Bottom-up and top-down computations in word- and face-selective cortex

Kendrick Kay

http://cvnlab.net

Center for Magnetic Resonance Research (CMRR)

University of Minnesota, Twin Cities

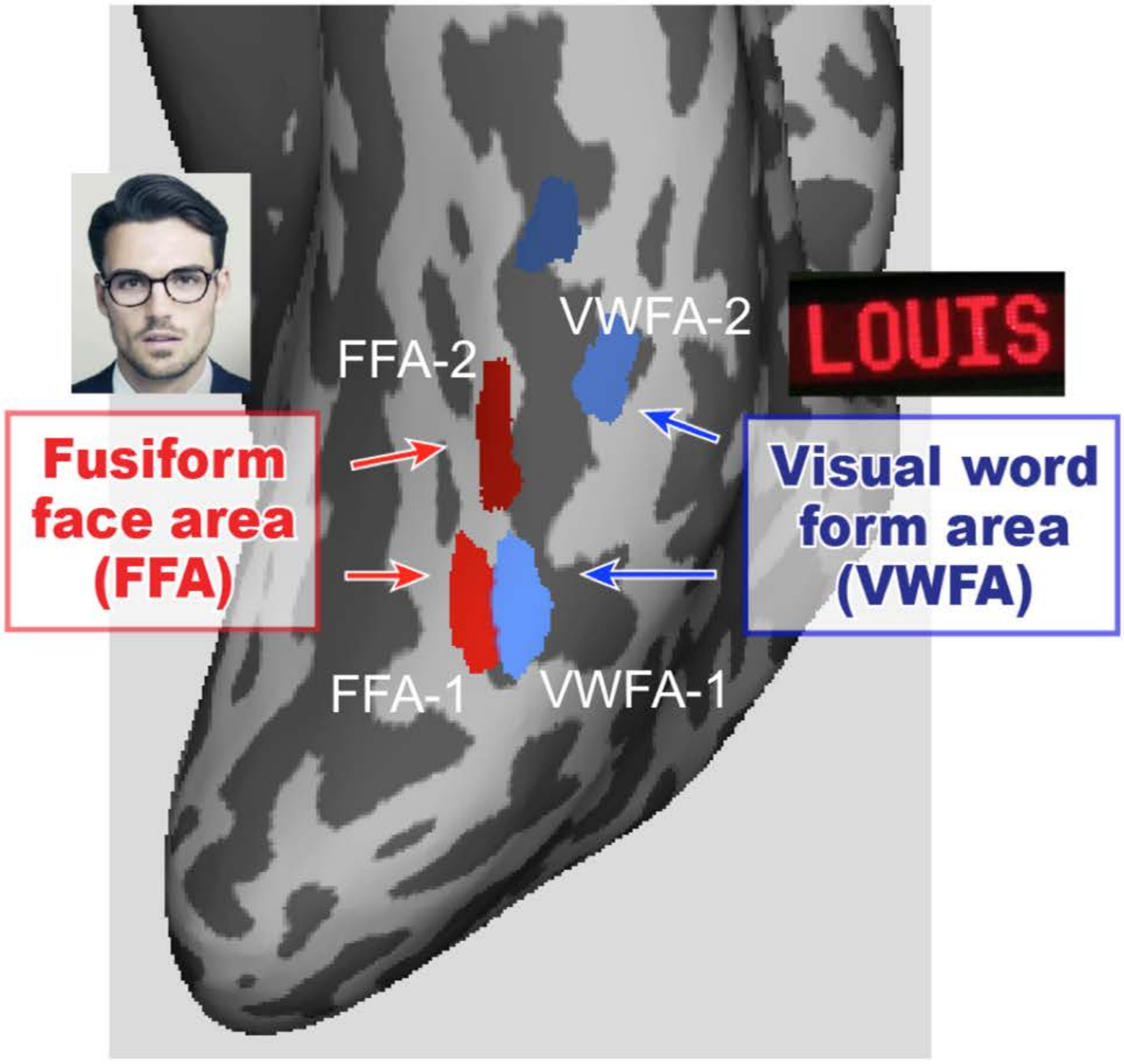
UNIVERSITY
OF MINNESOTA

Overview

Part 1:
Forward model for high-level visual cortex
Kay & Yeatman, *eLife*, 2017

Part 2:
General model principles
Kay, *NeuroImage*, 2017

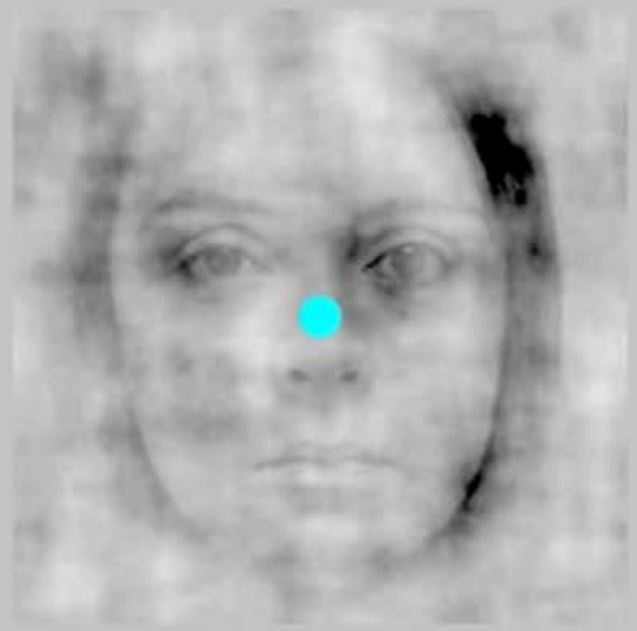
Ventral temporal cortex (VTC)



Kendrick Kay, CMRR, University of Minnesota

Experiment

- fMRI parameters (3 T, 2.5-mm, 2 s TR)
- 9 subjects



Methods:

Slice time correction
Motion correction
Fieldmap-based undistortion
Denoising using GLMdenoise

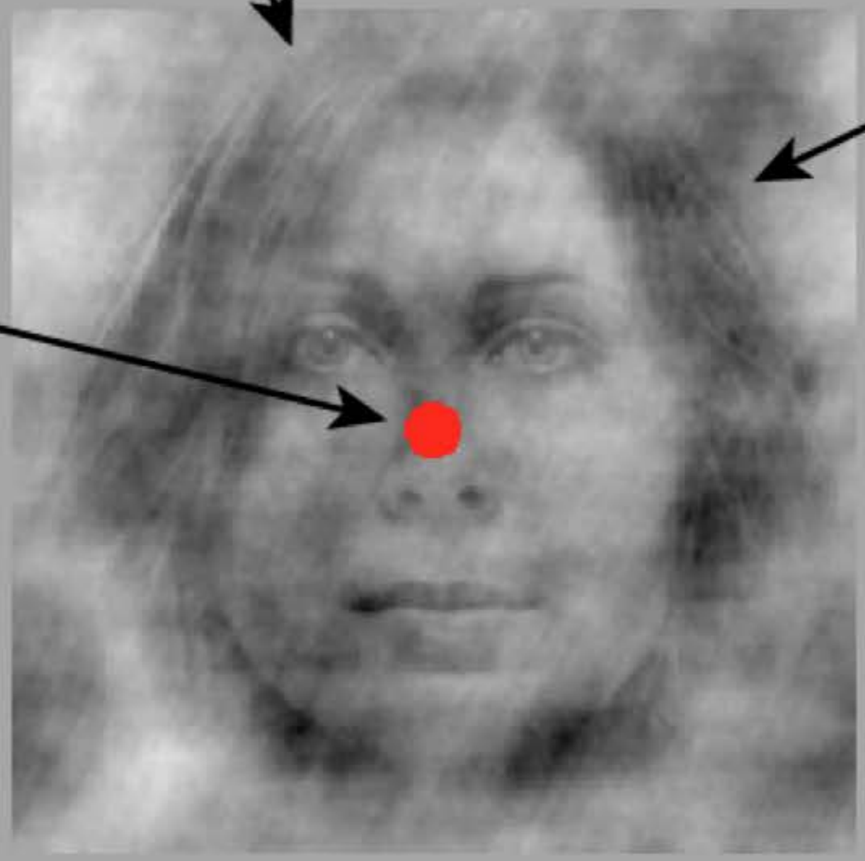
Kay & Yeatman, *eLife*, 2017

Experiment

- 24 stimuli x 3 tasks = 72 conditions (12 trials each)

Categorization task

Is the stimulus a word, a face, or neither?



One-back task

Is the stimulus the same as the previous one?

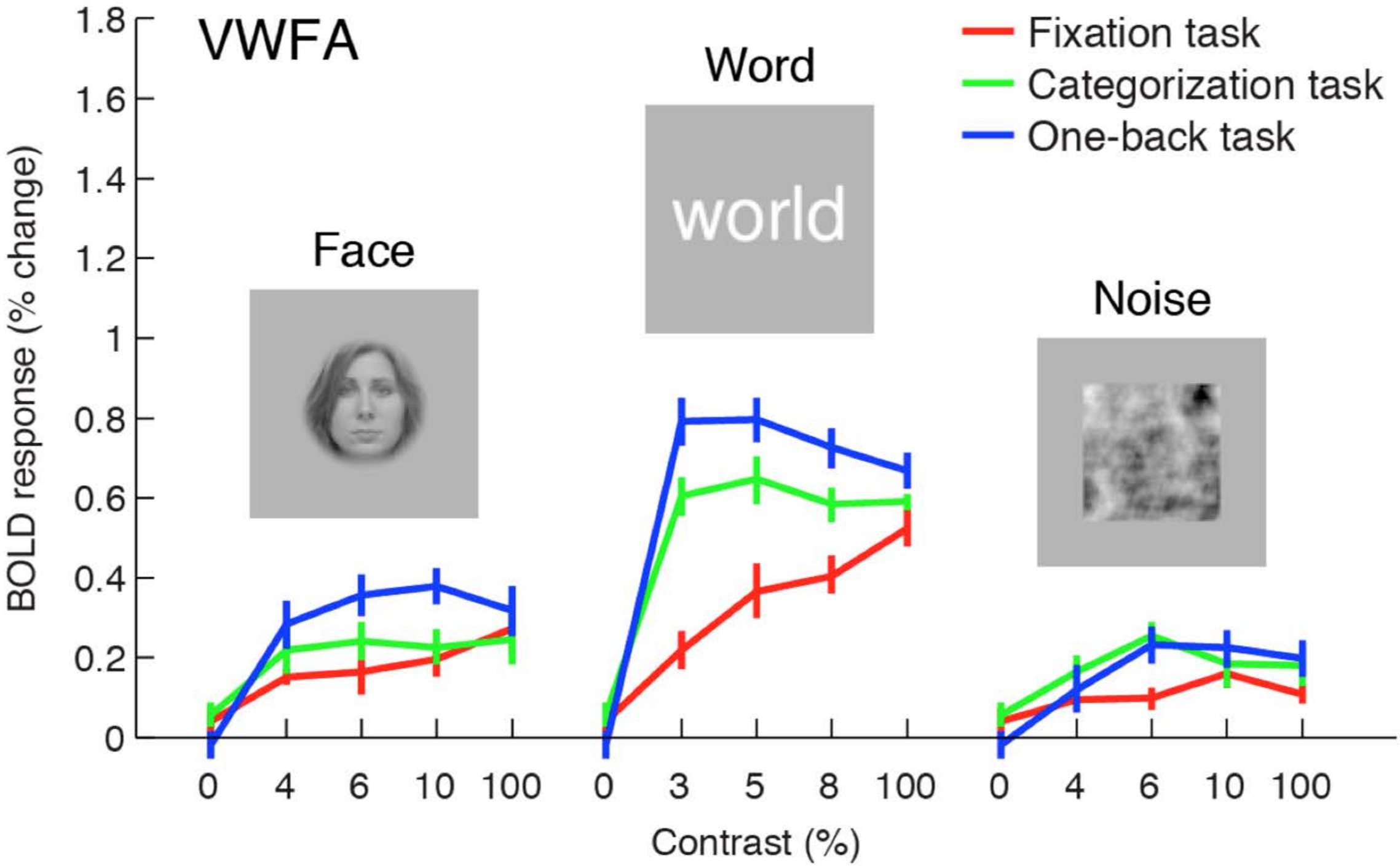
Fixation task

Is the dot red?

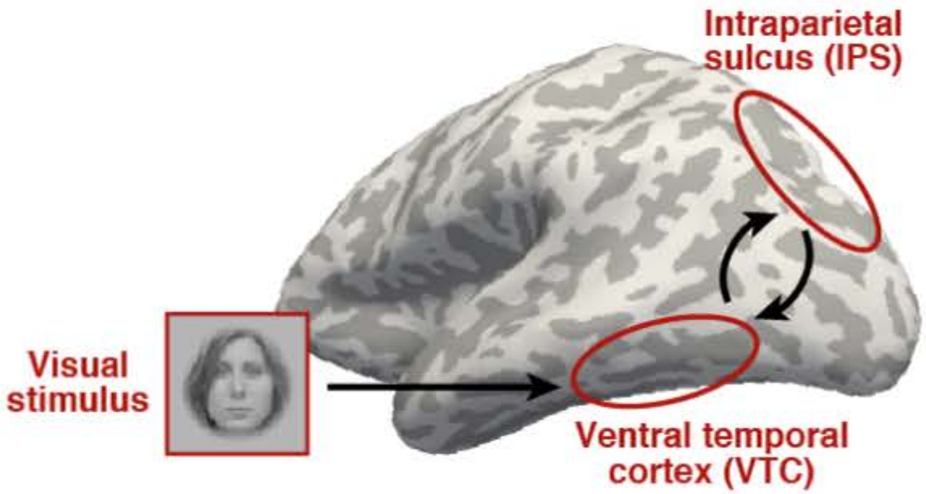
Kay & Yeatman, *eLife*, 2017

Both the stimulus and the task matter

Kay & Yeatman, *eLife*, 2017

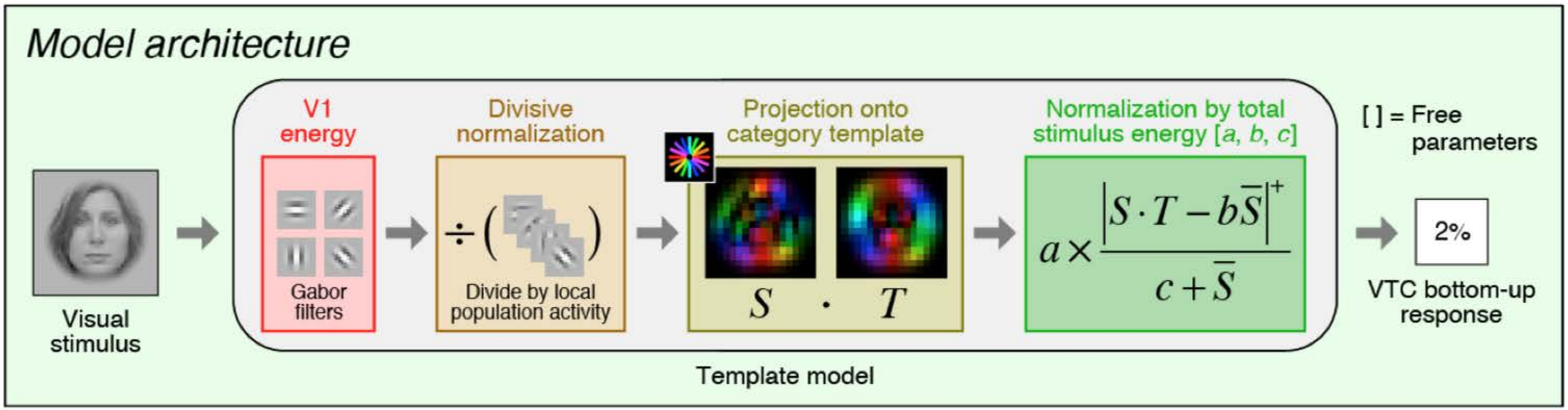


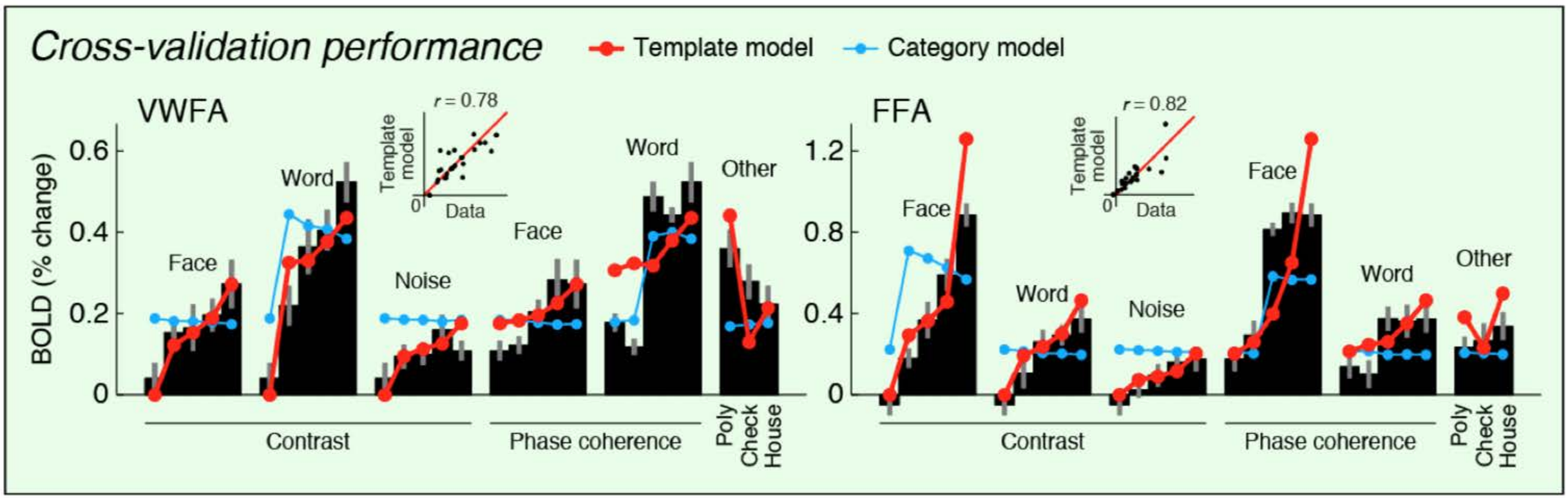
The model in Kay & Yeatman 2017



Template model of VTC

Kay & Yeatman, *eLife*, 2017





Code implementation

http://github.com/kendrickkay/vtcipsmodel/

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kendrickkay / vtcipsmodel

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Kendrick Kay edited this page 6 days ago · 12 revisions

History

- 2017/02/19 - Initial release. Contents are complete.

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Introduction

This github repository provides data and modeling code corresponding to the following paper:

> Kay, K.N. & Yeatman, J.D. Bottom-up and top-down computations in word- and face-selective cortex. *eLife* (in press).

If you use these materials in your research, please cite the above paper. You might also be interested in other available datasets and modeling code -- see this, this, and this. If you have any questions, contact Kendrick.

Clone this wiki locally

https://github.com/kendrick

Clone in Desktop

Example script illustrating the T...

htmlpreview.github.io/?https://github.com/kendrickkay/vtcipsmodel/blob/master/html/model_template.html

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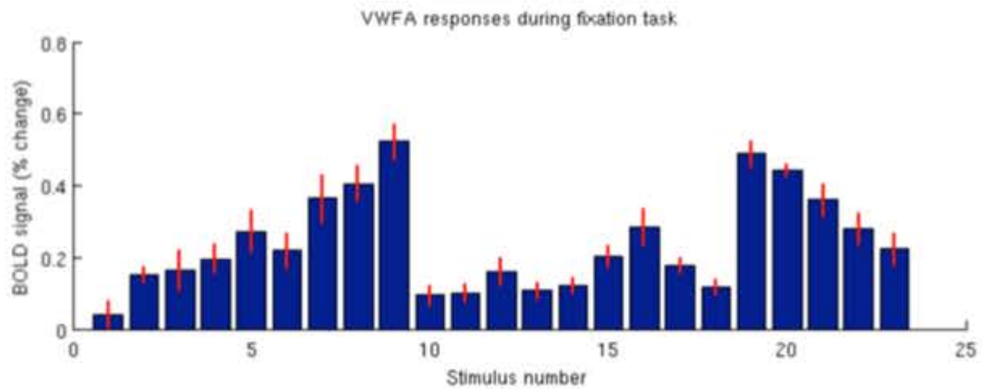
```
% look at the group-averaged beta weights for VWFA during the fixation task
figure; setfigurepos([100 100 600 200]); hold on;
beta =   a1.groupbeta(5,:,1);
betase = a1.groupbetase(5,:,1);
bar(beta);
errorbar2(1:length(beta),beta,betase,'v','r-','LineWidth',2);
xlabel('Stimulus number');
ylabel('BOLD signal (% change)');
title('VWFA responses during fixation task');
```

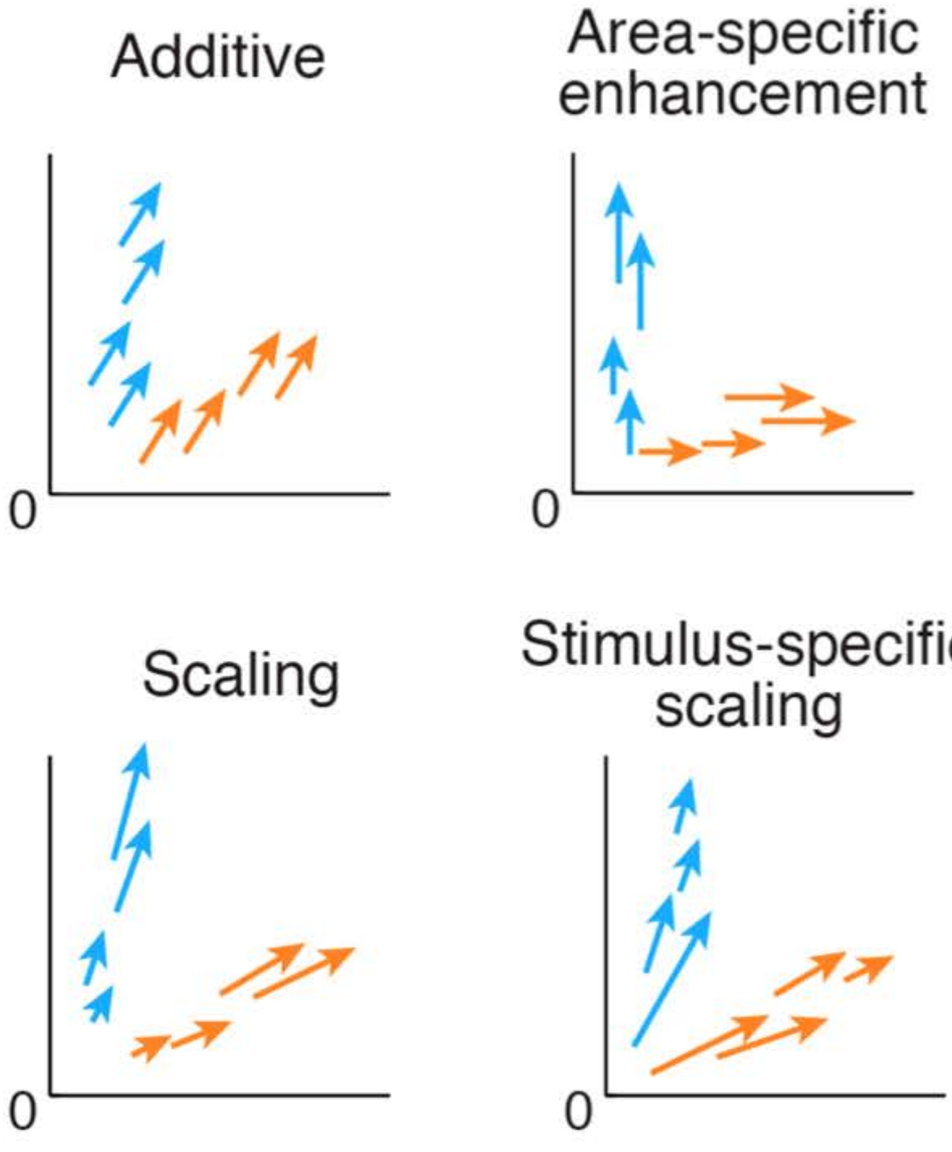


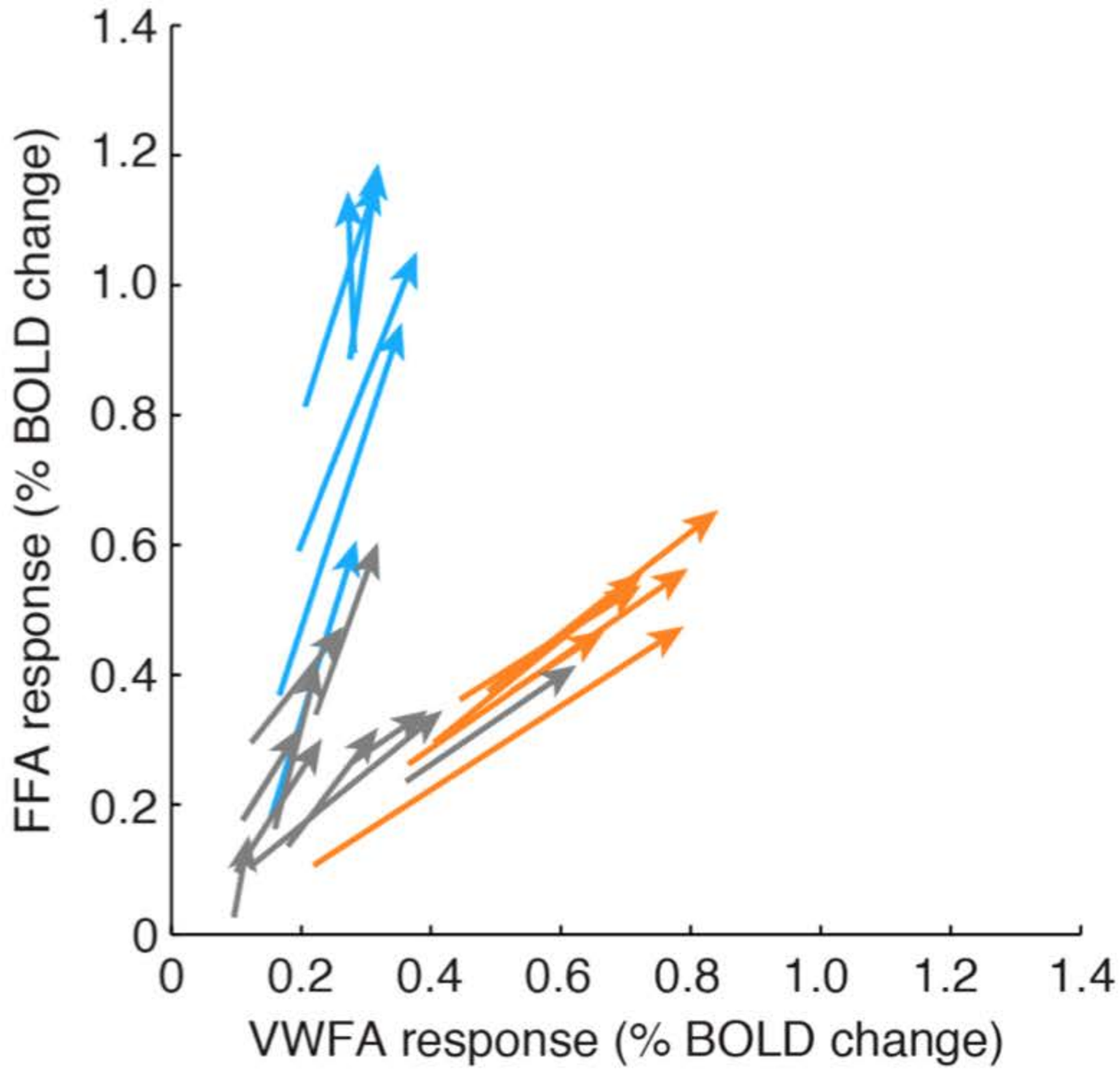
Perform some pre-processing of the stimuli

```
% The rationale is that there are a series of image processing steps
% that occur before the free parameters of the model take influence.
% Thus, we can do these computations up front before we move
% on to model fitting.

% convert to single format so that we can actually do computations.
% also, reshape so that all of the stimulus images lie along the third dimension.
X = reshape(single(a1.stimuli),[500 500 10*23]);

% resize the images to 250 pixels x 250 pixels to reduce computational burden.
X = single(processmulti(@imresize,double(X),[250 250]));  % dimensions are now 250 x 250 x 10*23

% note that pixel values are proportional to actual luminance values,
% so no special handling of gamma is required.

% convert the pixel range from [0,254] to [-.5,.5] by rescaling values
```

Top-down: stimulus-specific scaling

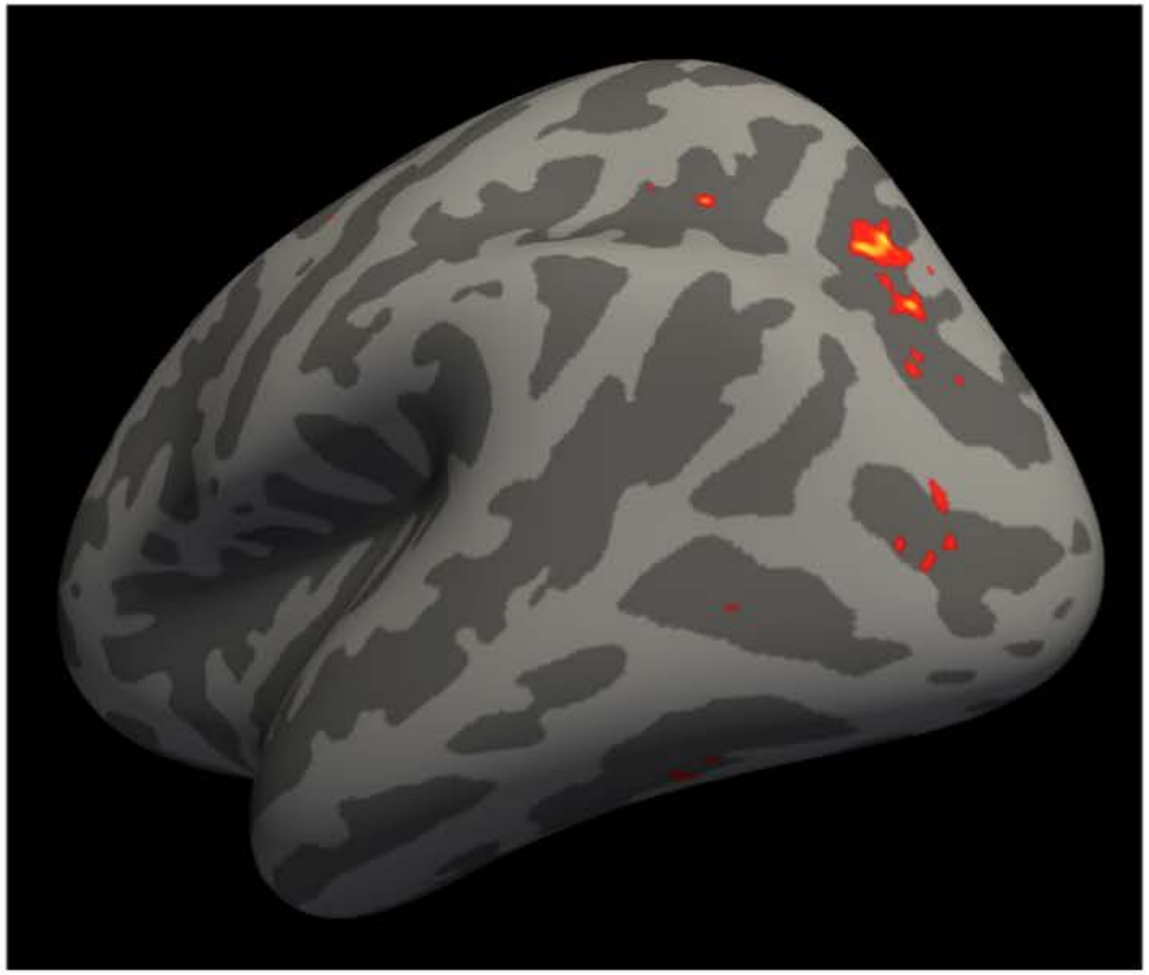
Kay & Yeatman, *eLife*, 2017

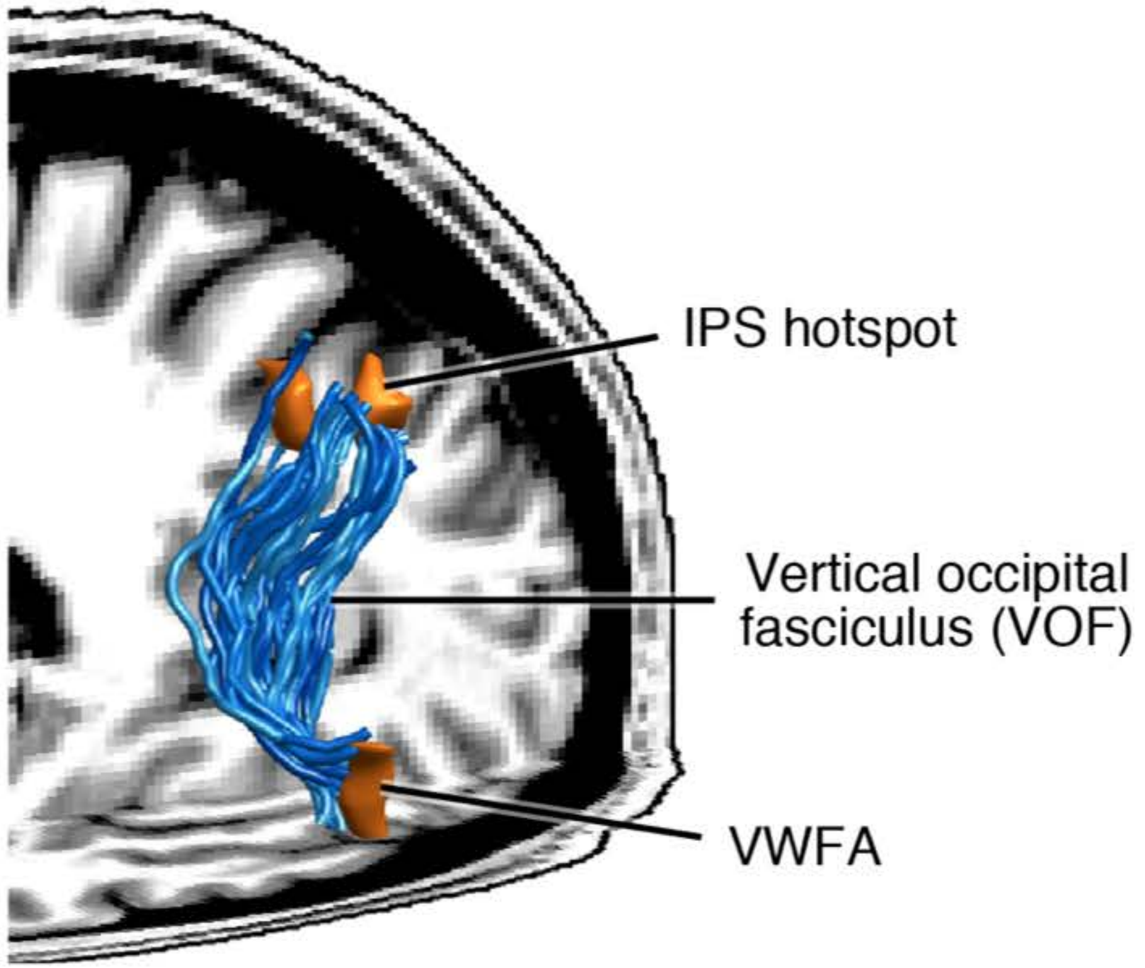




IPS as source of top-down signals

Kay & Yeatman, *eLife*, 2017

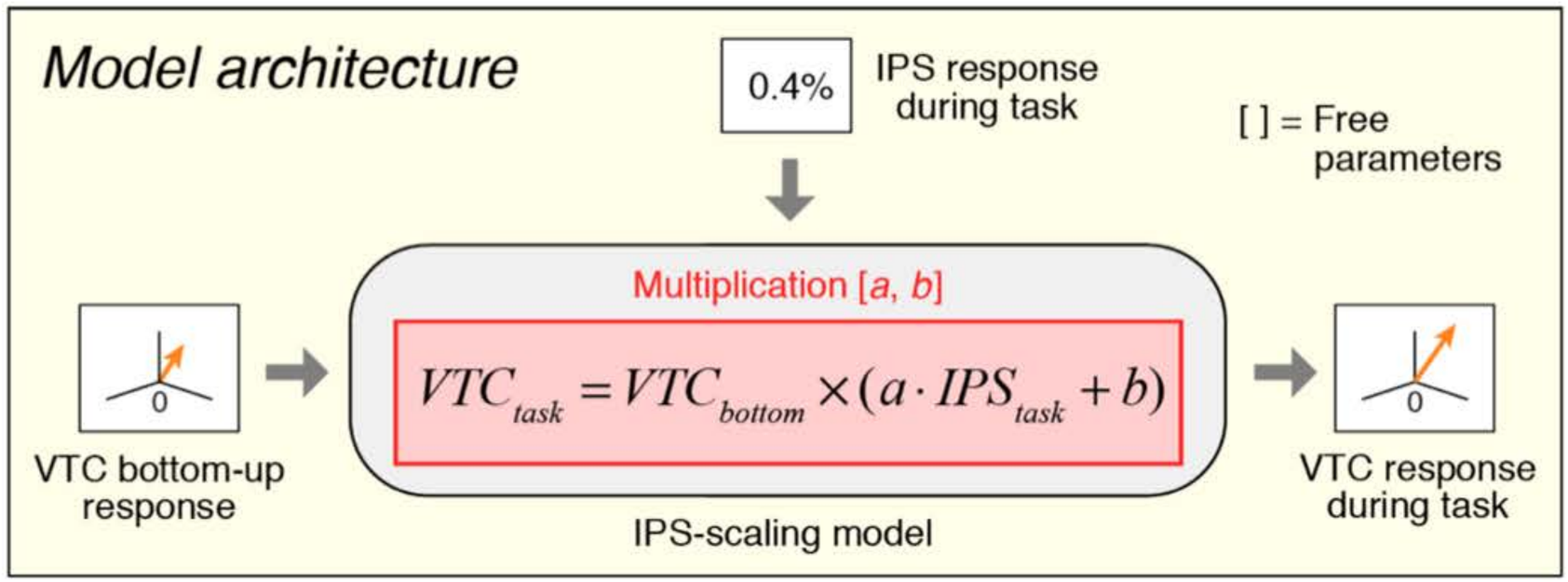


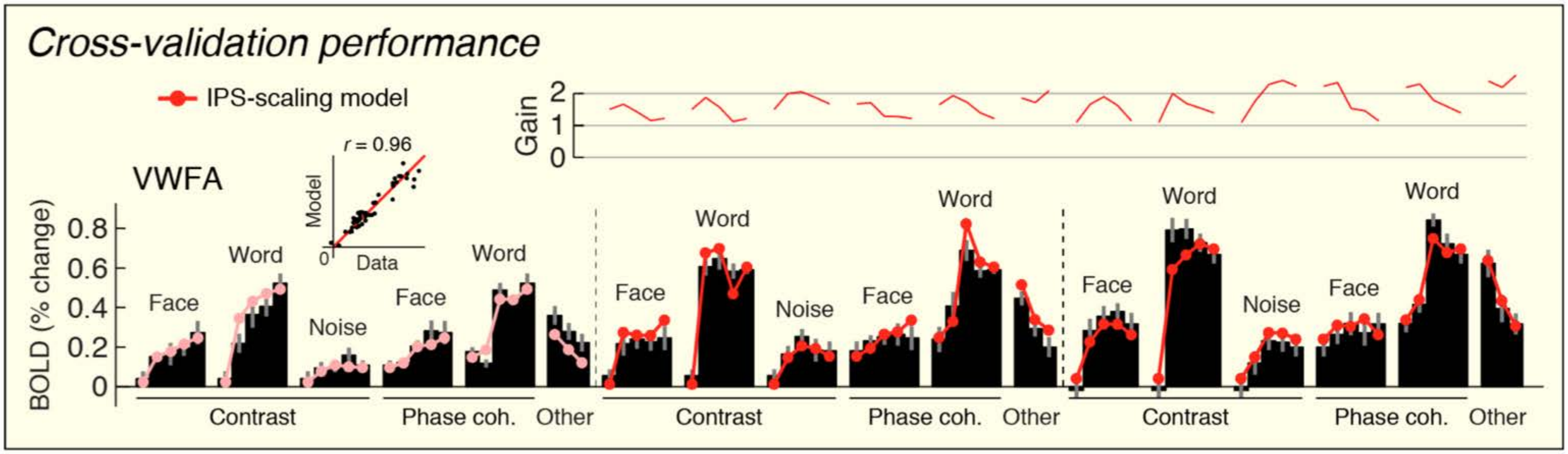


See Yeatman et al., *PNAS*, 2014

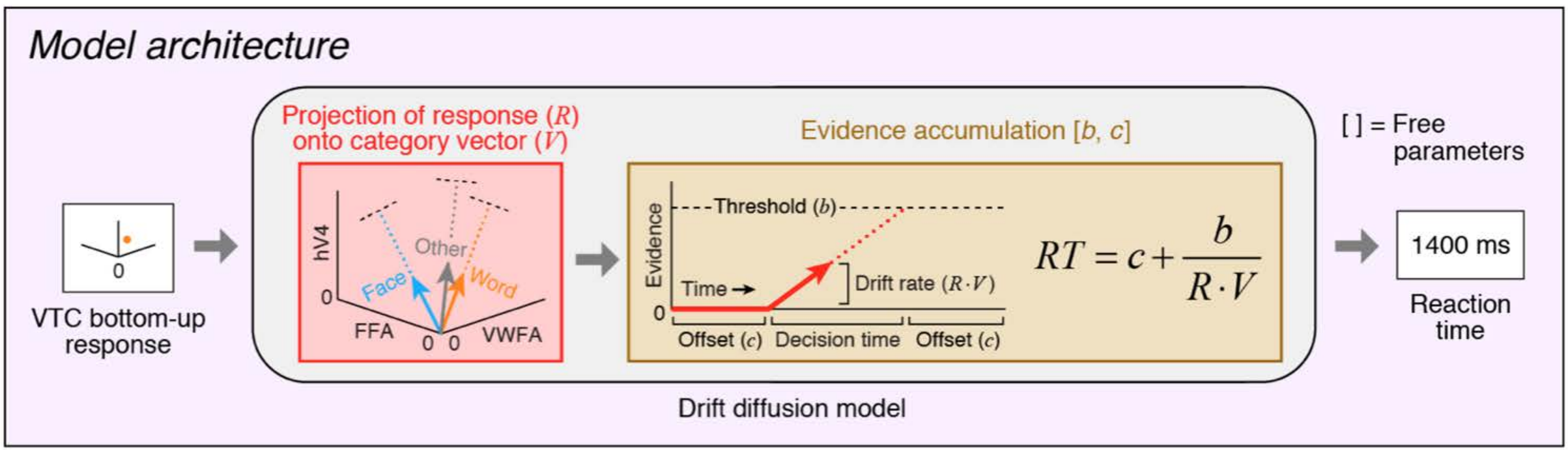
IPS-scaling model

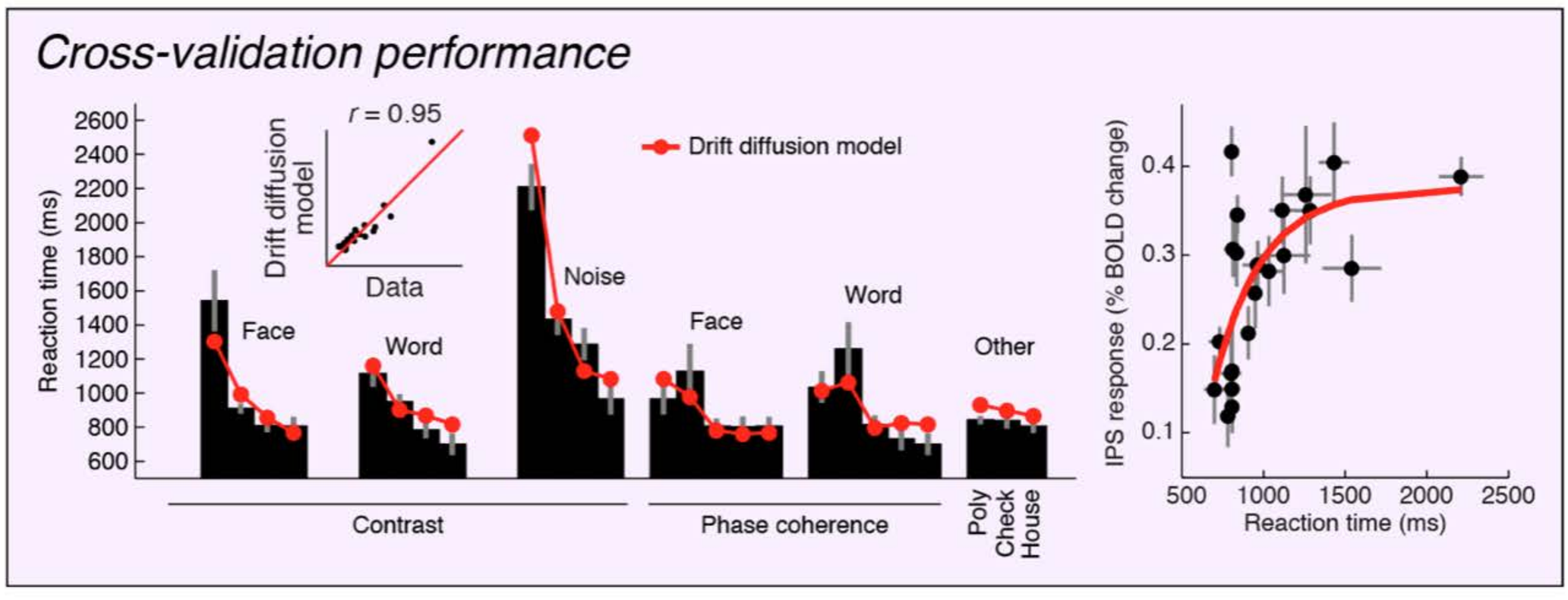
Kay & Yeatman, *eLife*, 2017



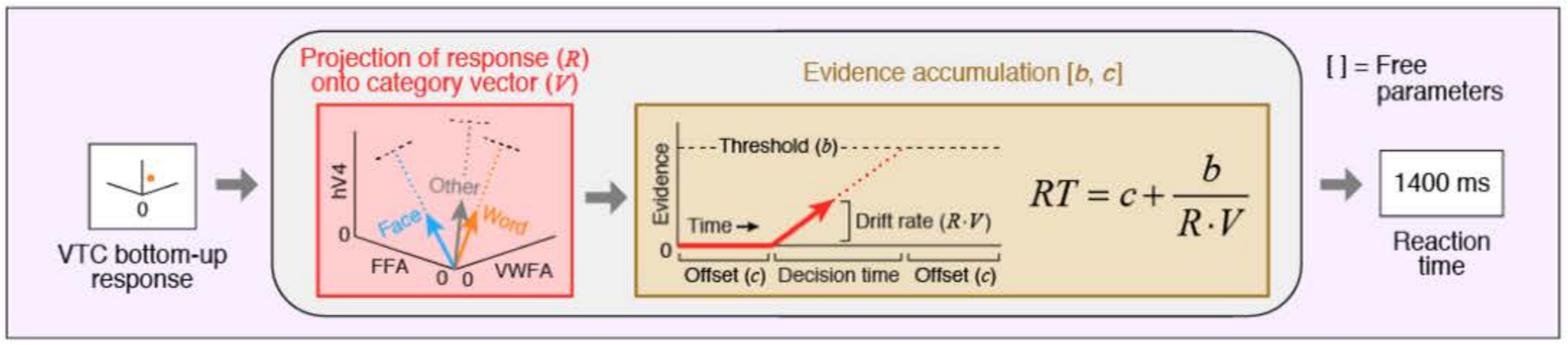


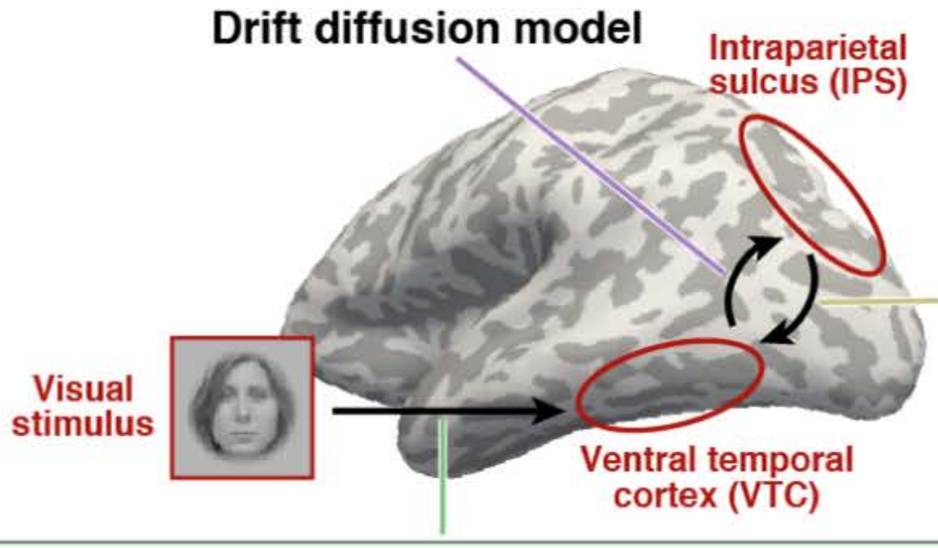
Drift diffusion model of IPS

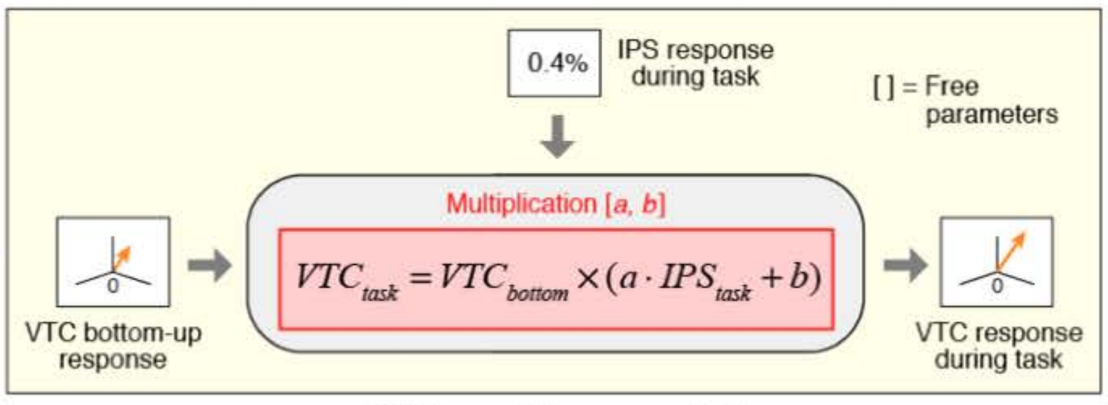




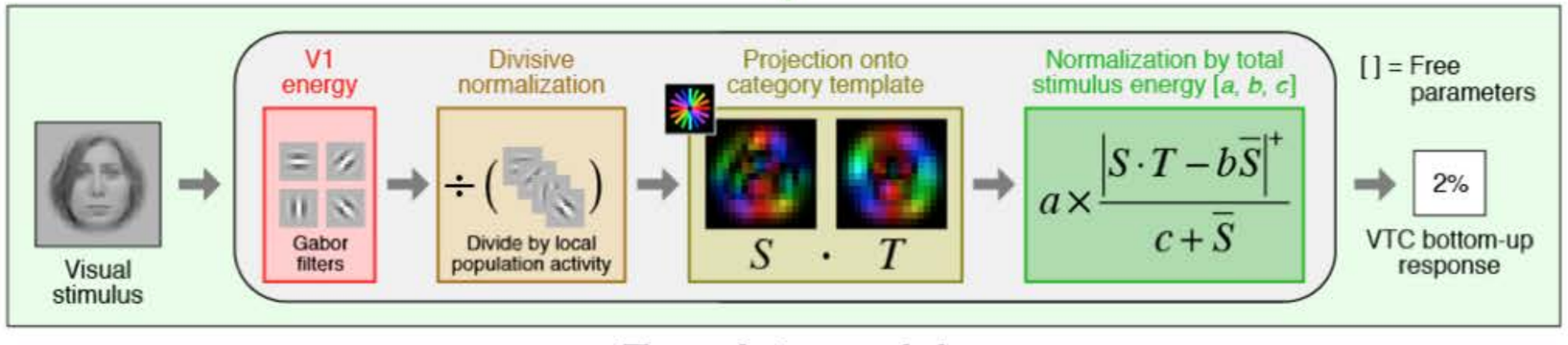
The model in Kay & Yeatman 2017







IPS-scaling model

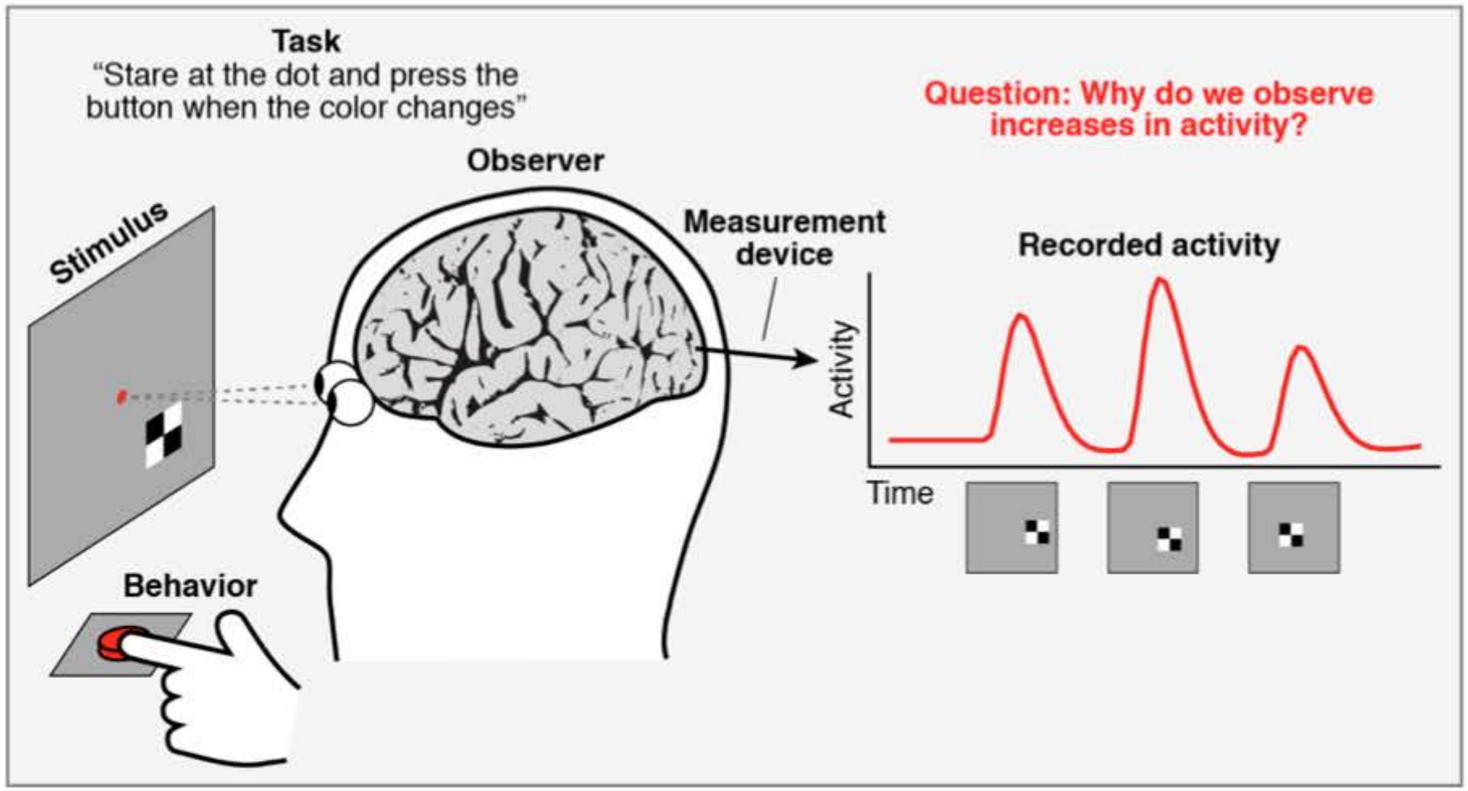


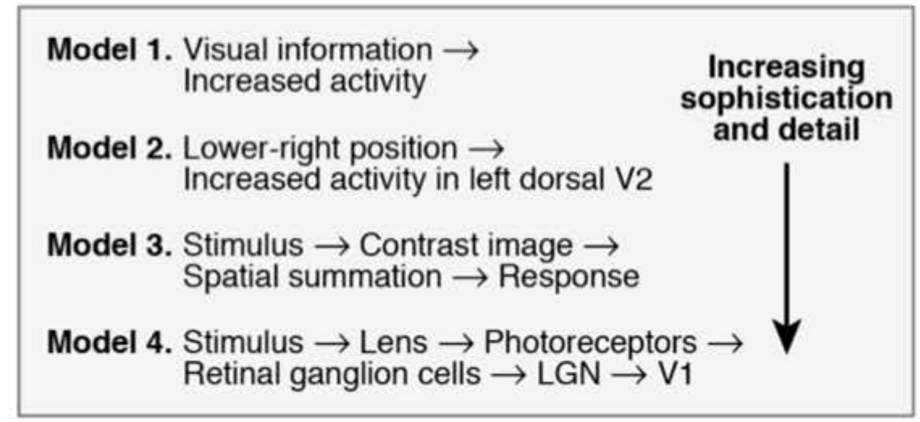
Template model

The concept of forward models

- Cognitive neuroscience is about linking experimental properties to neural activity
- Forward models just make this explicit

Kay, *NeuroImage*, 2017





The concept of forward models

Kay, *NeuroImage*, 2017

- Cognitive neuroscience is about linking experimental properties to neural activity
- Forward models just make this explicit
- Forward models for visual responses need both the ***stimulus*** and the ***task***

On the issue of biological detail

Kay, *NeuroImage*, 2017

- Both ***functional*** and ***mechanistic*** models are useful

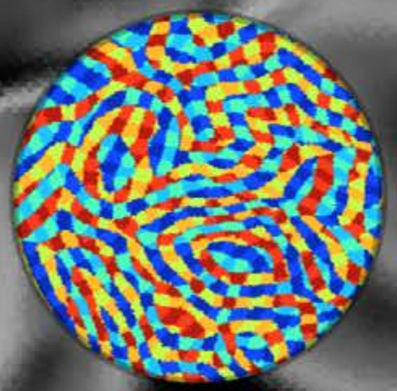
- Two criteria for models:
  - ***Accuracy:*** Does the model accurately match experimental measurements for a diverse range of manipulations?
  - ***Understanding:*** Do we grasp the relationship between model components and the outcomes the model predicts?

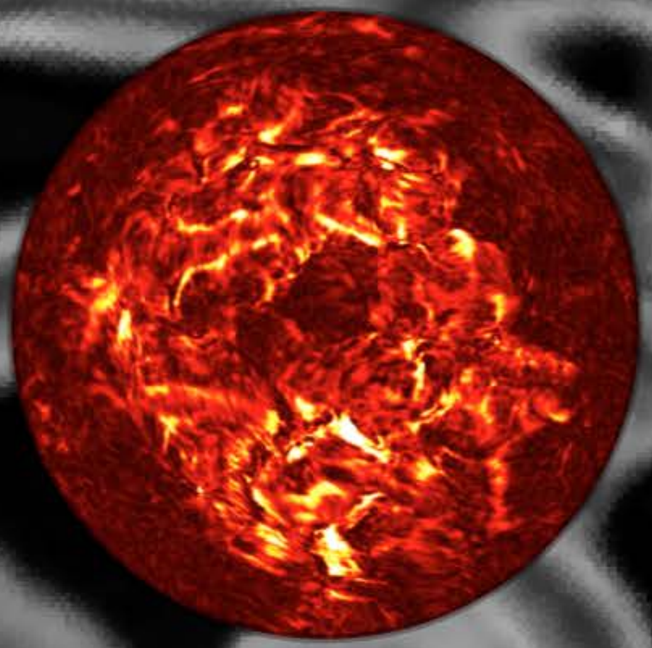
- Should we have included the retina in our model?
  - Yes, that is necessary for a mechanistic model...
  - But if we can build a functional model that is ***accurate*** for our data...
  - Also, omitting helps us ***understand*** model components

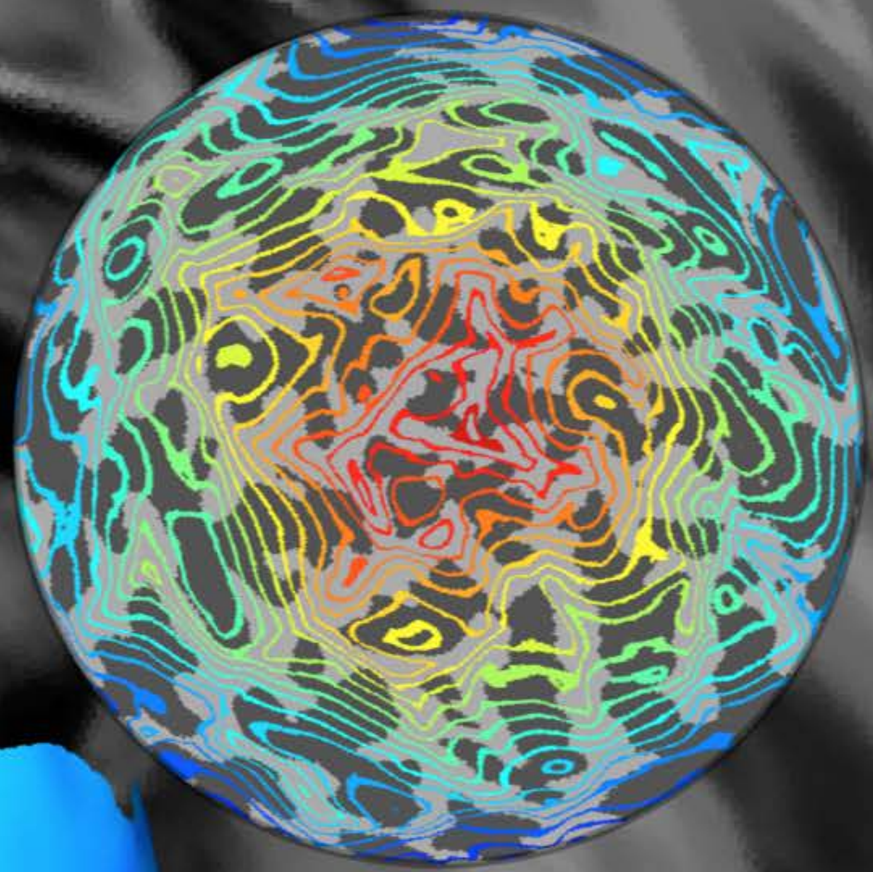
Acknowledgments

- Jason Yeatman
  University of Washington
  (*eLife* paper)

- Kevin Weiner
  UC-Berkeley
  (*NeuroImage* paper)







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