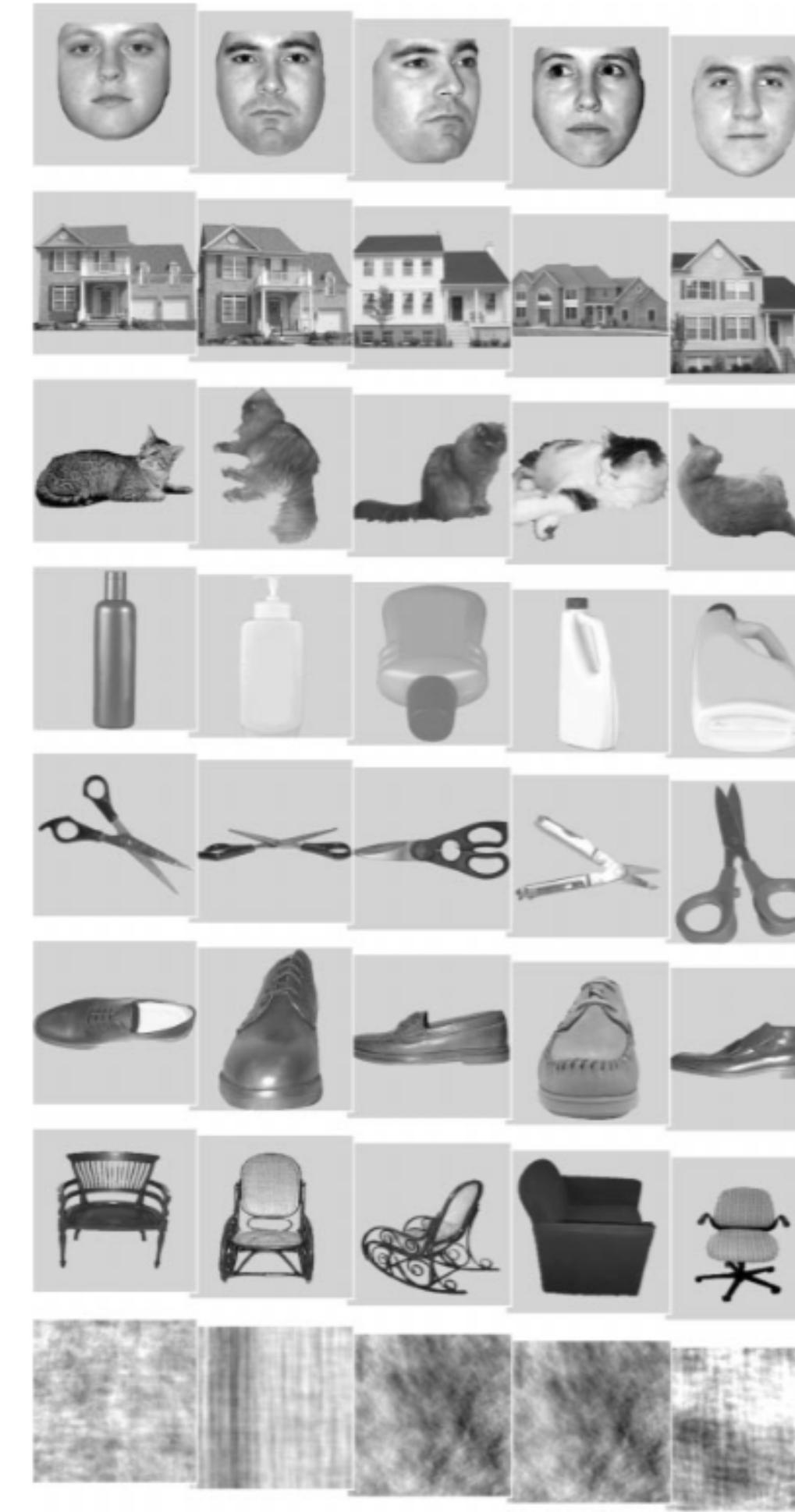
multivariate searchlight
(4-mm radius for 2-mm isotropic voxels)



Applications of MVPA



Decoding stimulus category

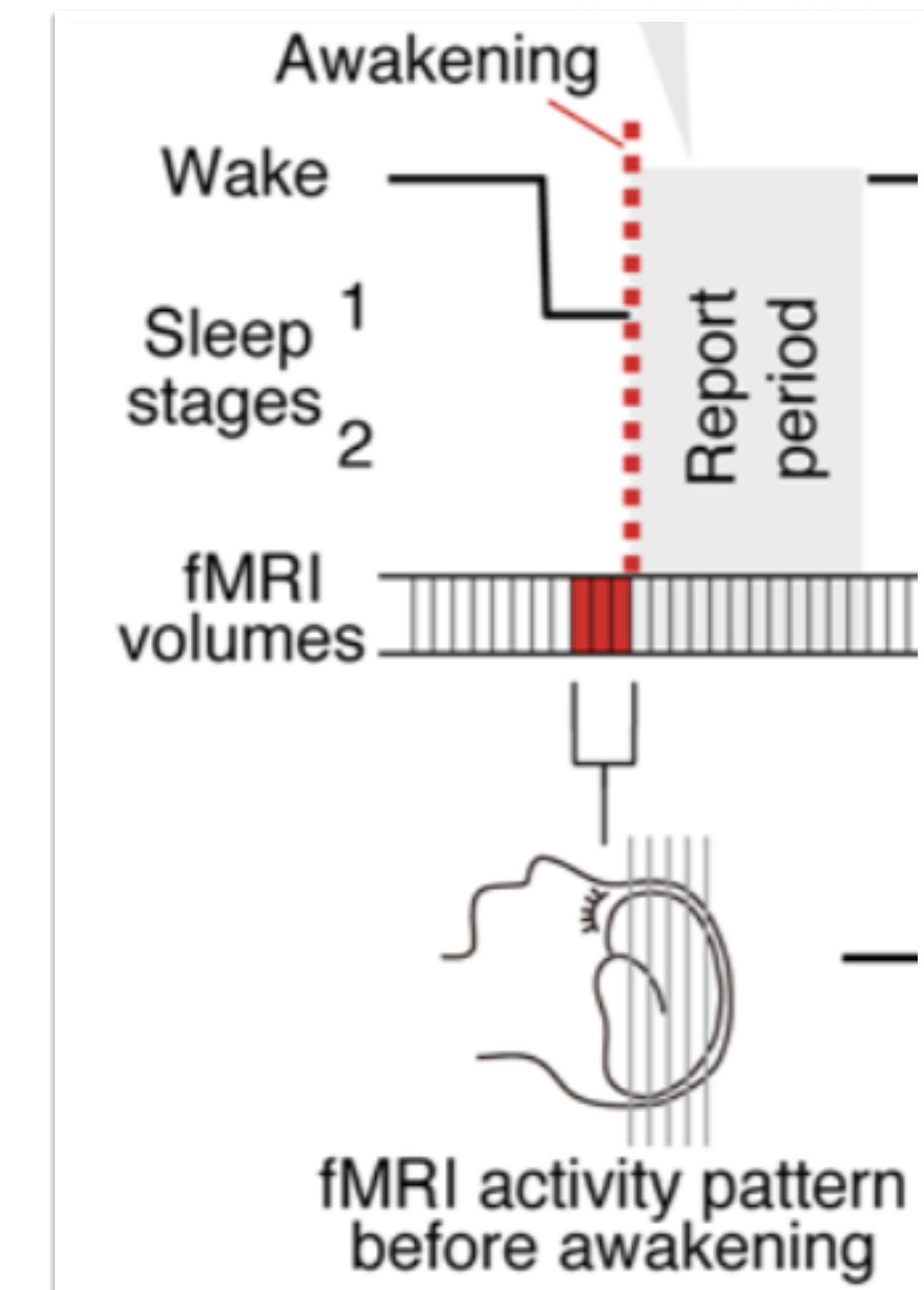
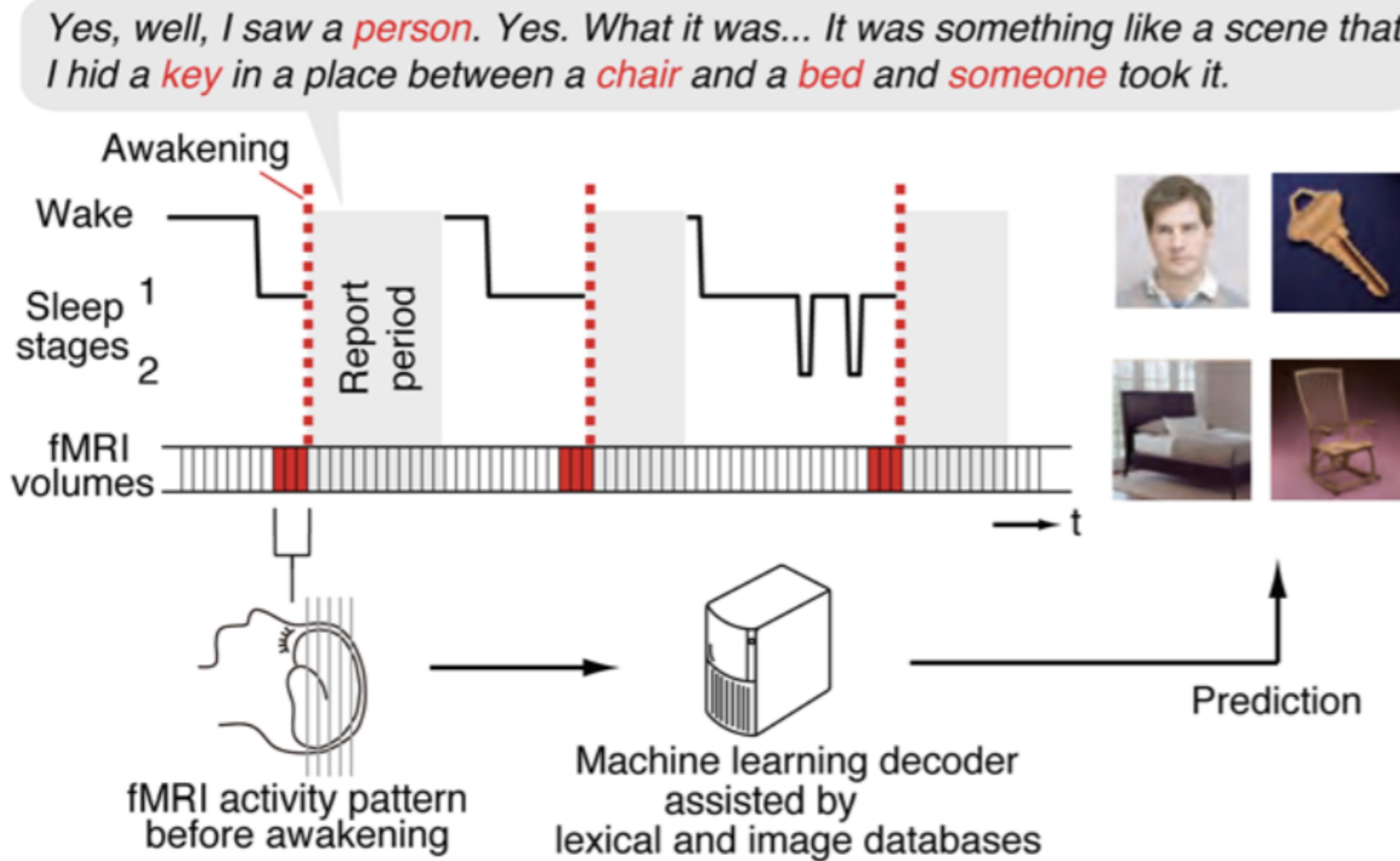


Decoding conscious perceptual state



Decoding unconscious perceptual state: Dreams

We can decode the content of people's dreams from their brains



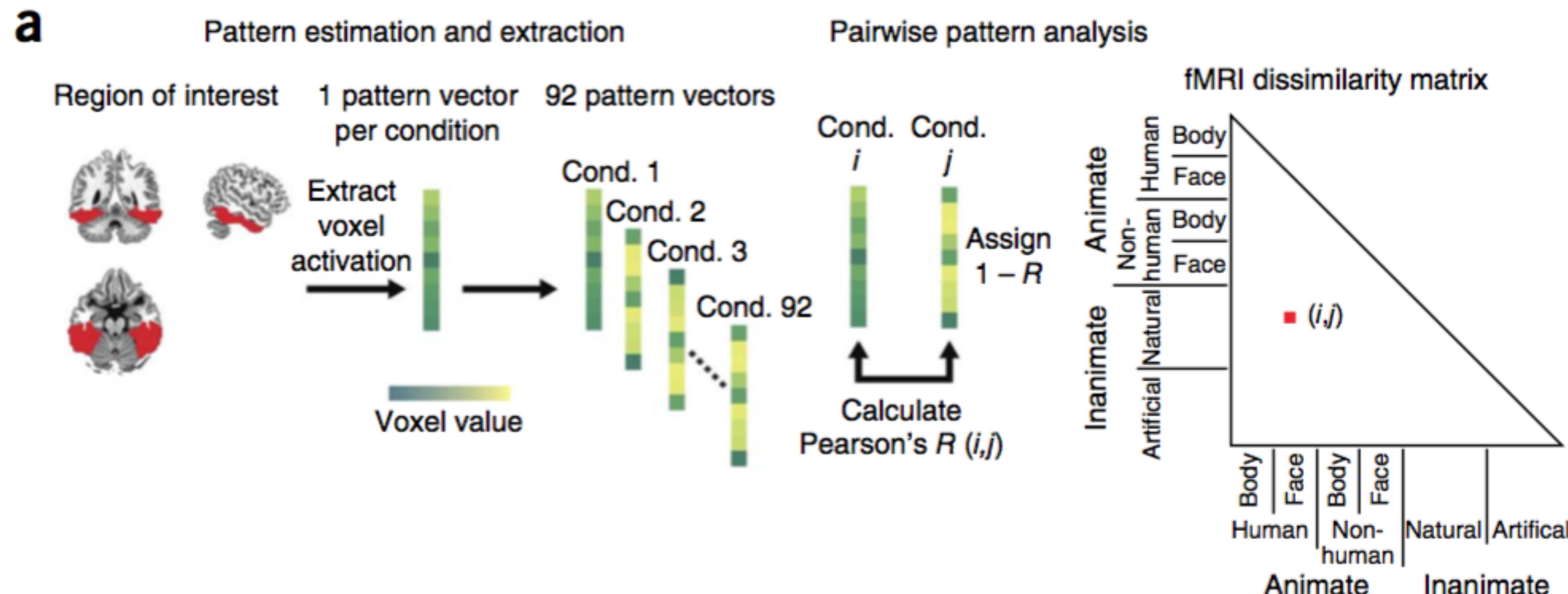
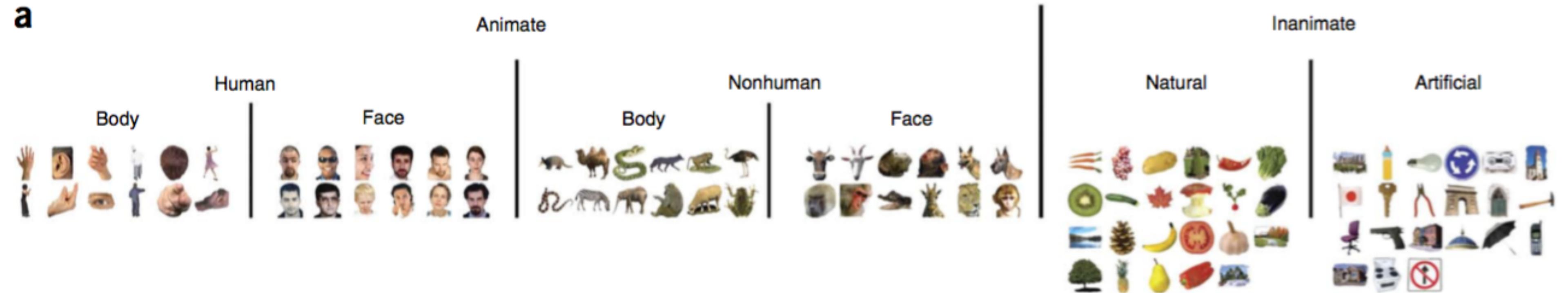
Time to awakening=37 sec



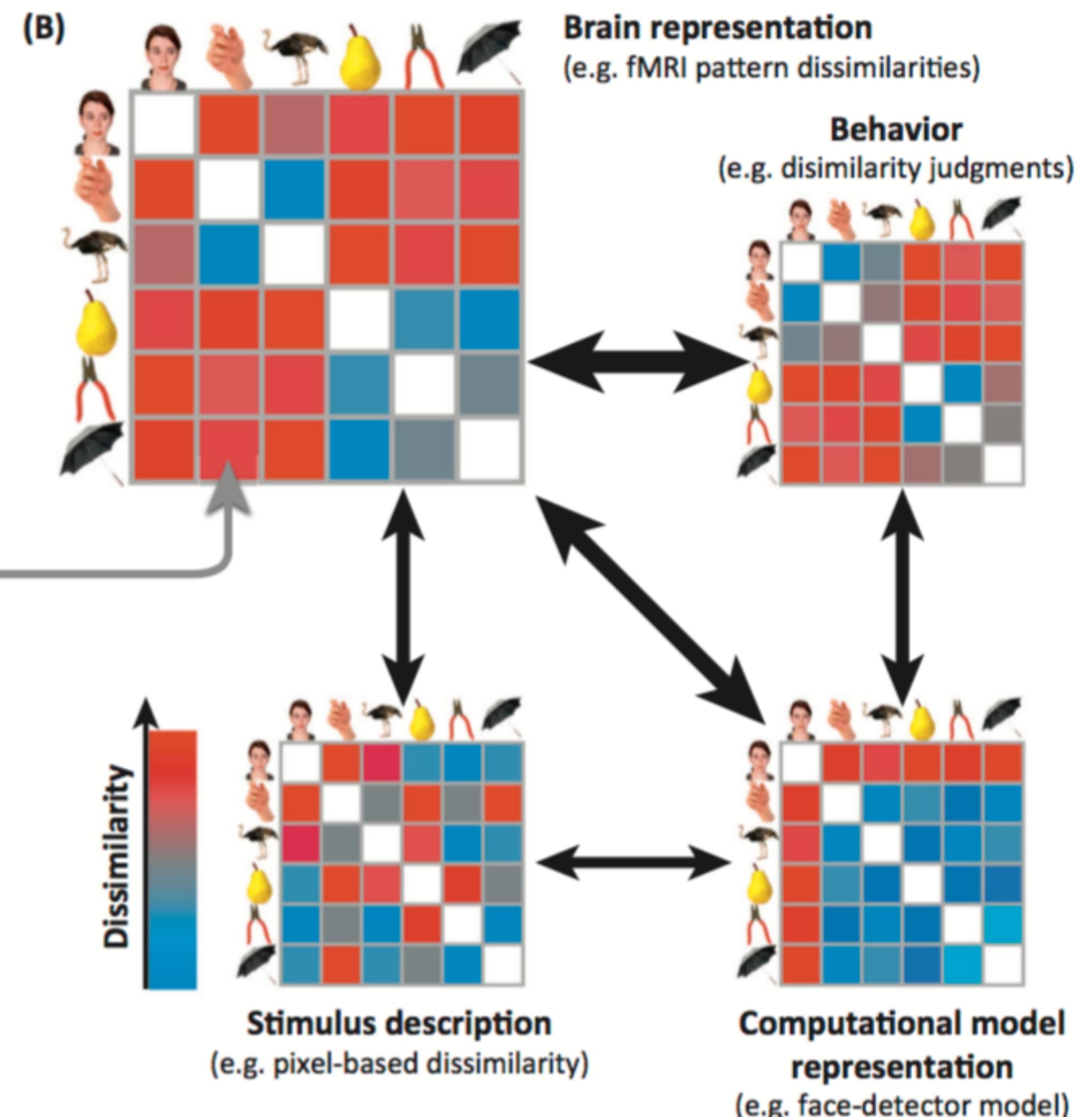
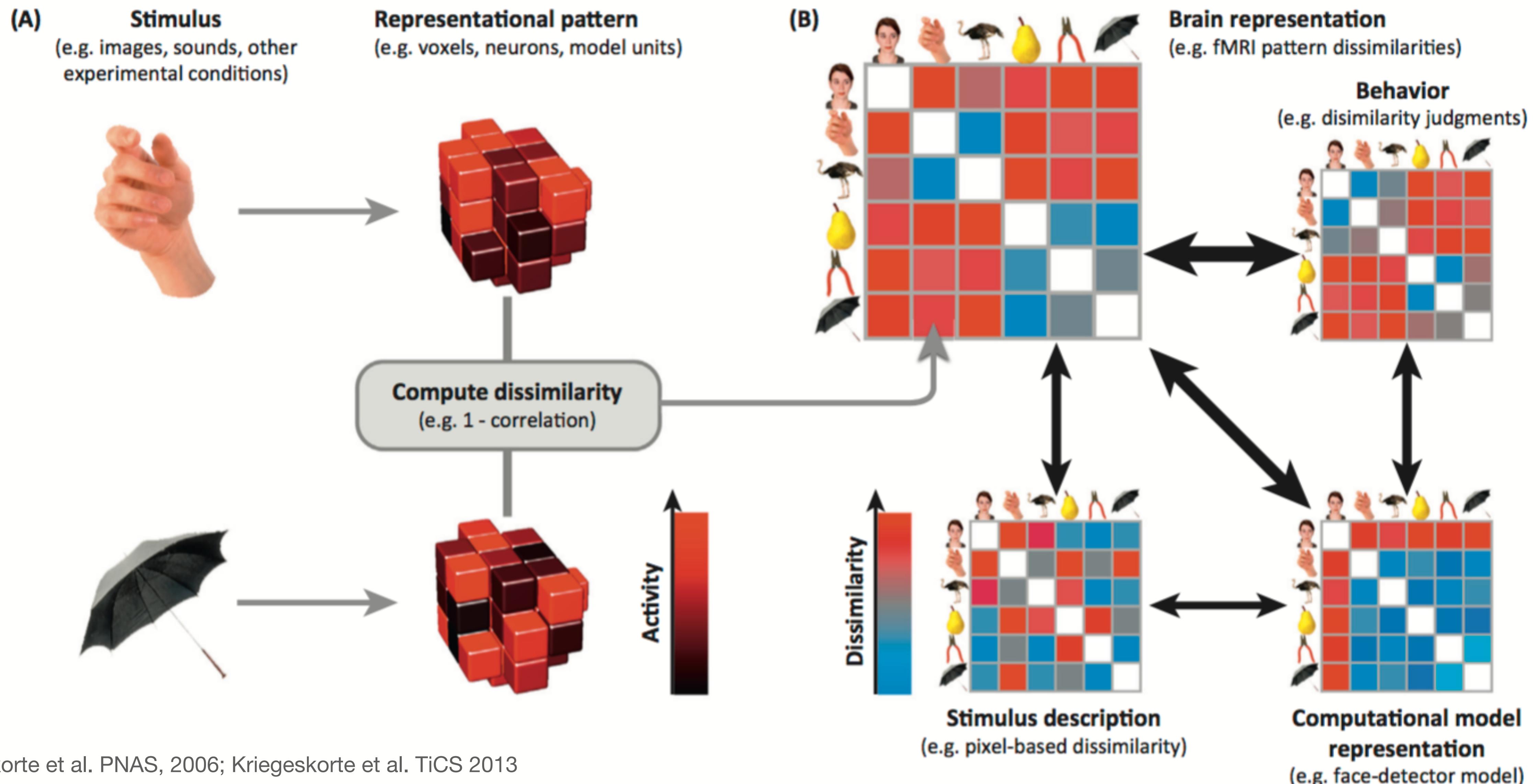
A blurry, overexposed photograph of a landscape featuring a large, dark, textured building in the foreground and a dense forest of tall, thin trees in the background under a bright sky.

book	building	car	character
commodity	computer-screen	covering	
dwelling		electronic-equipment	
female	food	furniture	male
mercantile-establishment		point	
region	representation		street

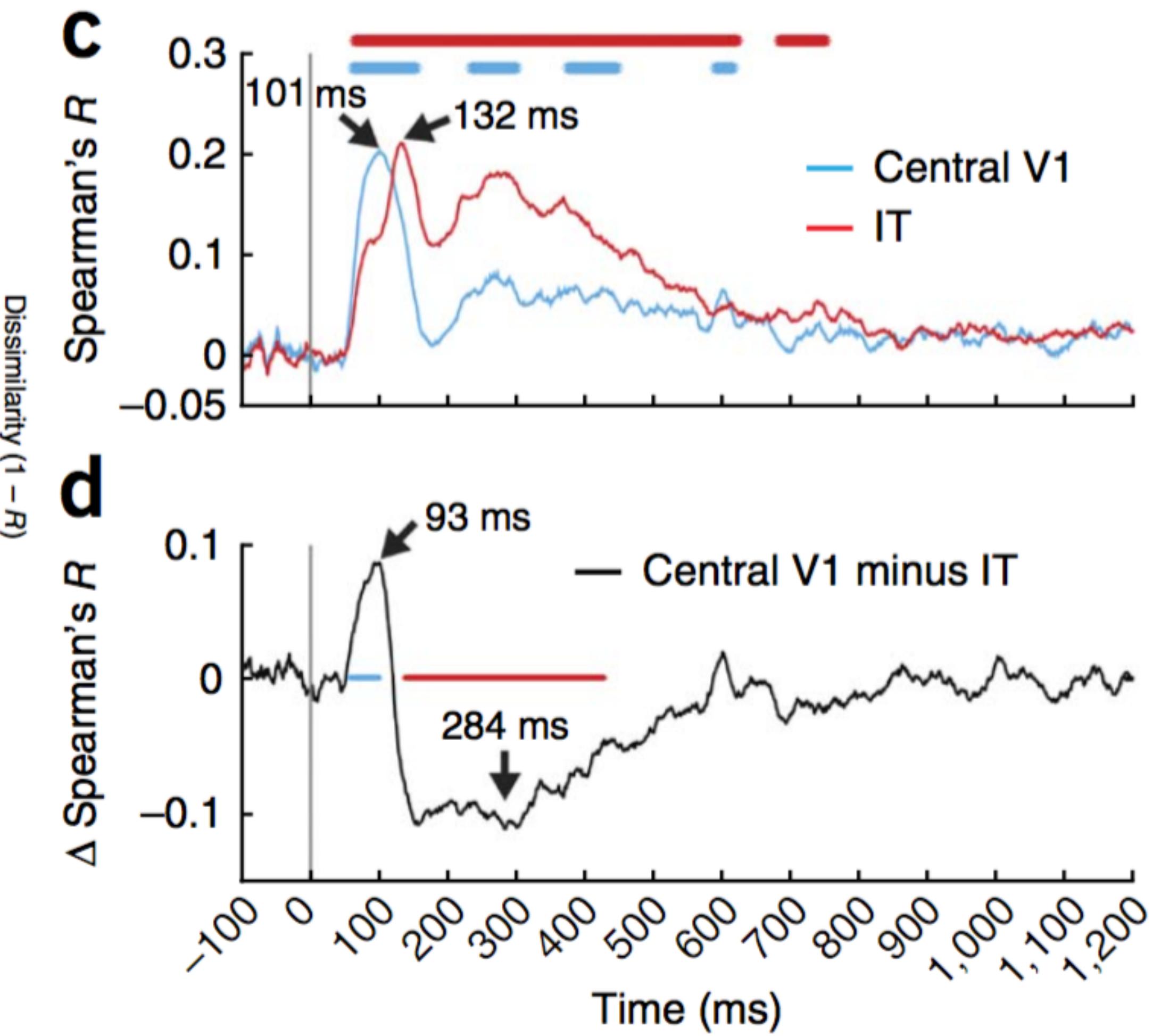
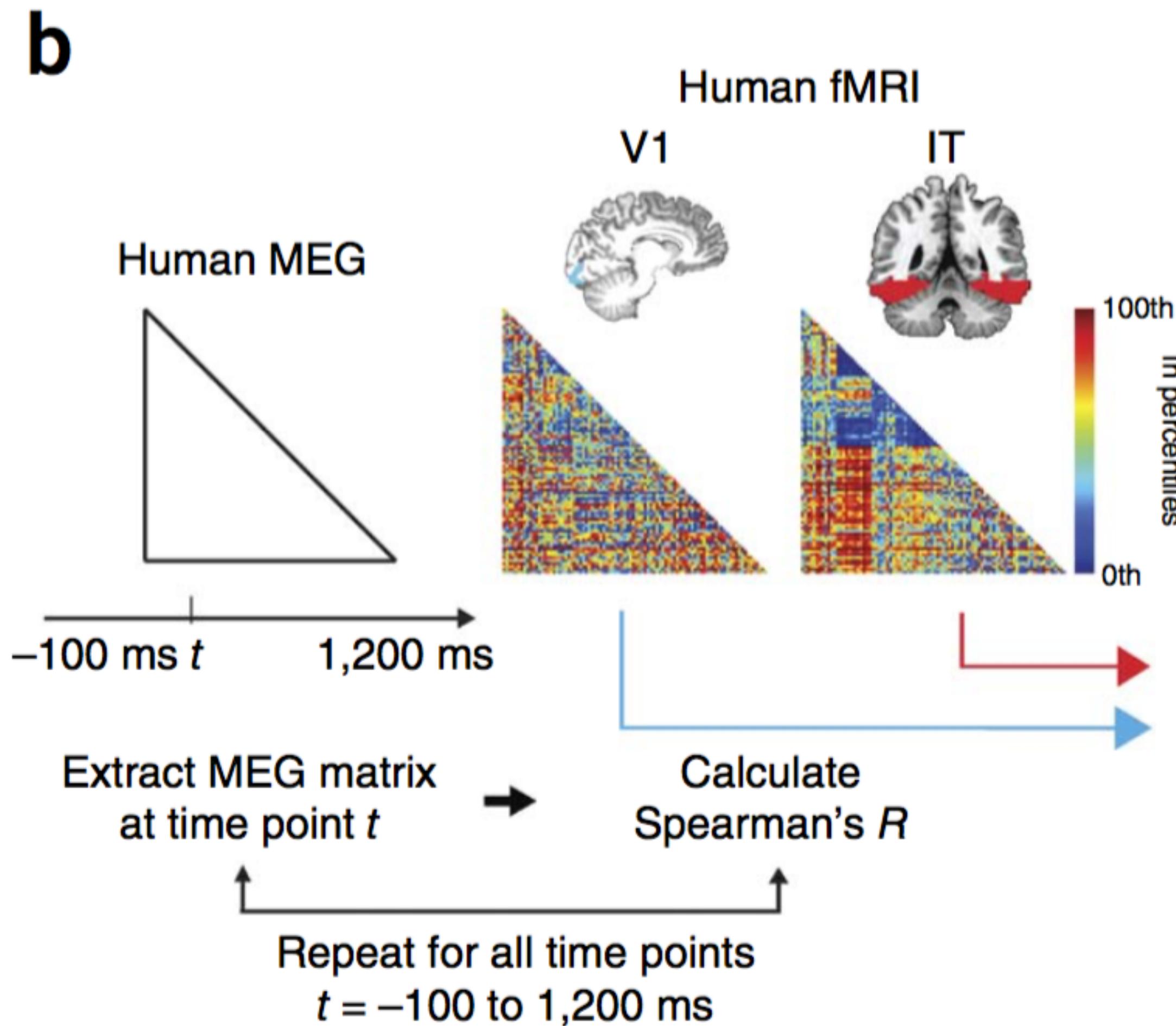
Representational Similarity Analysis



Representational Similarity Analysis

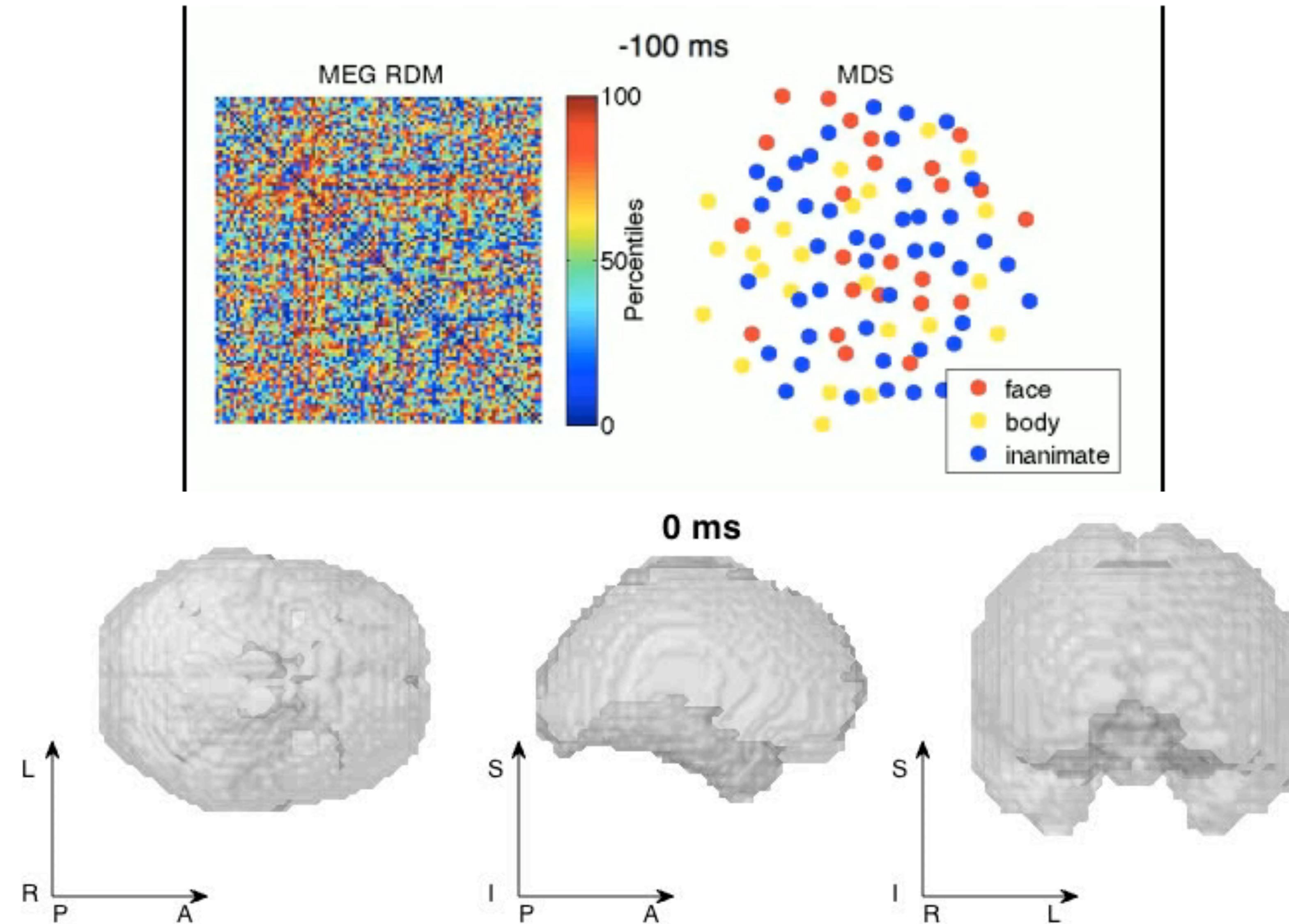


Representational Dissimilarity Analysis



Combining MEG & fMRI

Over time



how did MVPA help?

- Focus moved away from activation towards information
 - where in the brain can we find information about X?
 - how similar are stimulus X and Y?
- now able to tease apart stimuli that activate the same brain region equally strongly (on average)
- allowed comparison between modalities (MEG - fMRI - behaviour - animal physiology)

How did MVPA not help?

- Thresholding problem remains (searchlight), but less prominently: the classification algorithm creates an elaborate (pattern-based) new ROI, for which some comparison is significant
- ***Important:*** The reverse inference problem remains: what is it really about the stimulus that causes an activation pattern.
 - Leaving the hard work to an algorithm makes the researcher blind
 - We still have no explicit model of computation and representation:
Need forward model for that!
- *Perusall - Kay & Naselaris paper*