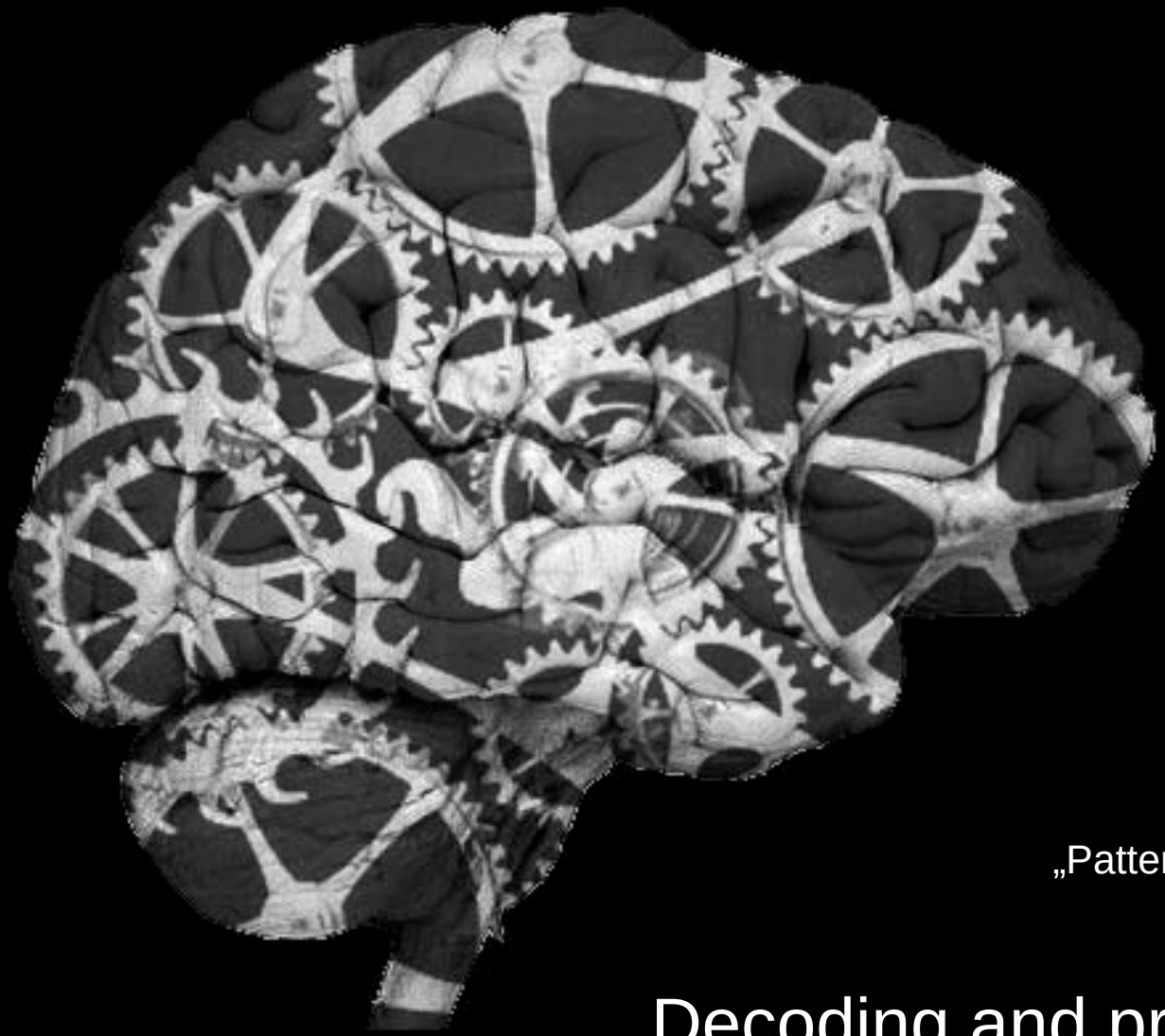
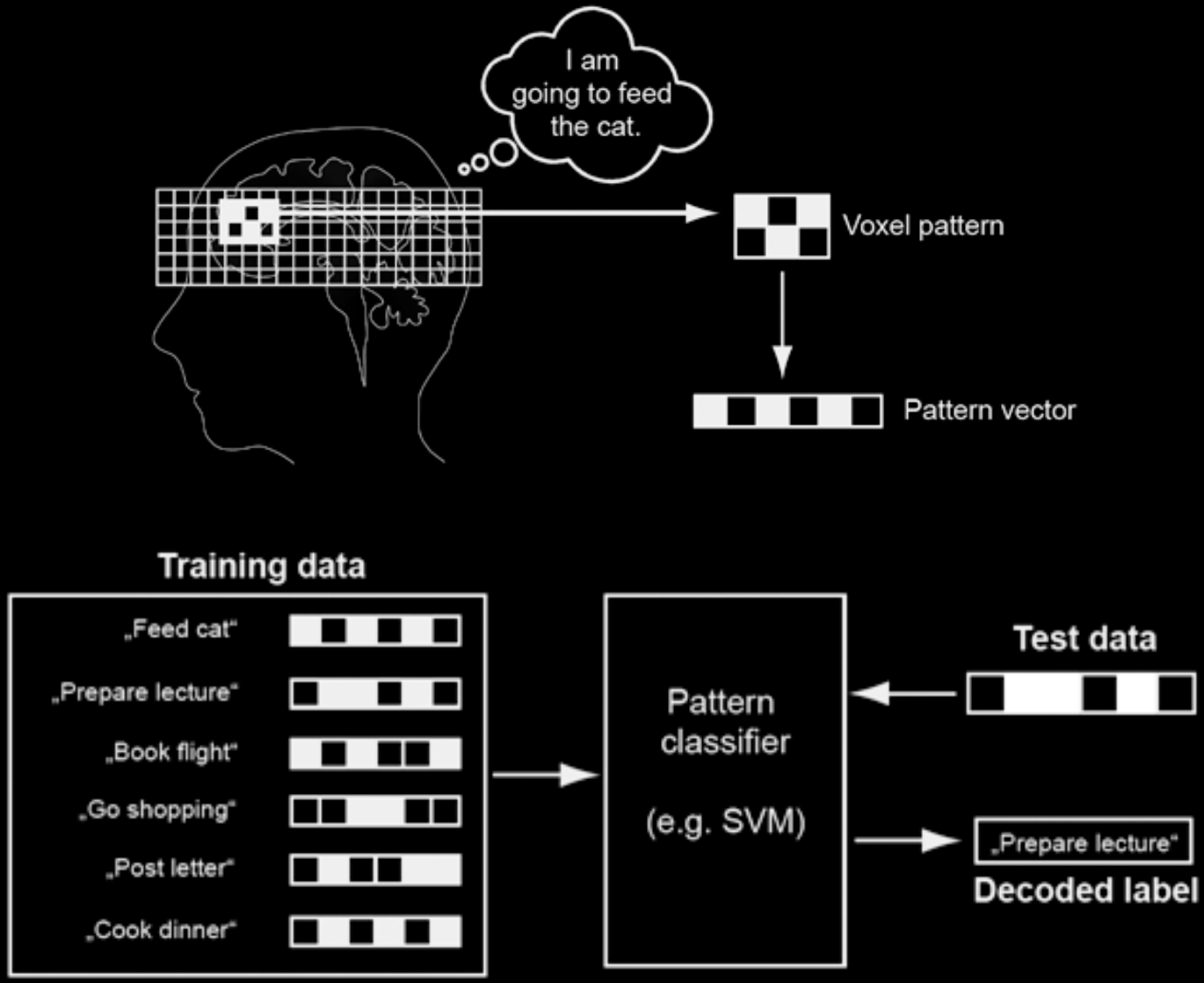


OHBM 2014 Educational Course
„Pattern Recognition for NeuroImaging“

John-Dylan Haynes
Charité – Universitätsmedizin Berlin

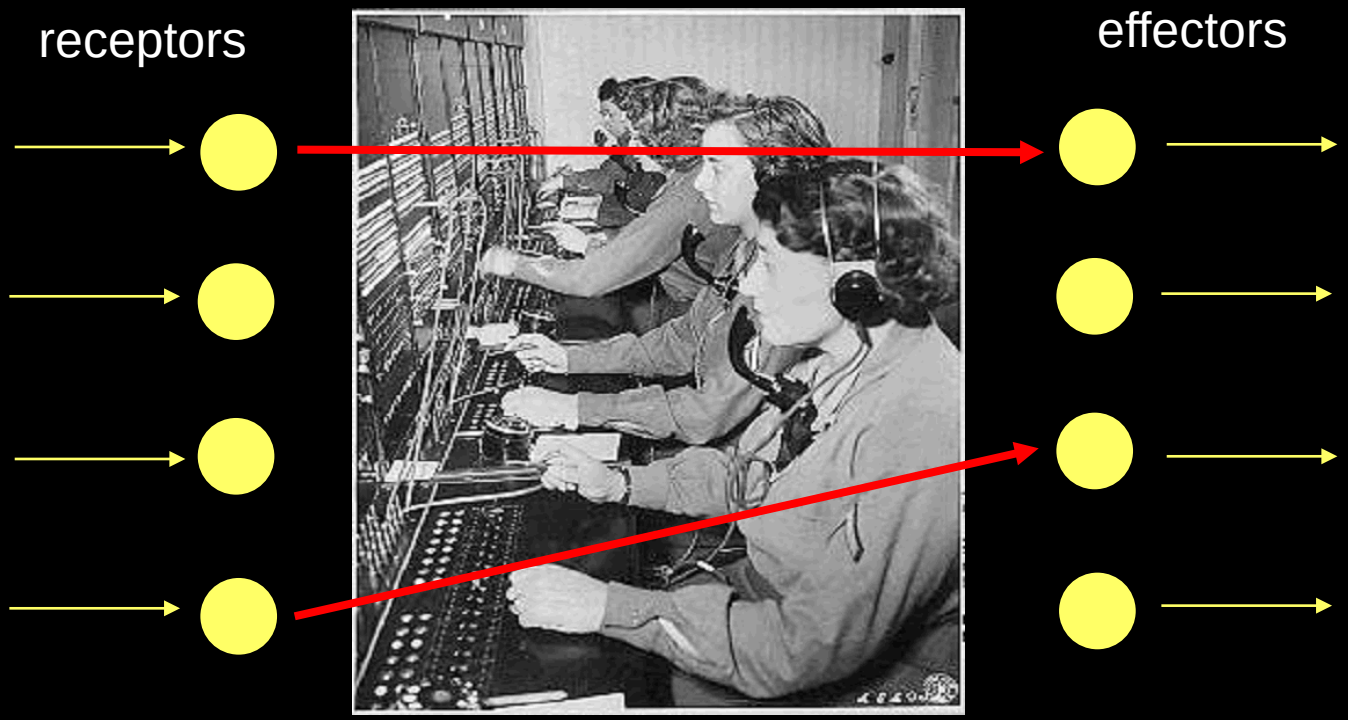
Decoding and predicting intentions: A case study for MVPA applications

Decoding intentions

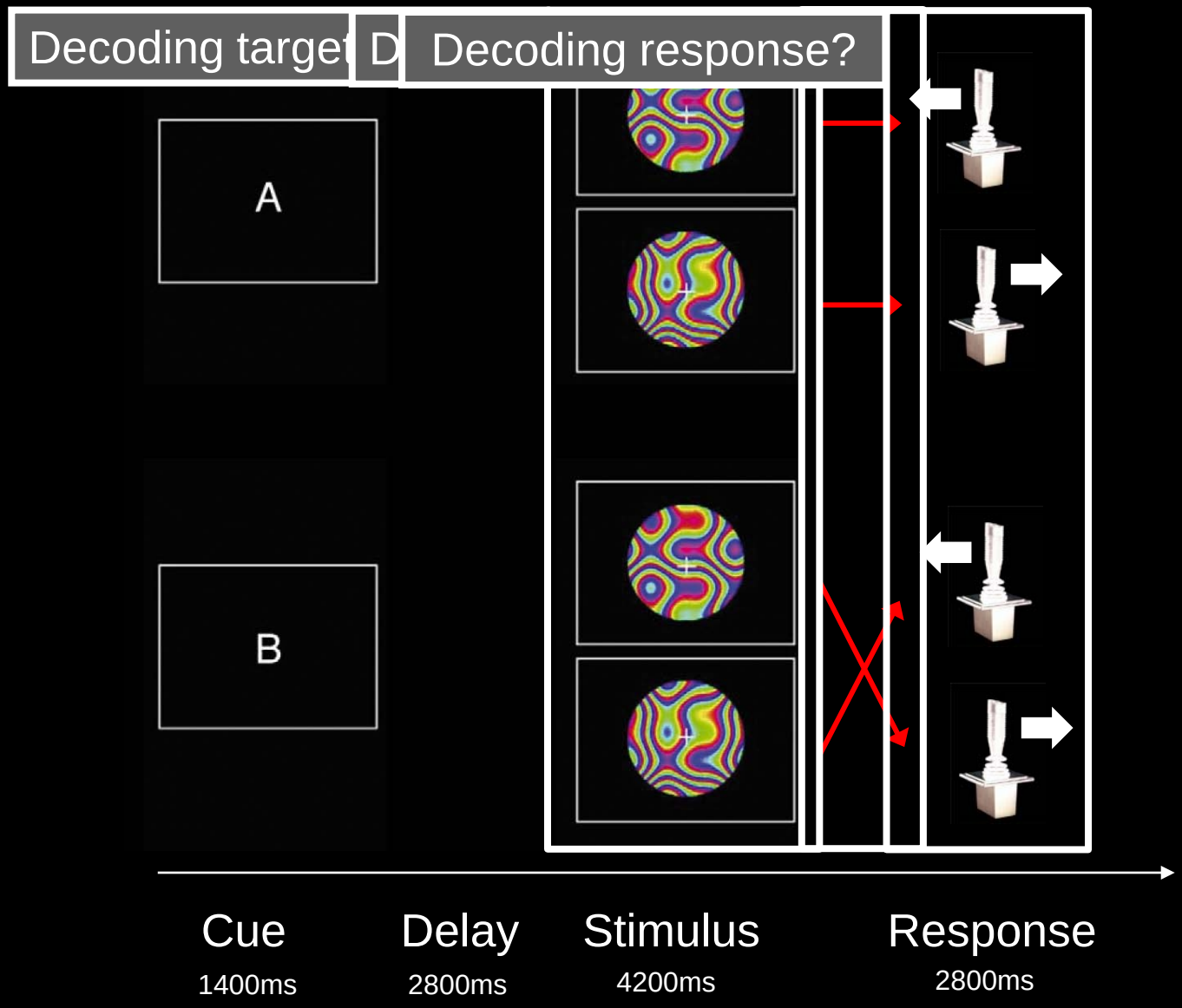


Haynes et al. Curr Biol 2007; Soon & Haynes Nat Neurosci 2008; Bode & Haynes Neuroimage 2009; Reverberi, Görgen & Haynes Cer Cor 2011; Bode et al. PLoS One 2011

Task sets as mapping of receptors to effectors



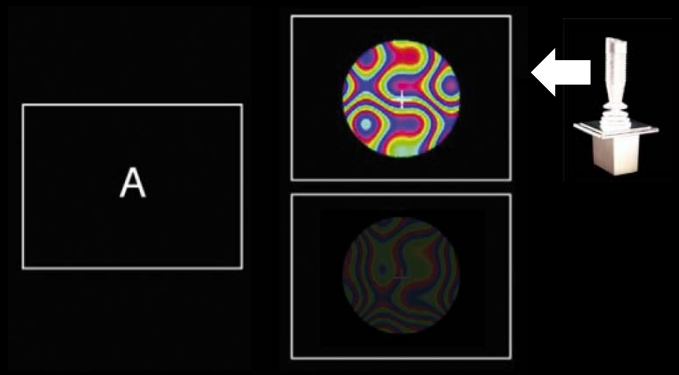
Experimental paradigm “task sets”



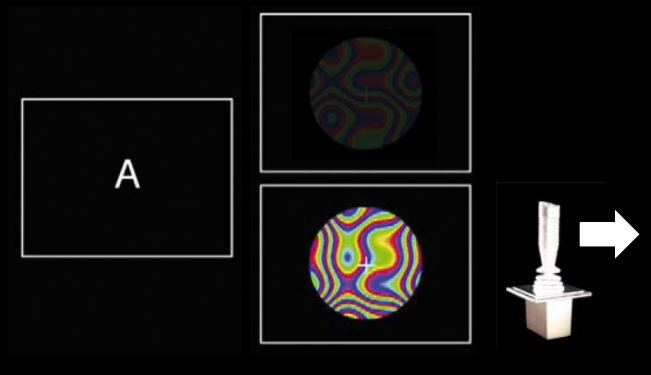
Bode & Haynes *Neuroimage* 2009

Trial types

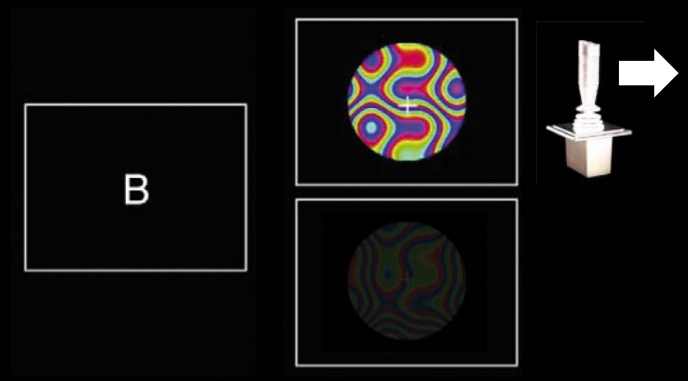
TT1



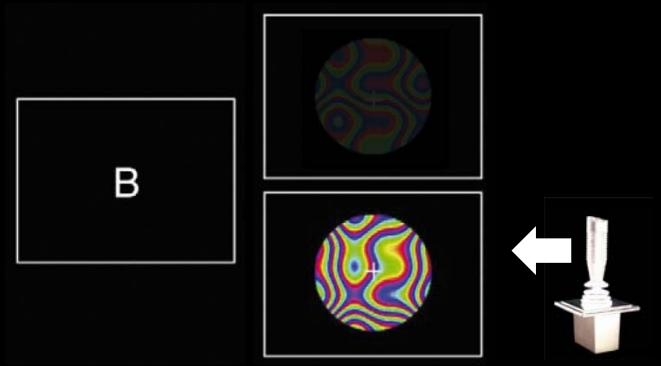
TT2



TT3

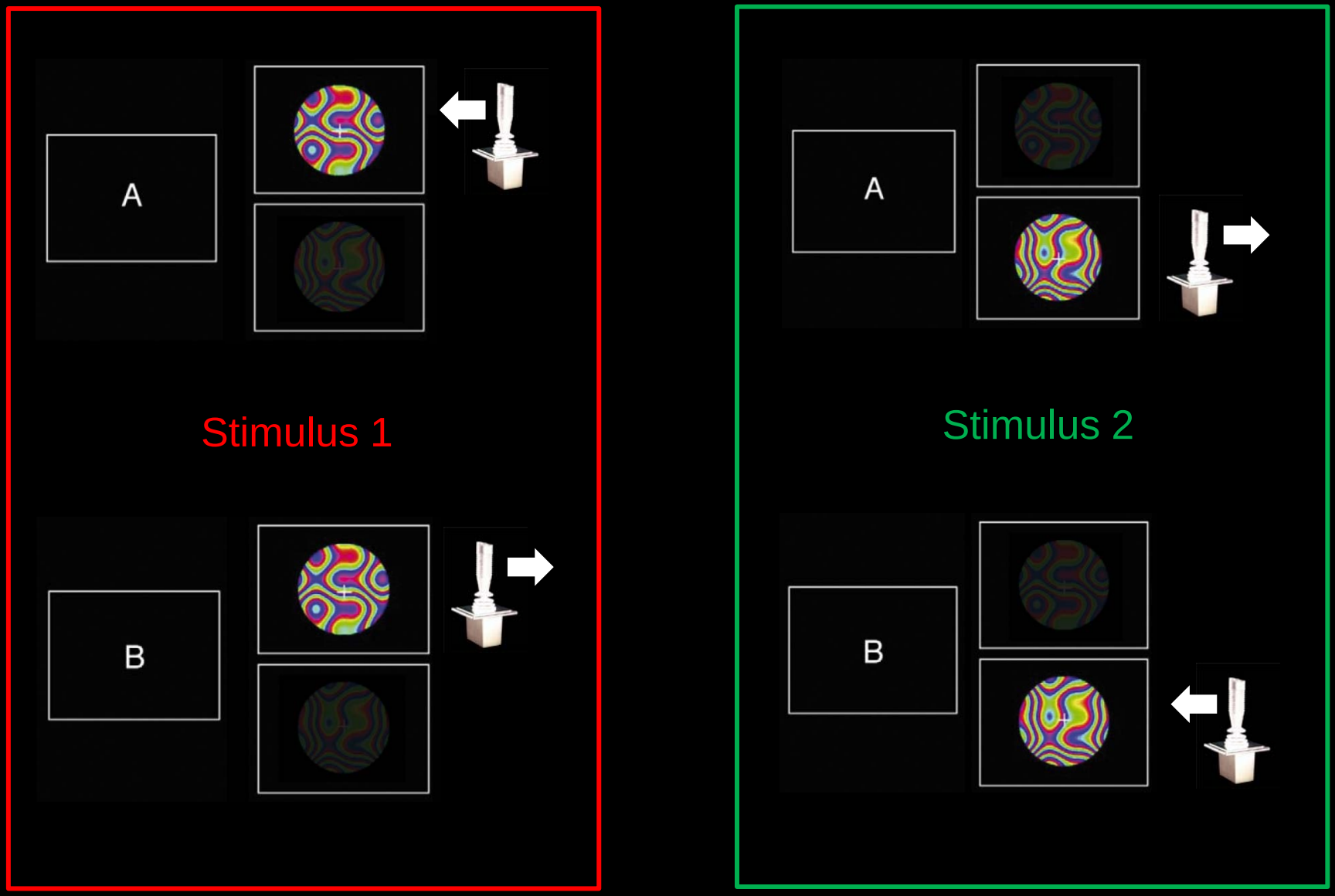


TT4



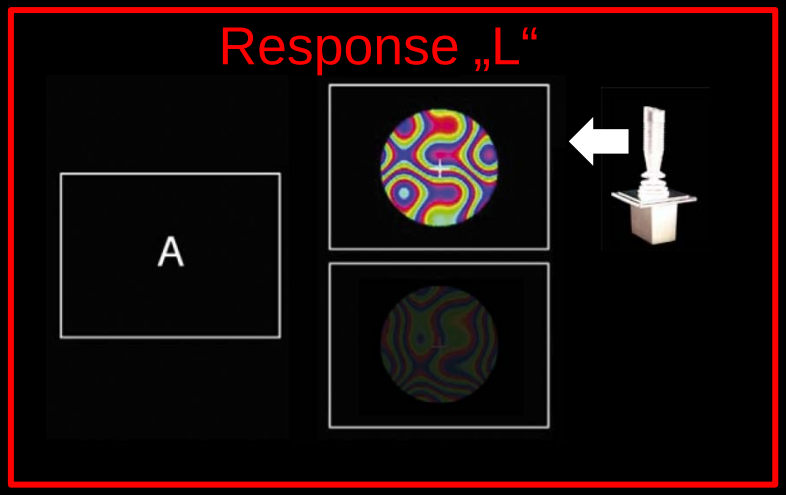
Bode & Haynes *Neuroimage* 2009

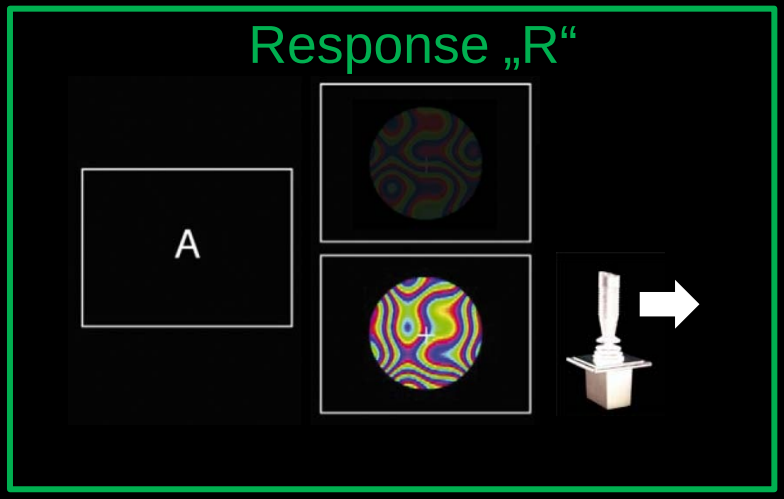
Labels for decoding stimuli

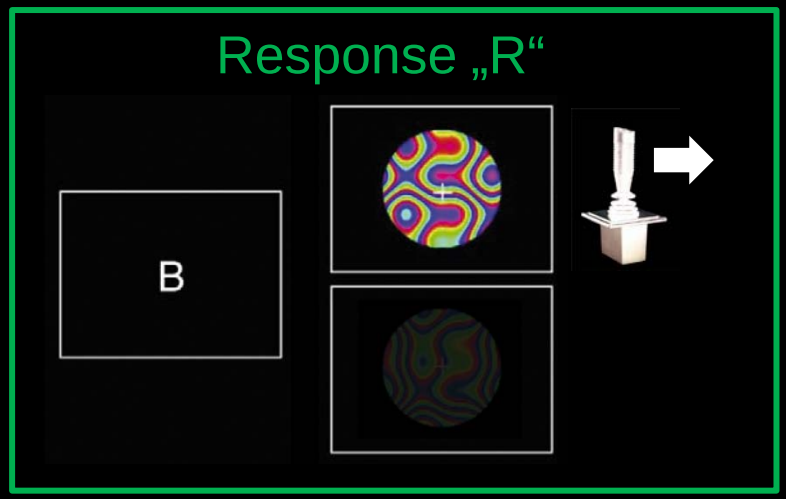


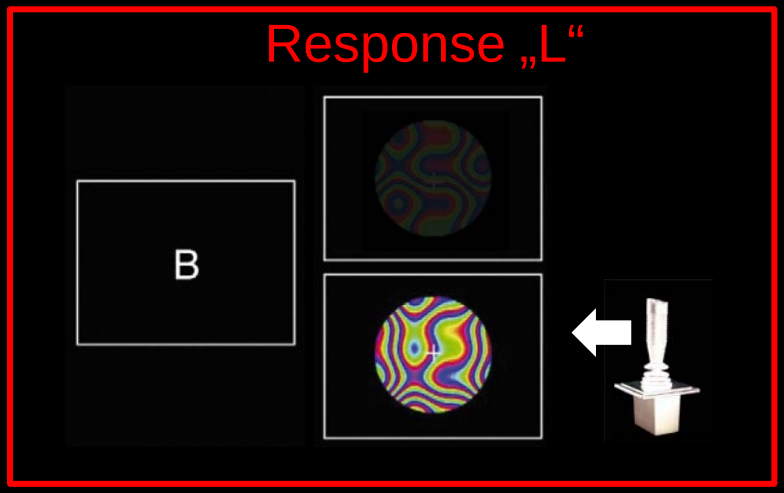
Bode & Haynes *Neuroimage* 2009

Labels for decoding responses



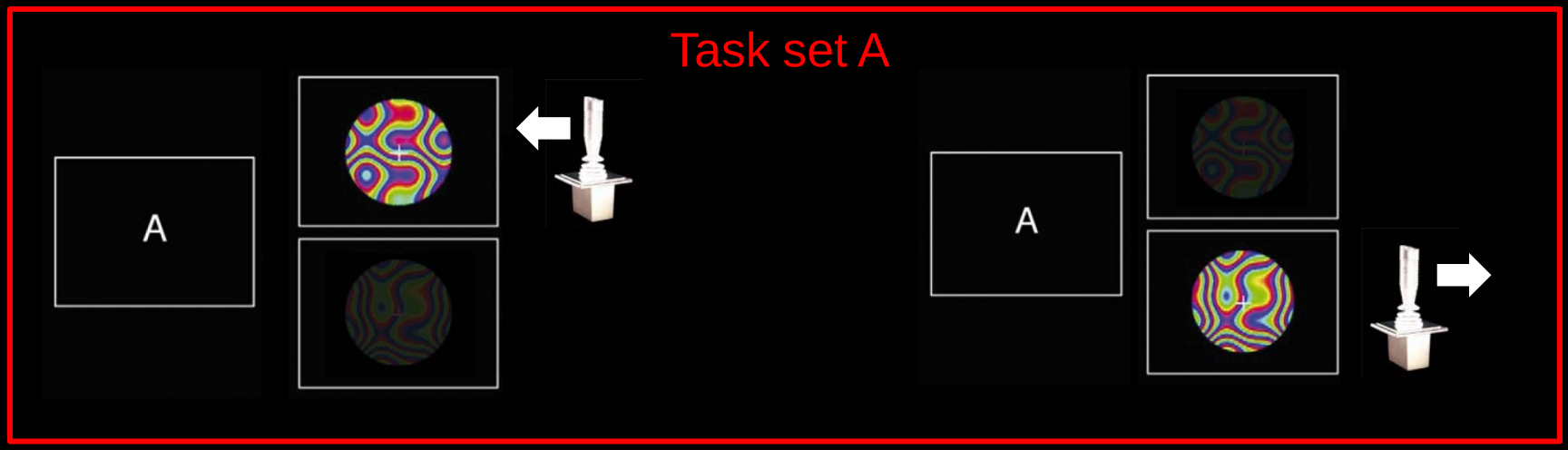


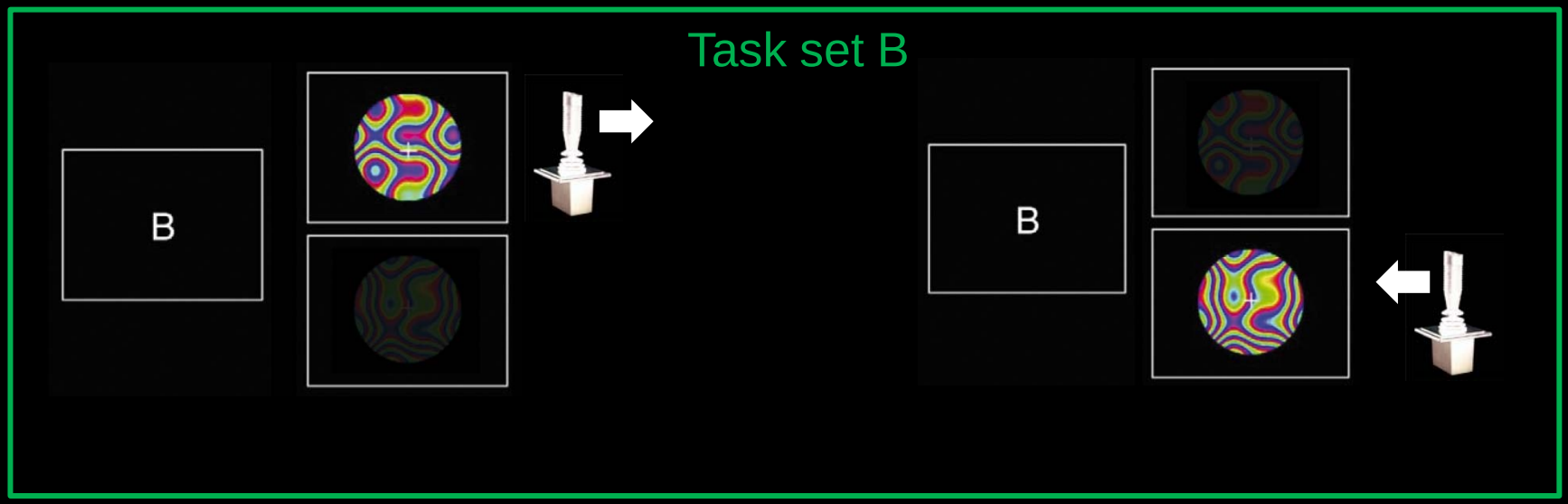




Bode & Haynes *Neuroimage* 2009

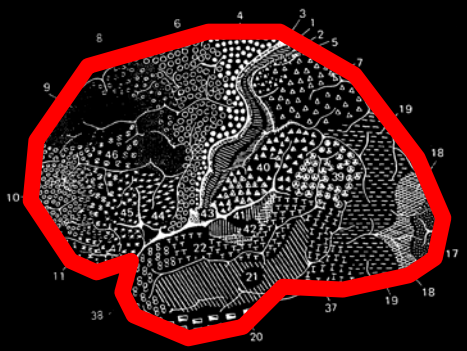
Labels for decoding task sets





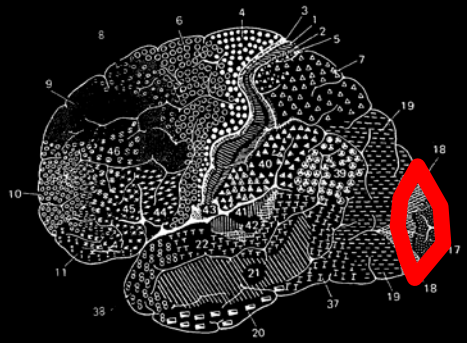
Bode & Haynes *Neuroimage* 2009

What to put into your classifier (space)

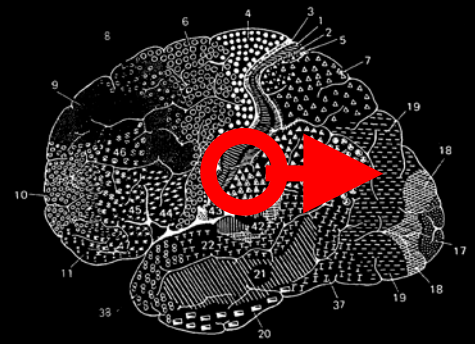


Whole-brain decoding

Curse of dimensionality (→ PCA)
Biological plausibility?



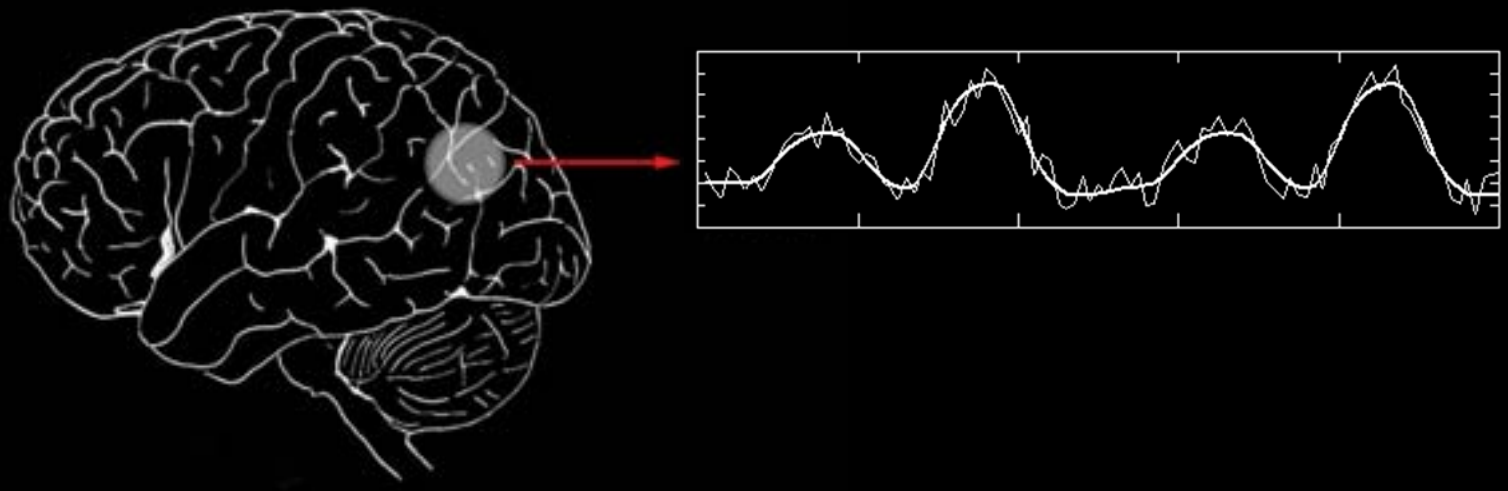
Region of interest

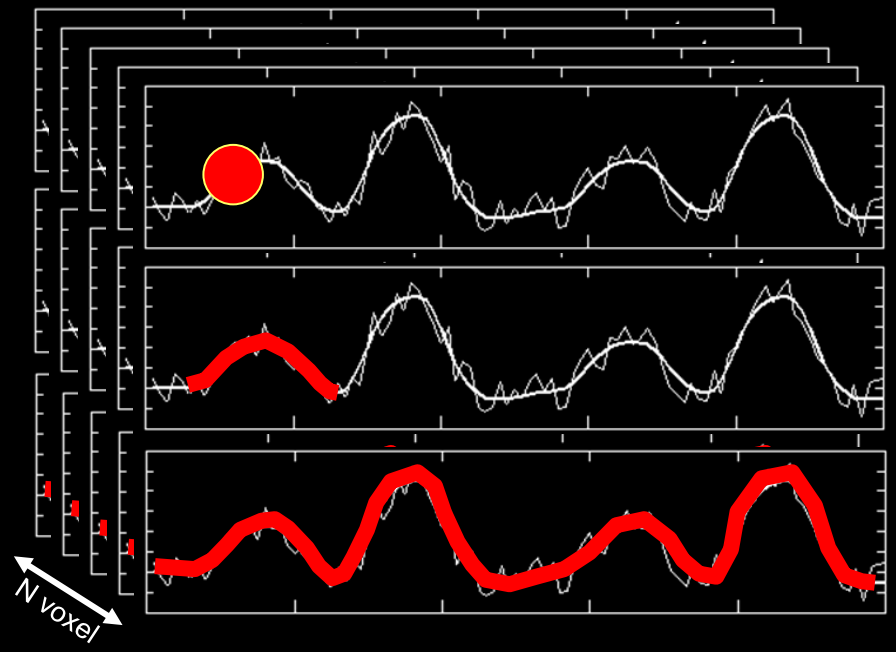


Searchlight decoding

Specific subspace
Locality assumption
Spatially unbiased

What to put into your classifier (time)



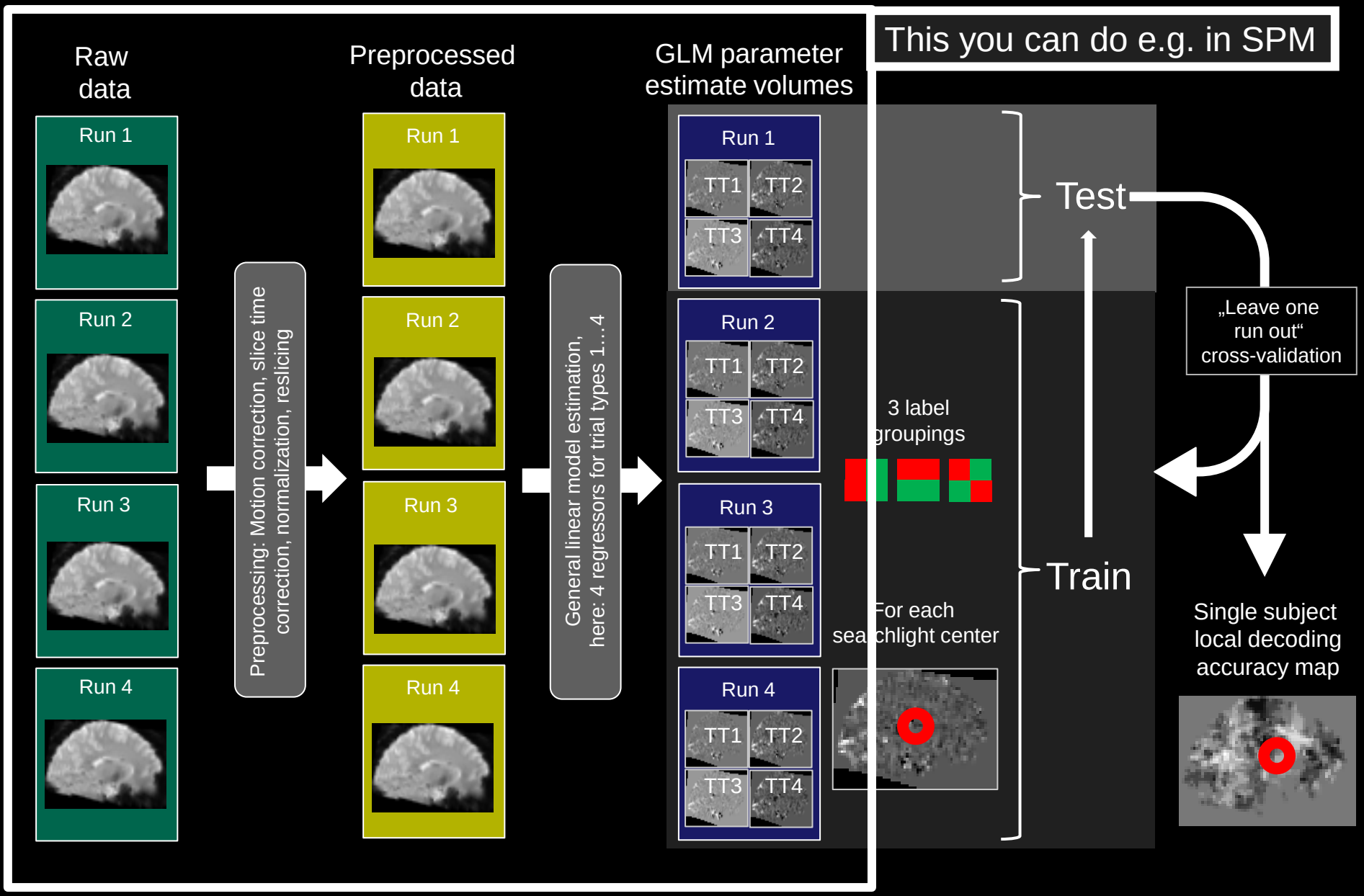


Singe volume activity
(typically baseline corrected)

HRF-fitted single-trial parameter estimate

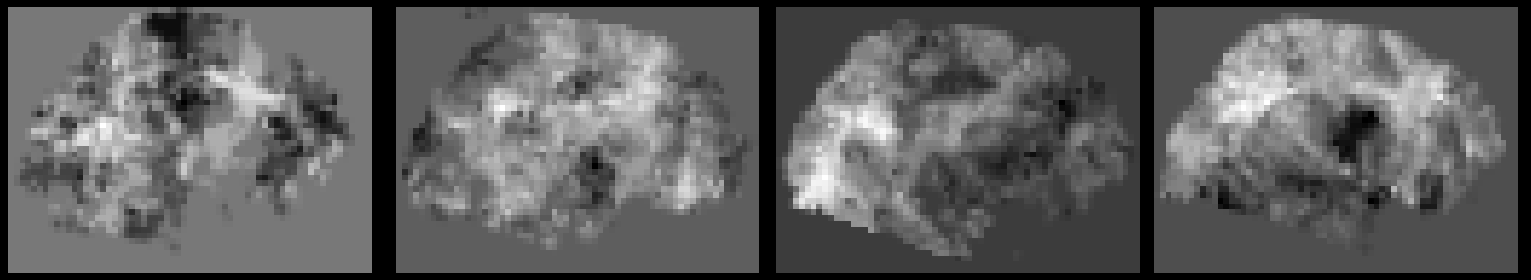
Runwise GLM parameter estimates

Practical implementation



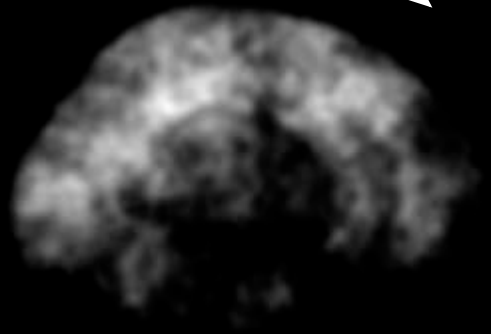
Spatial normalization can occur before or after classification. This flow chart shows „early“ normalization.

Averaging accuracy/information across subjects



One local decoding accuracy map per subject

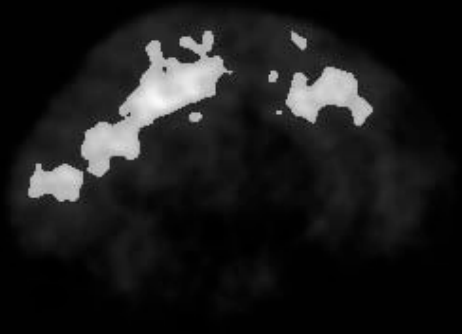
You can do this in SPM
if you are ok with a T-test



Average map of local
decoding accuracy

FWE-threshold

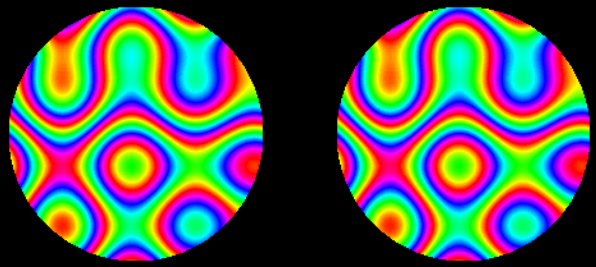
(T-test,
permutation test)

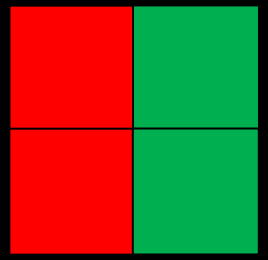


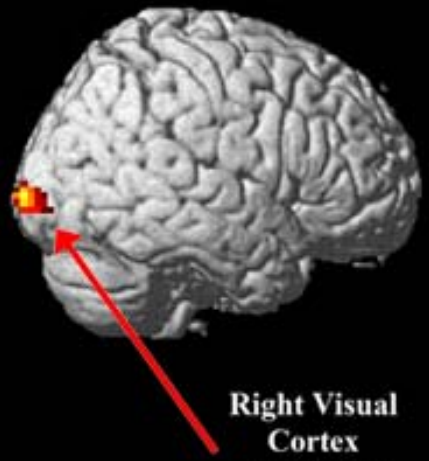
Thresholded map of local
decoding accuracy

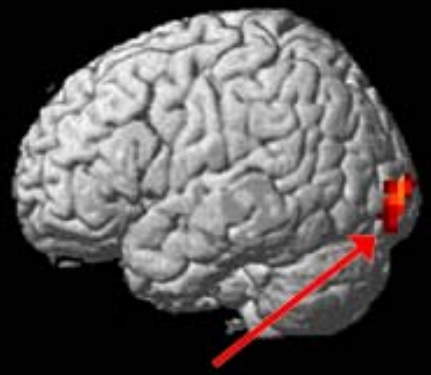
Stimulus decoding

Note of caution:
When using a searchlight and a second level threshold these accuracies are not independent estimators of effect size / information (for a related discussion See Vul et al. 2009). For this you would need an additional validation data set. The analysis primarily assesses the existence of information at a specific location.



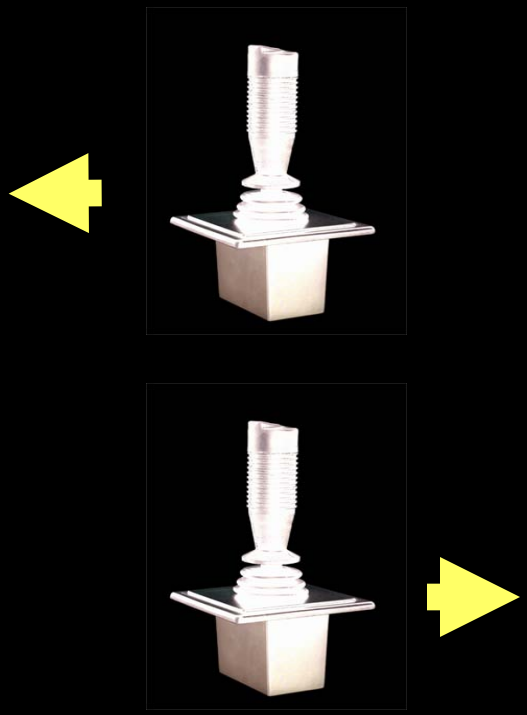


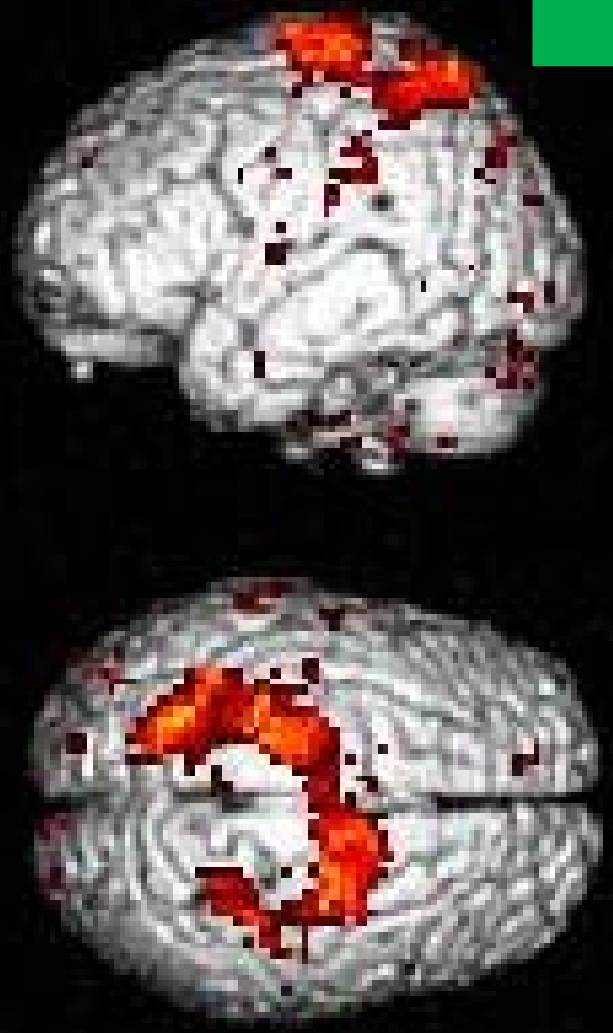




Bode & Haynes *Neuroimage* 2009

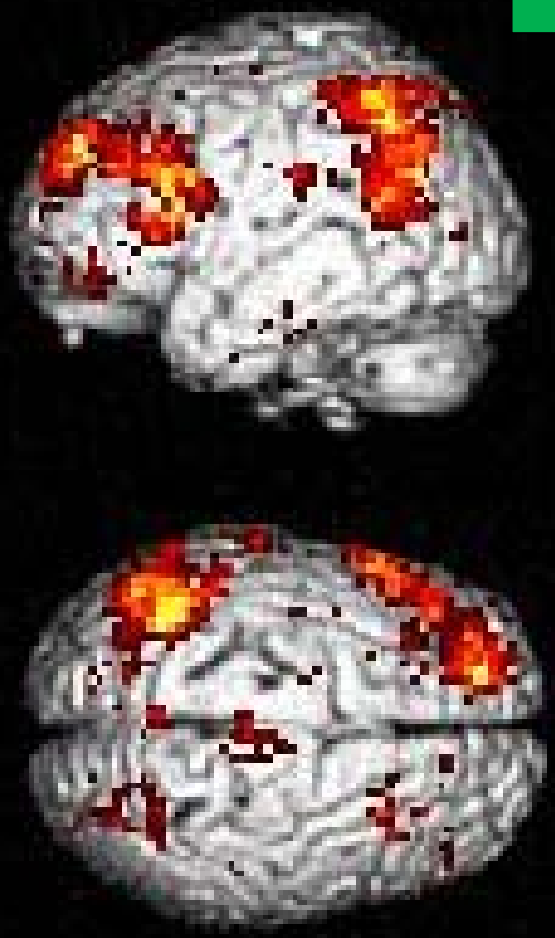
Response decoding





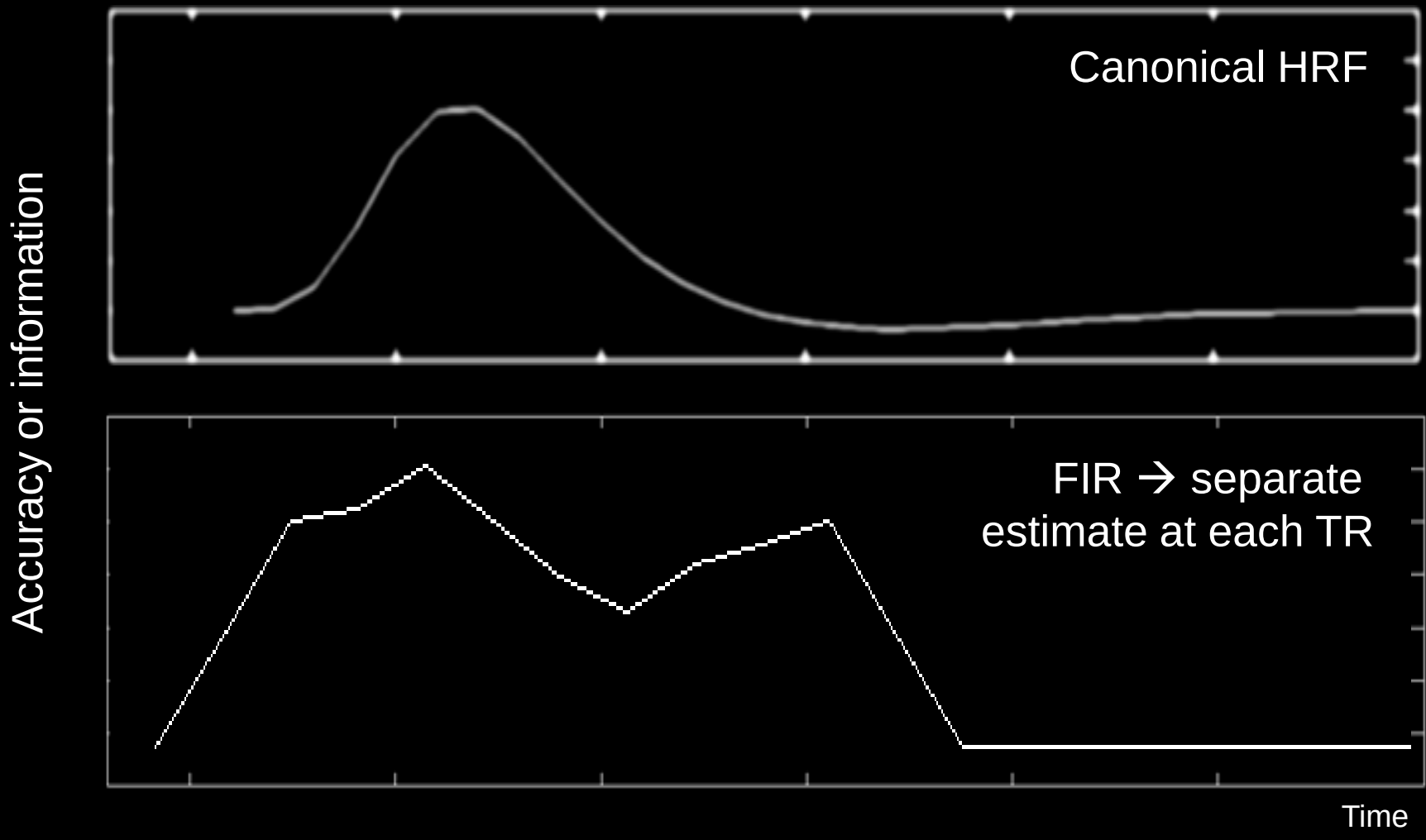
Bode & Haynes *Neuroimage* 2009

Decoding of stimulus-response mapping

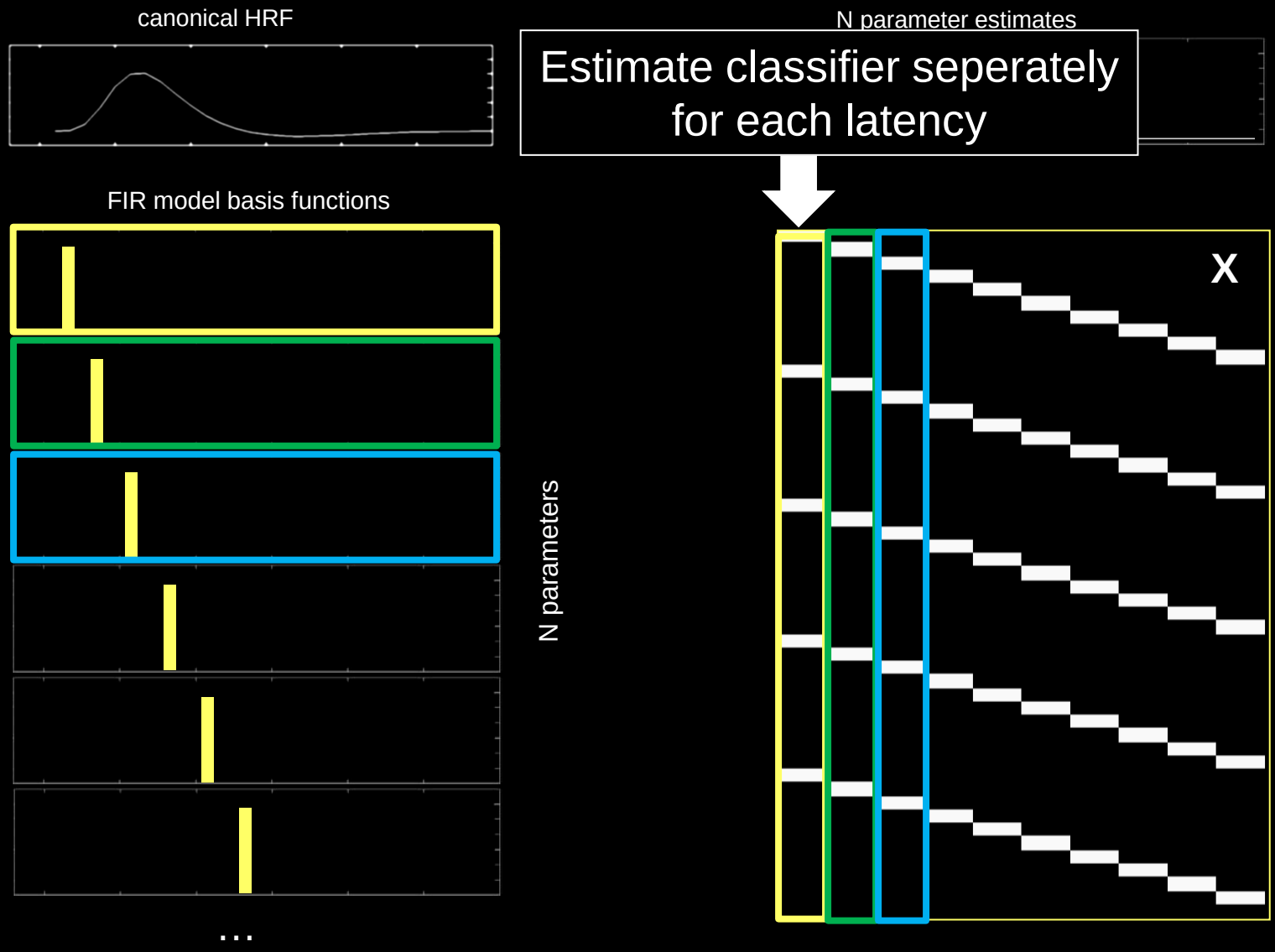


Bode & Haynes *Neuroimage* 2009

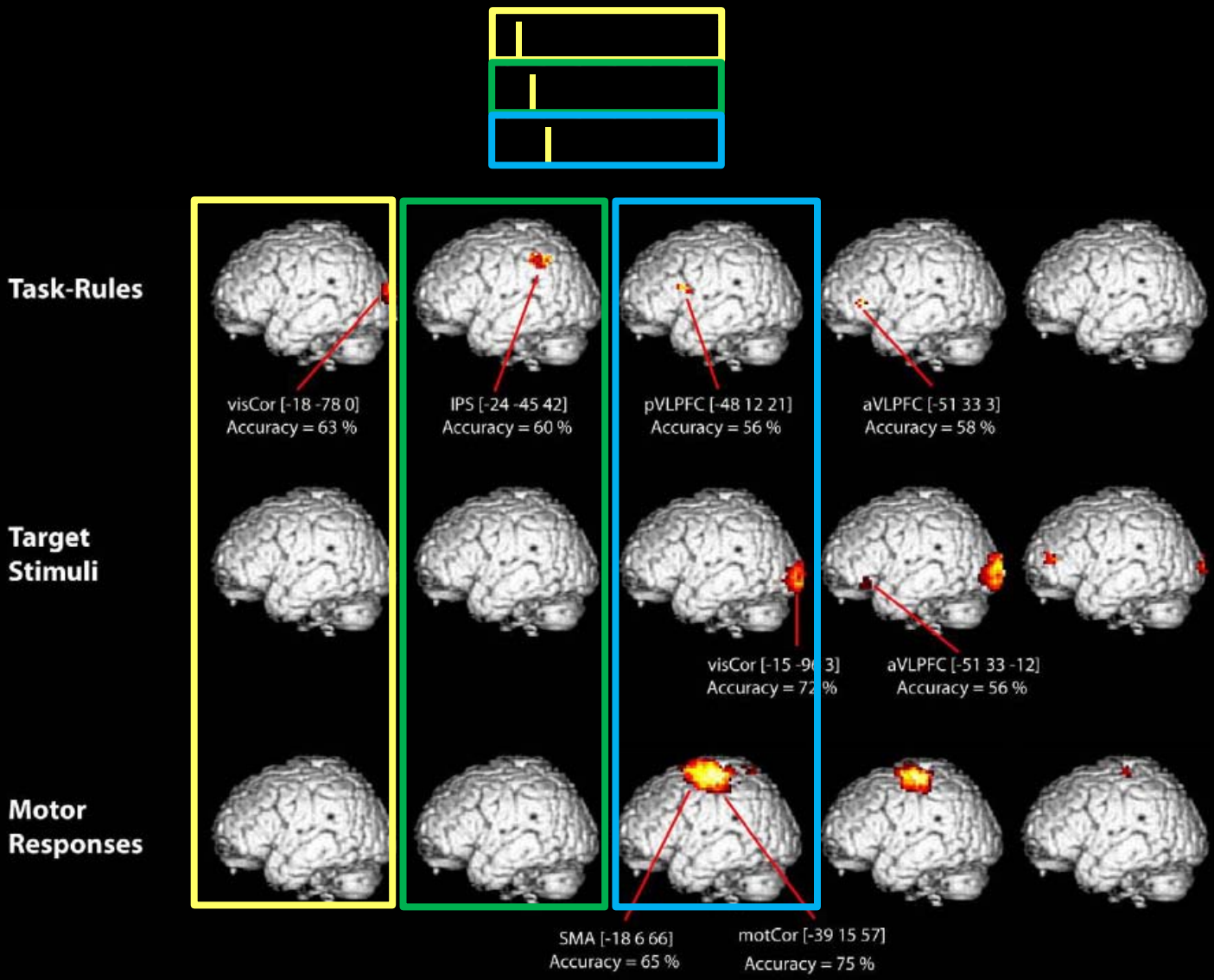
Decoding Across Time:
Finite Impulse Response Functions



Decoding Across Time:
Finite Impulse Response Functions

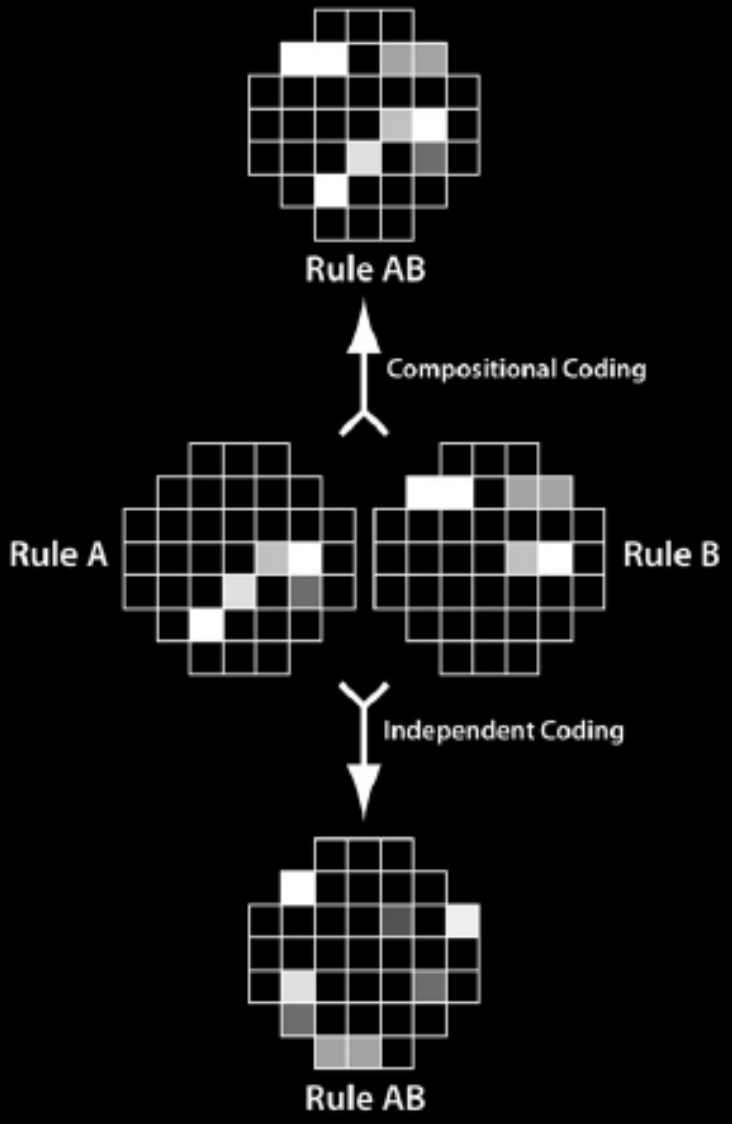


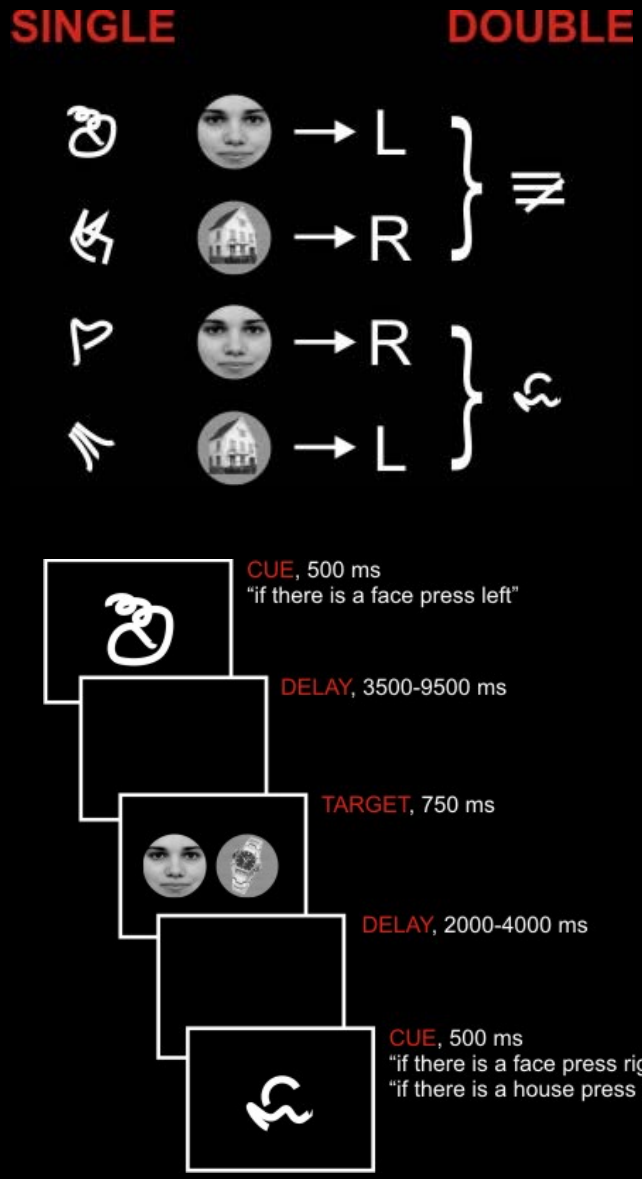
Decoding across time



Bode & Haynes *Neuroimage* 2009

Hierarchy and compositionality: Cross-classification



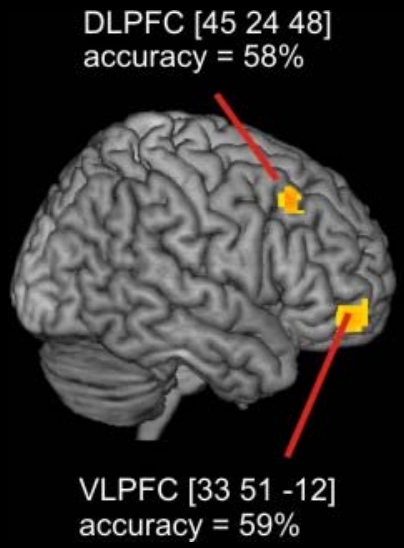


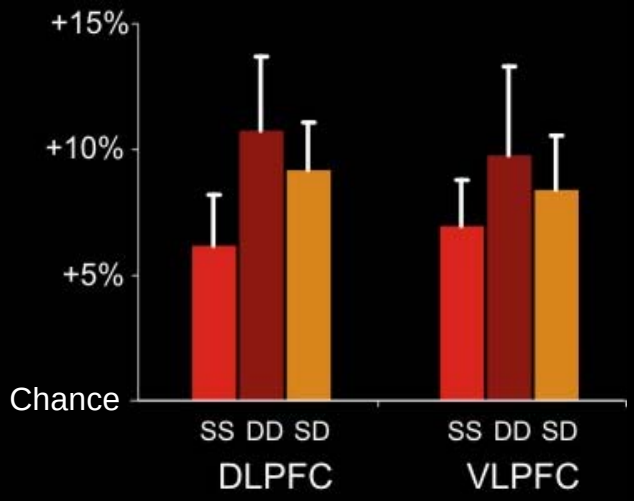
Carlo Reverberi
Postdoc

Reverberi , Görgen & Haynes (Cer Cortex 2012)

Hierarchy and compositionality: Cross-classification

Carlo Reverberi
Postdoc





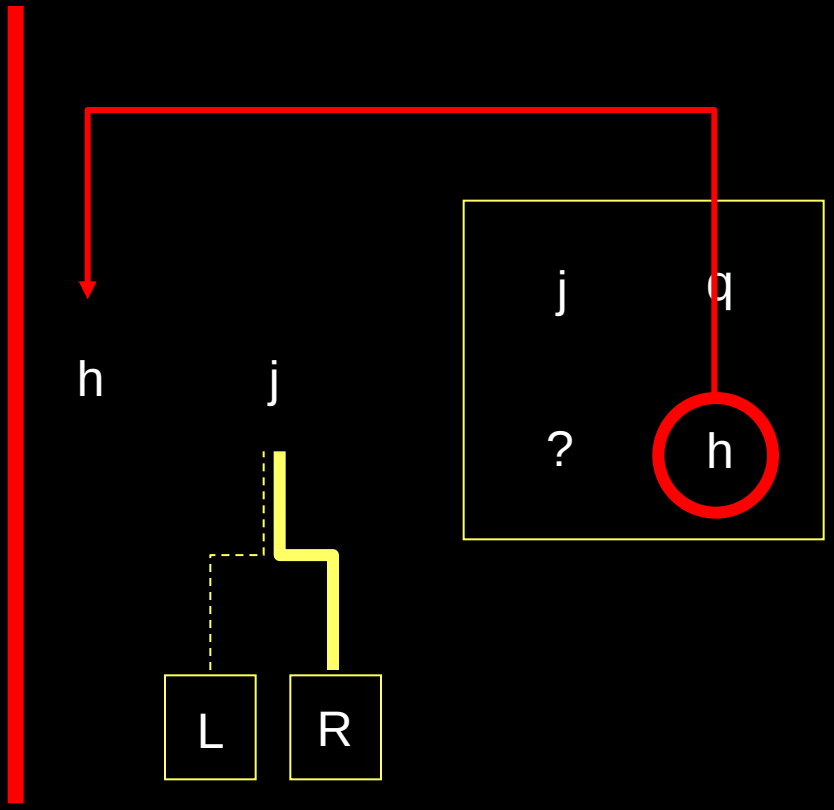
Reverberi , Görgen & Haynes (Cer Cortex 2012)

Predicting decisions

Chun Siong Soon
PhD student

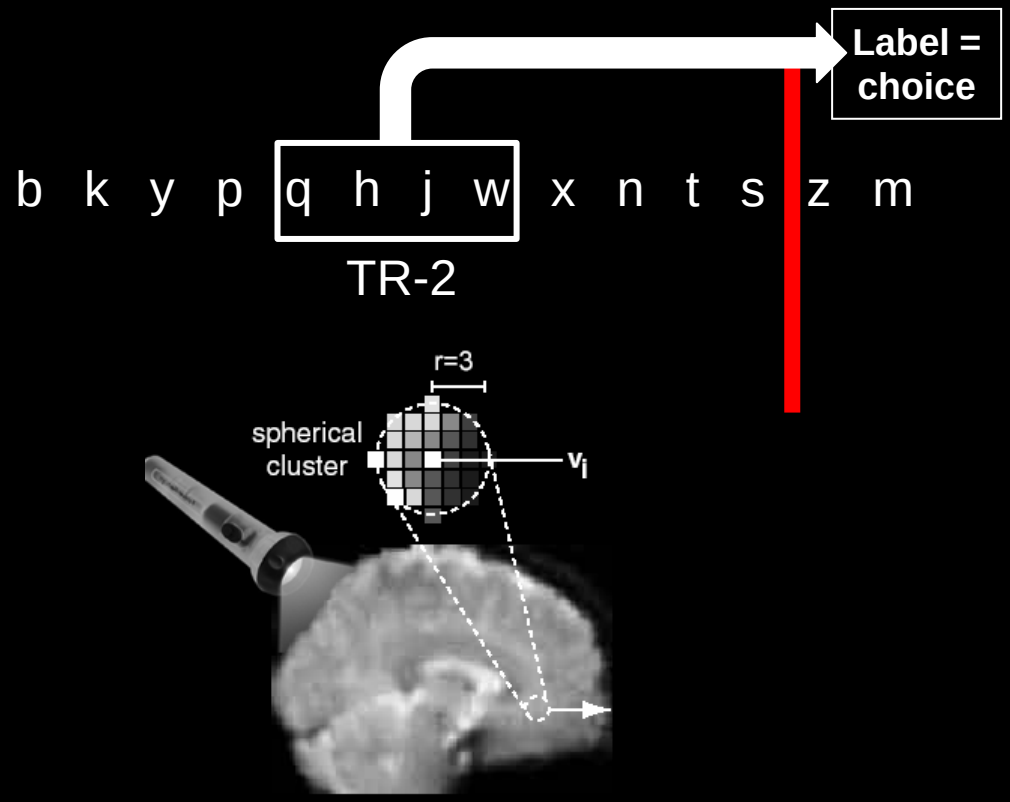
b k y p q

... potential predictors ...



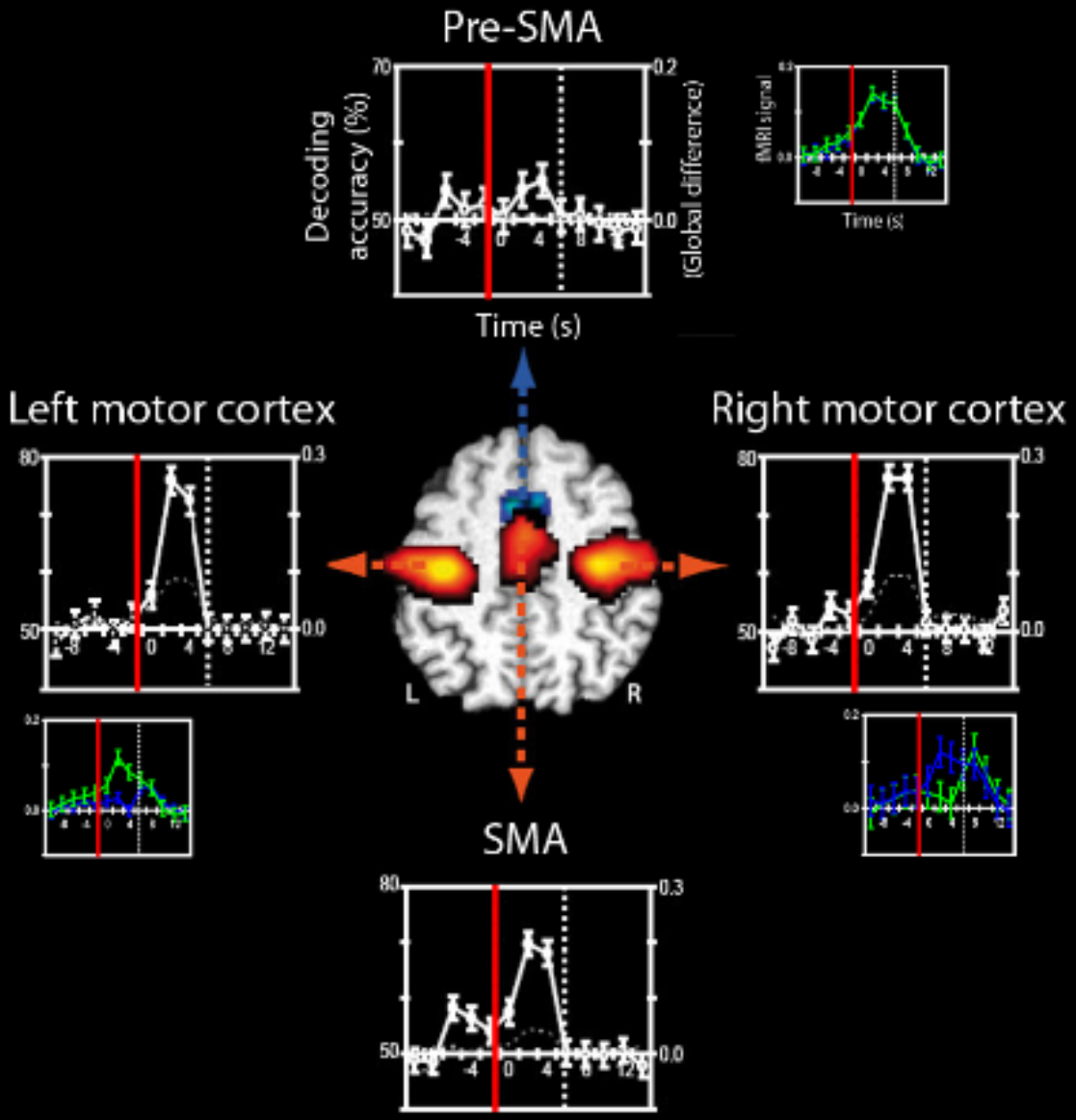
Soon, Brass, Heinze & Haynes Nature Neurosci 2008

Decoding at various TRs relative to choice



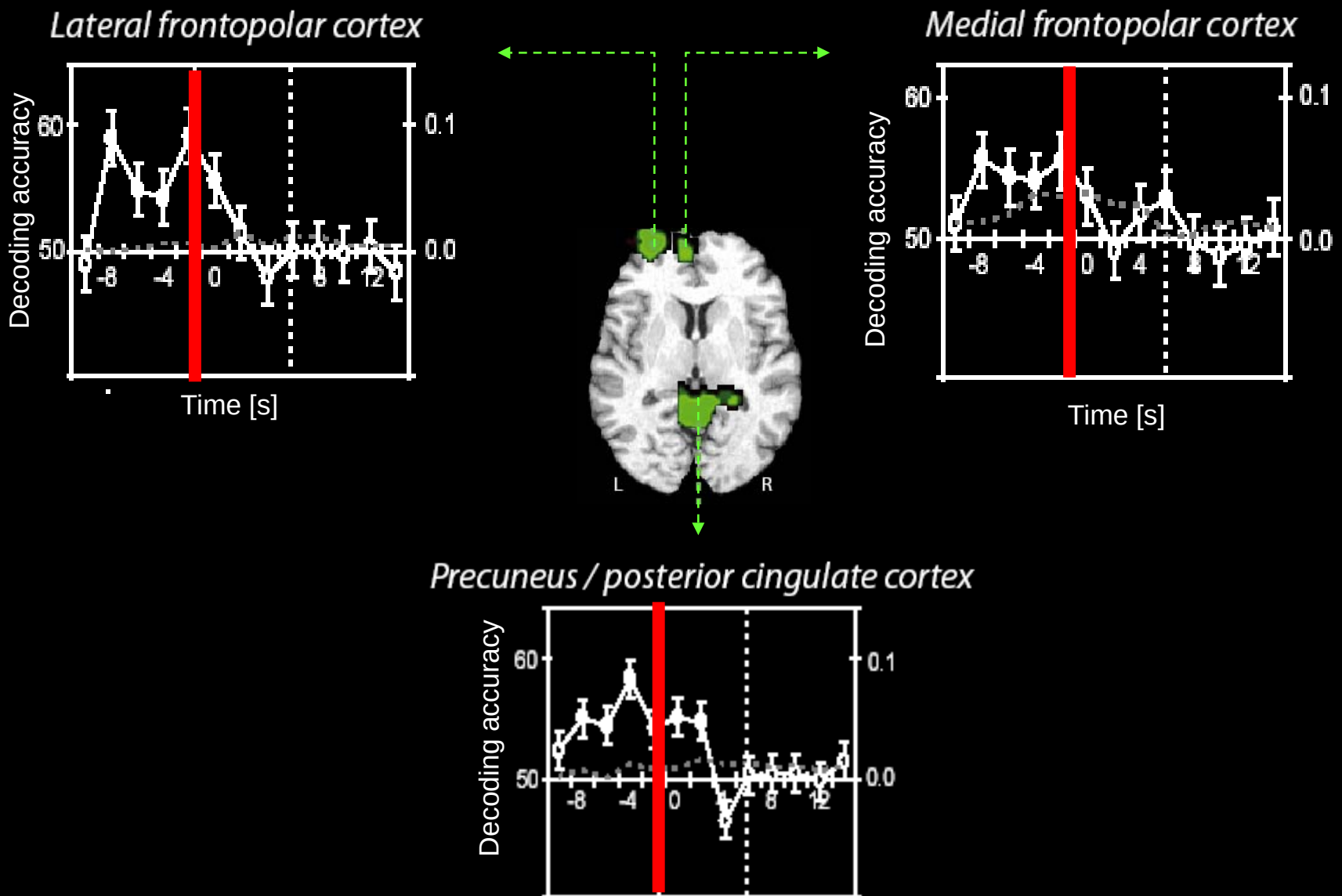
Soon, Brass, Heinze & Haynes Nature Neurosci 2008

Decoding choice after decision

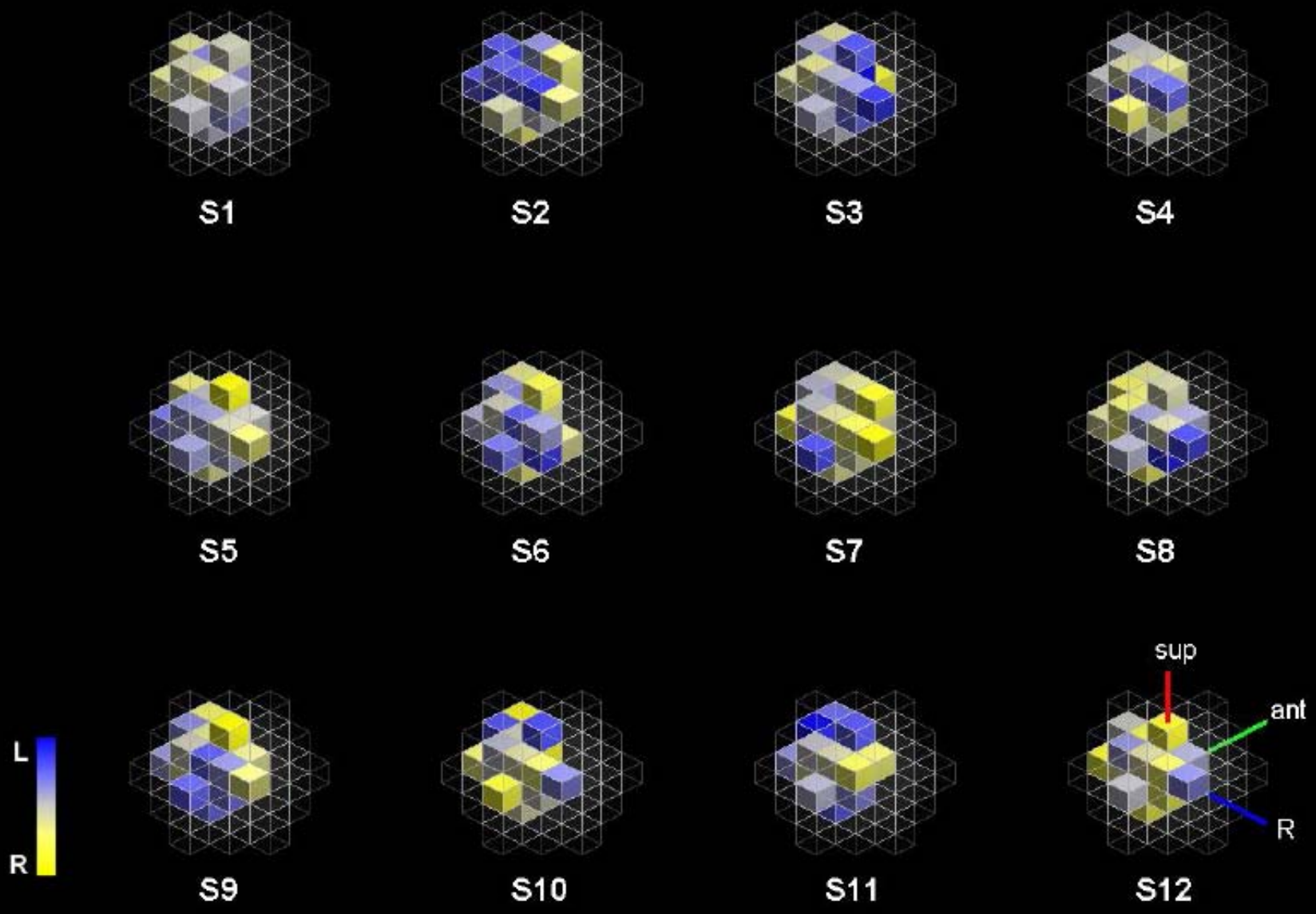


Soon, Brass, Heinze & Haynes Nature Neurosci 2008

Decoding choice <u>before</u> decision

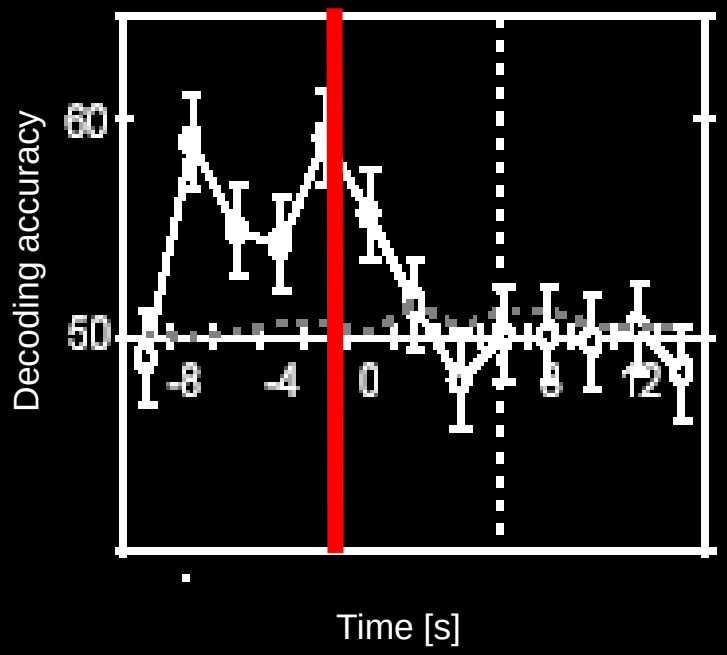


Searchlight classification weights in frontopolar cortex

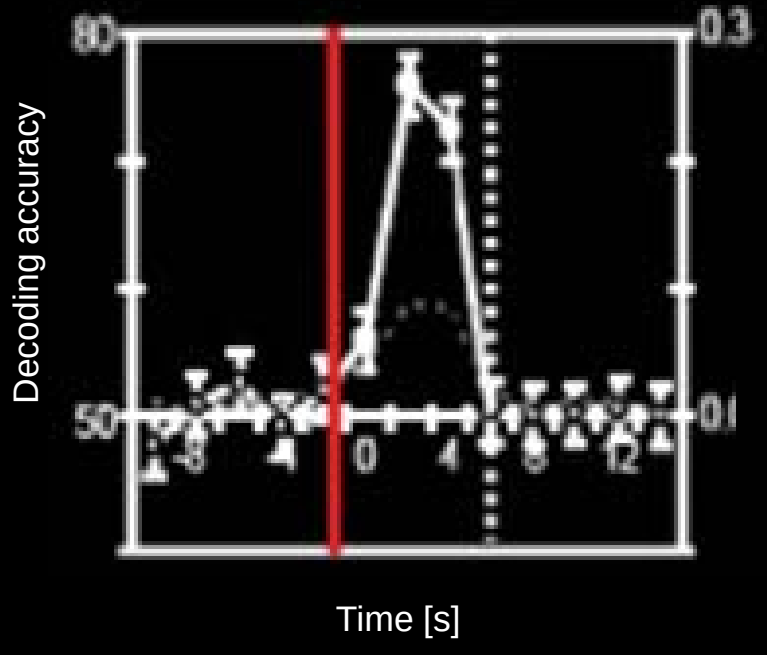


Early decision – late response?

Lateral FPC

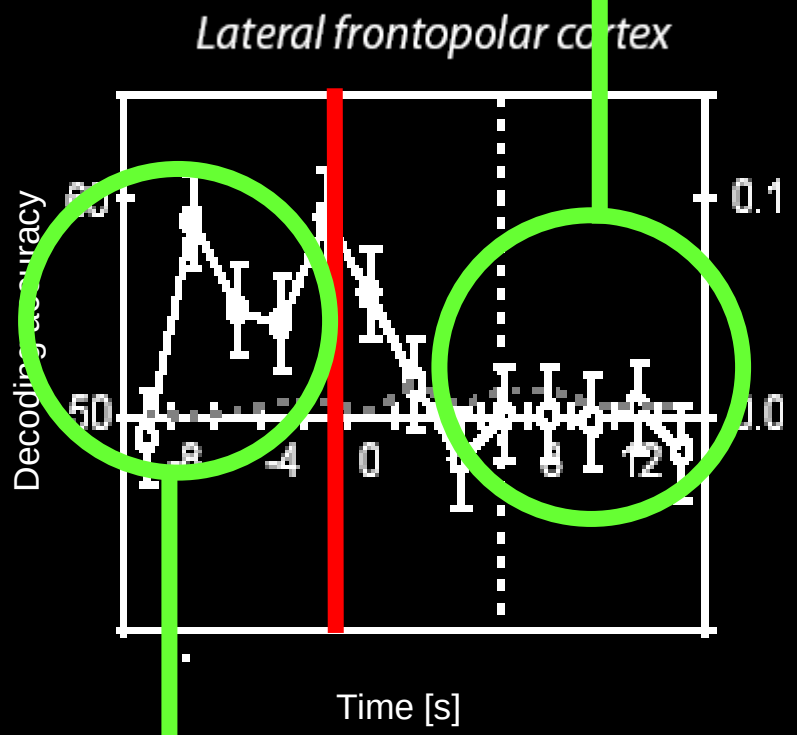


Left motor cortex



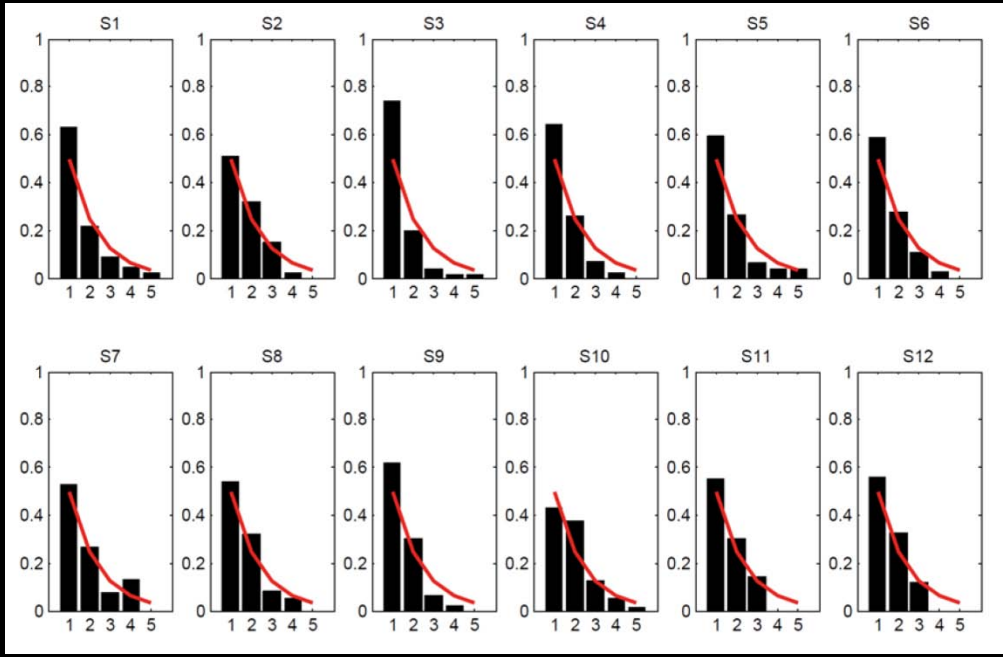
Link to previous trial?

No prediction of next trial



Increases with distance from previous trial

Sequential dependencies in detail

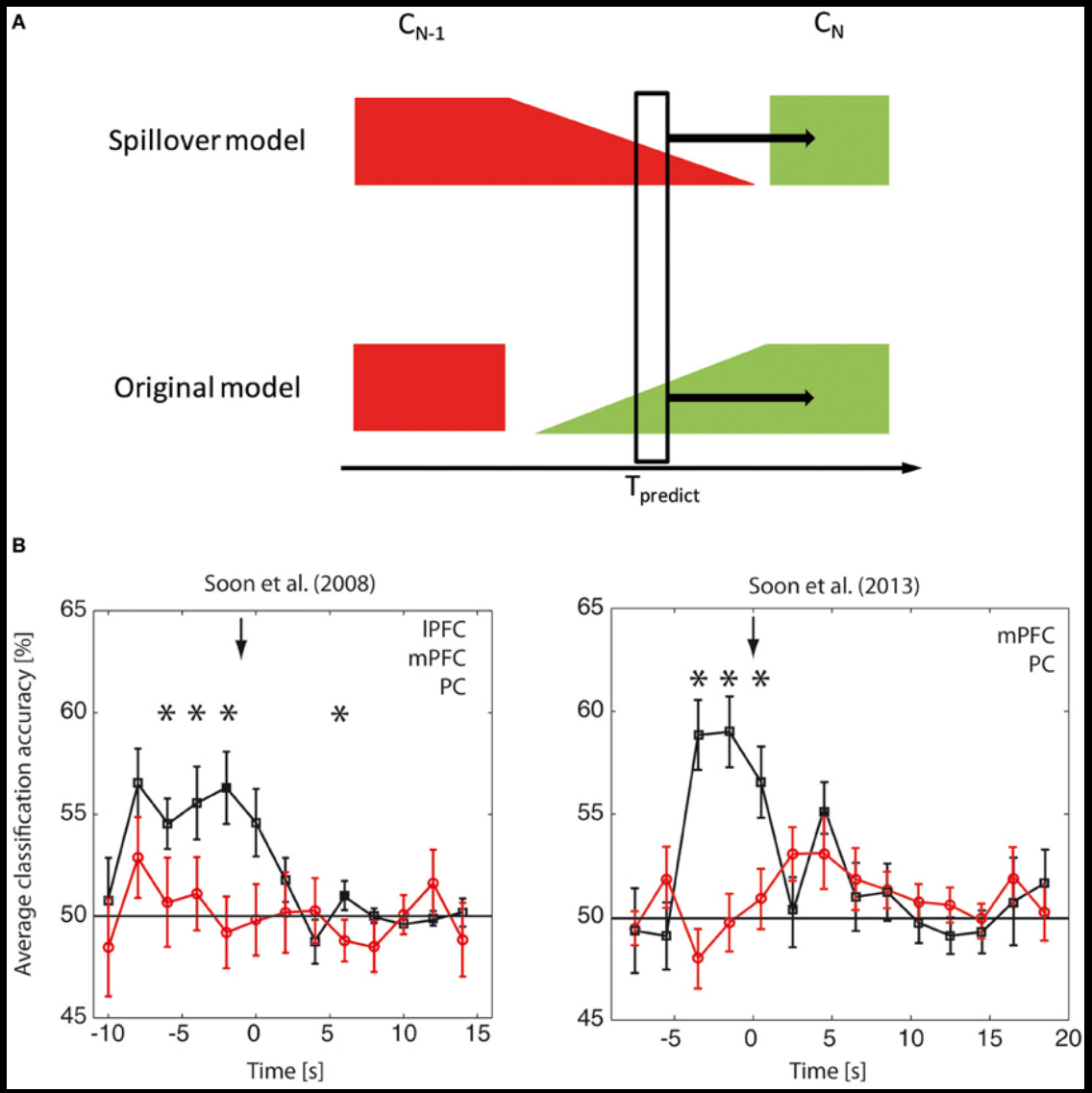


	L	R
–> L	0.37	0.66
–> R	0.63	0.34

	LL	LR	RL	RR
–> L	0.30	0.65	0.40	0.63
–> R	0.70	0.35	0.60	0.37

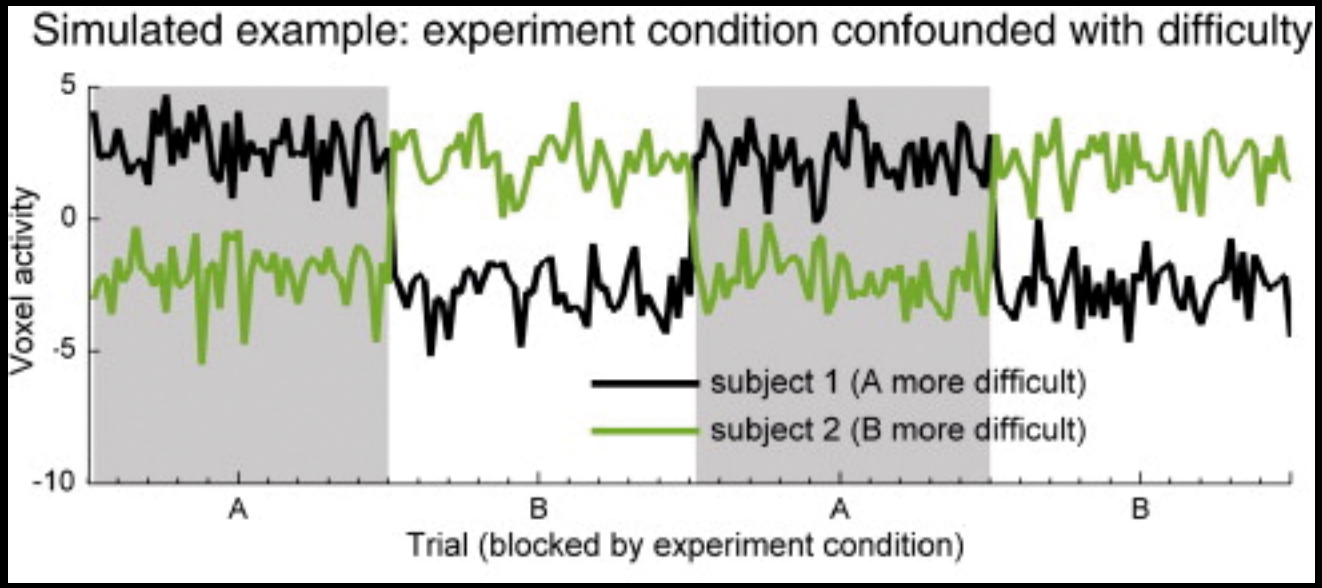
Allefeld et al. Arxiv 2013; see also Lages et al. 2013

Which model? Two “labelling” approaches



Soon et al. Frontiers (2014)

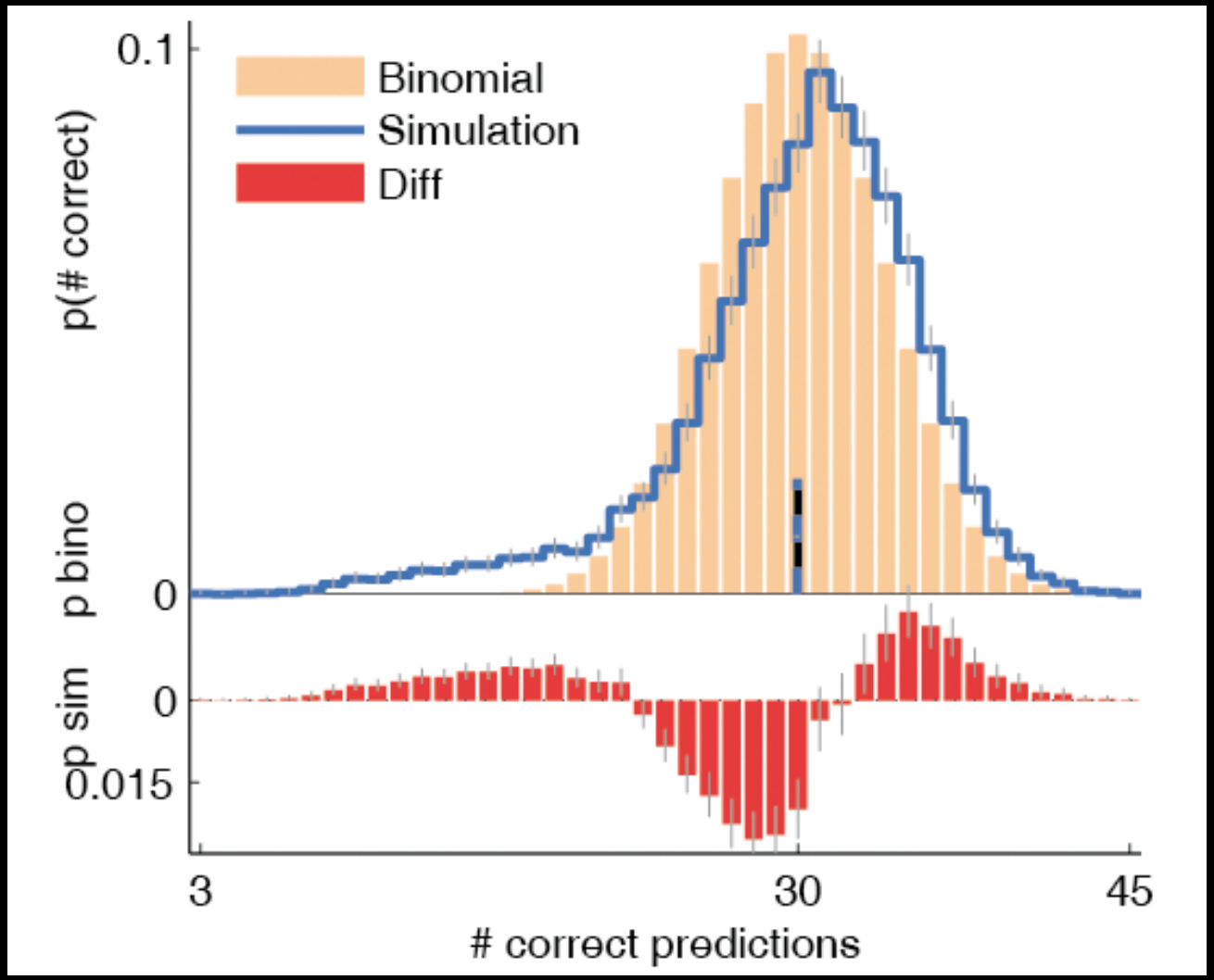
Pitfalls: Reaction times



One possible „fix“: Regress out reaction times before classification

Todd et al. Neuroimage 2013

Pitfalls: Statistical testing



Especially for chance accuracies other than p=0.5
better to use permutation tests.

Görgen & Haynes (in preparation)

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Collaborators:
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Bundesministerium für Bildung und Forschung

Deutsche Forschungsgemeinschaft DFG