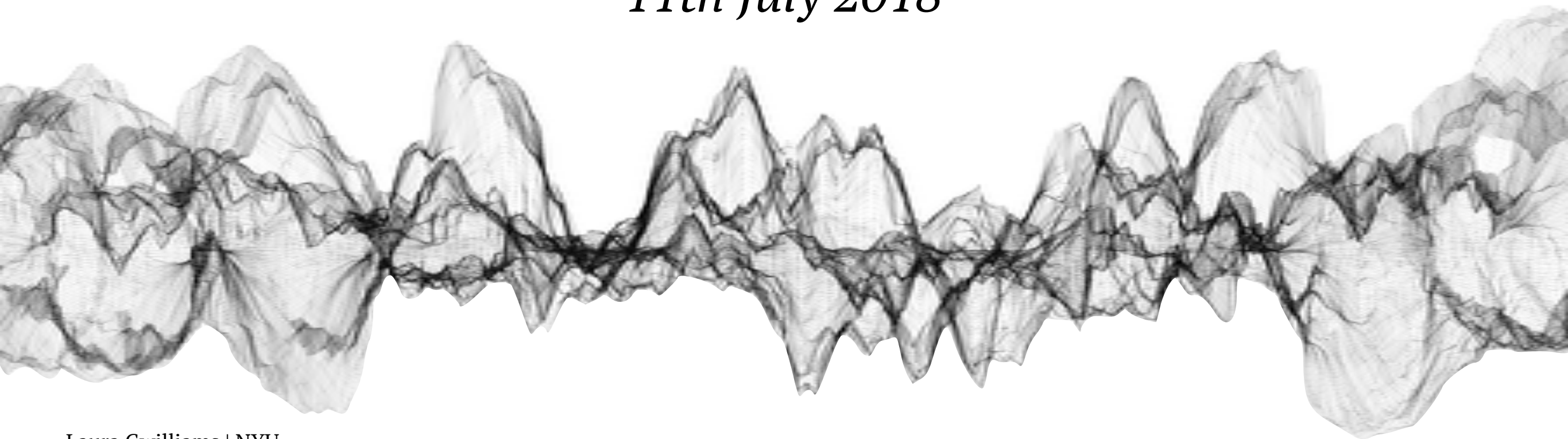# Perceptual decision making is supported by a hierarchical cascade
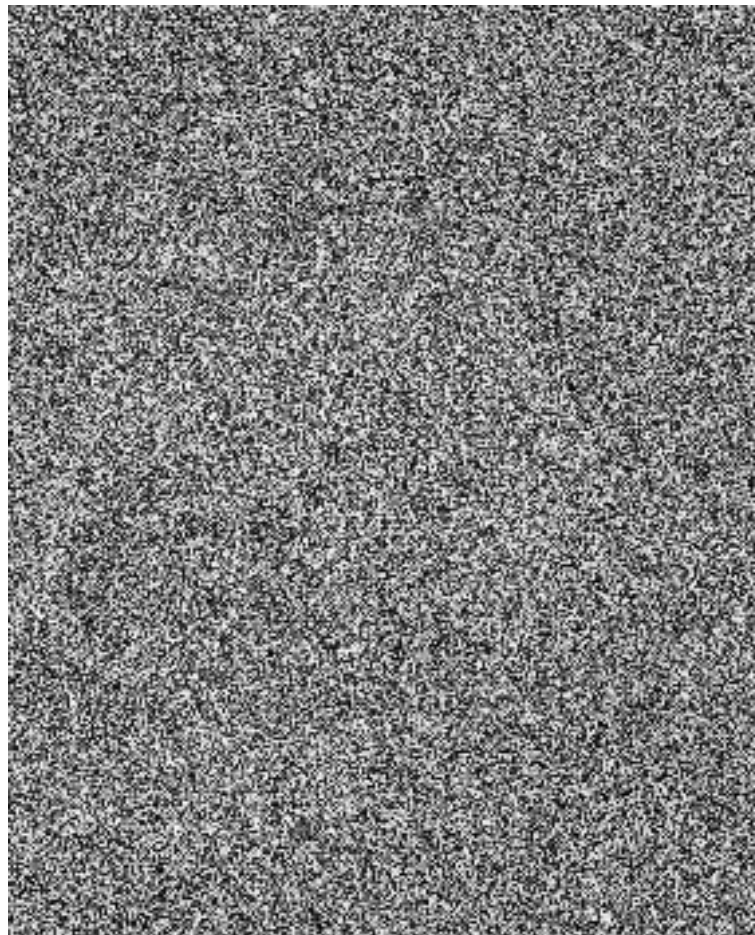# in both biological and artificial neural networks

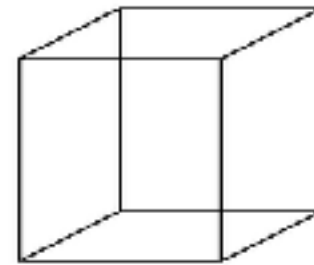**Laura Gwilliams**
11th July 2018
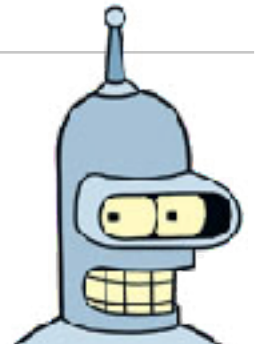
The world is an uncertain place

❖ Noise

❖ Ambiguity
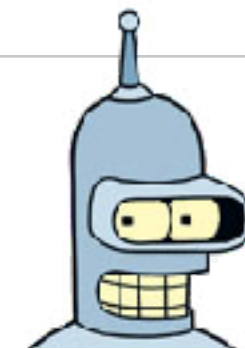
AI can categorise, too

- ❖ Artificial intelligence has sought to solve a similar problem in visual processing

- ❖ Deep neural networks (DNNs) can label images very accurately
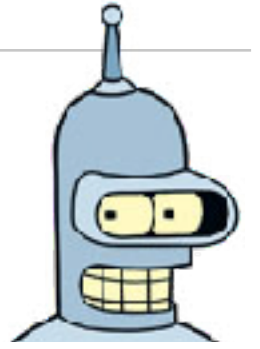
AI and neural convergence

❖ Correspondence has been found in terms of the *representations* employed by brains and DNNs
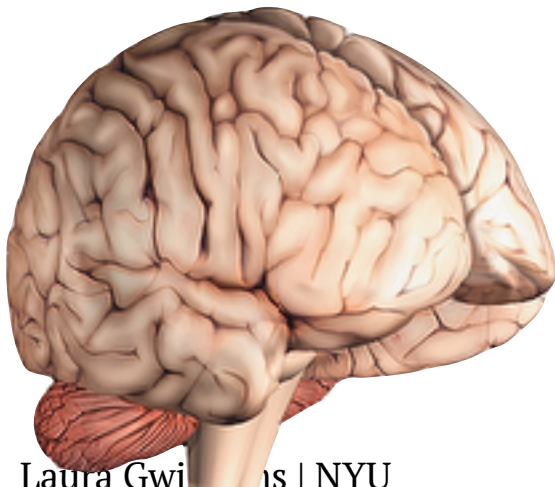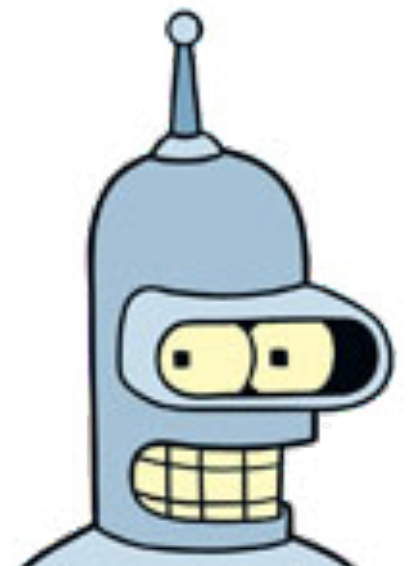
Yamins et al., 2014
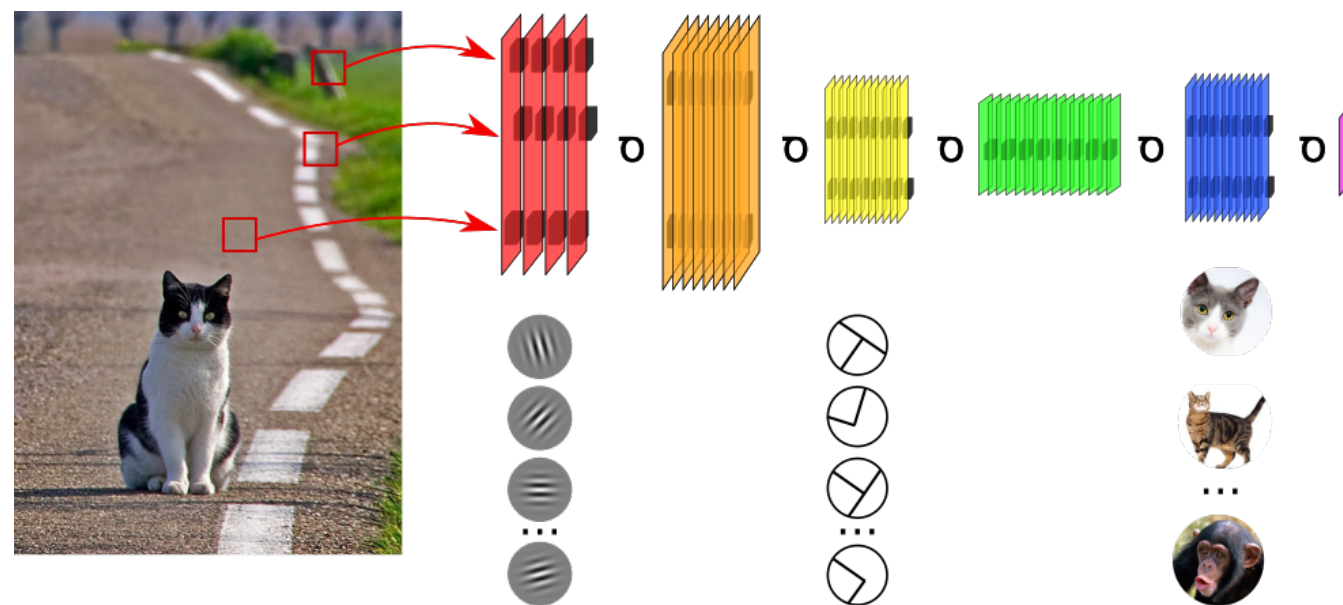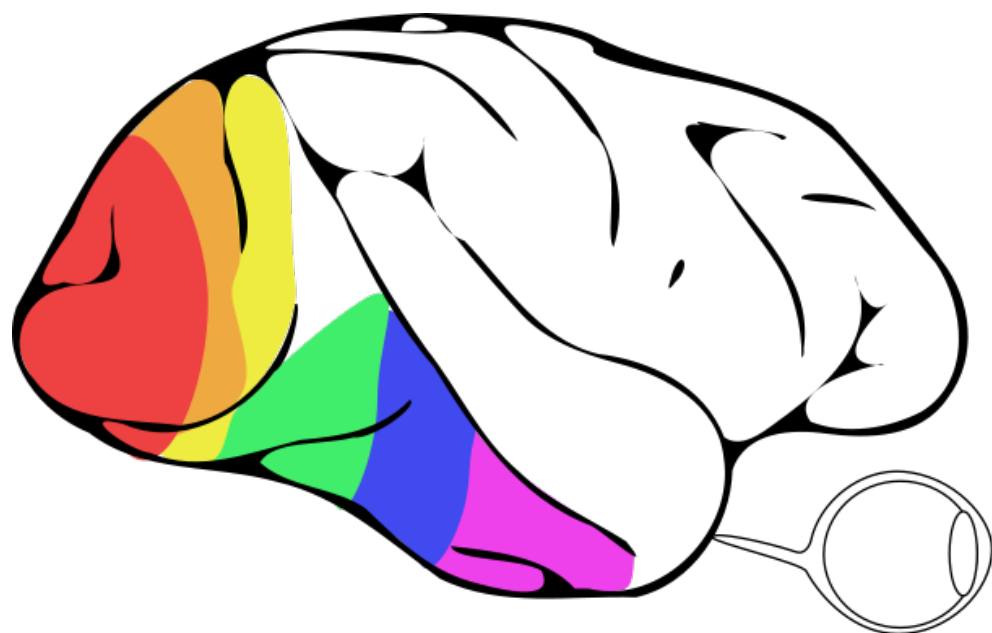
AI and neural convergence

❖ Not so surprising, given that aspects of DNNs are modelled on vision neuroscience

❖ There is more to characterising a system than simply knowing the representations it uses:

  ❖ Architecture

  ❖ Computation

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Research Question

What is the computational architecture of perceptual decision making?
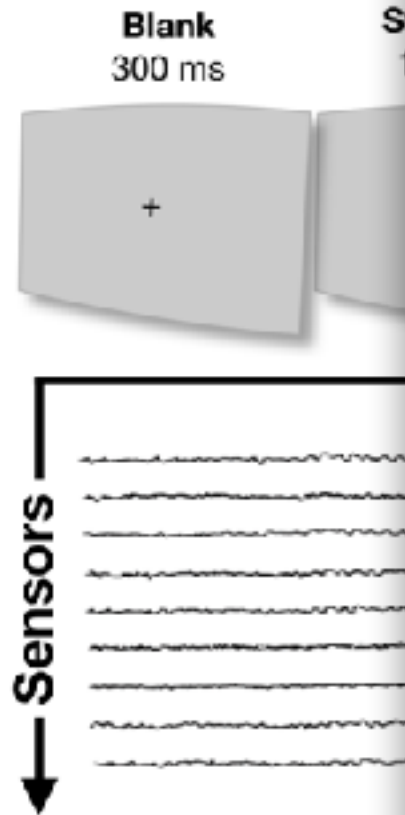
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Parallel Analysis

17 healthy adults
306 channel MEG

VGG19
19-layer CNN

$X =$

$Y =$

$\hat{Y} =$

$argmin_w \Sigma(L(WX, y)) + \lambda||w||^2$

Time / Layer

Correlation between y and ŷ

**

position 1.
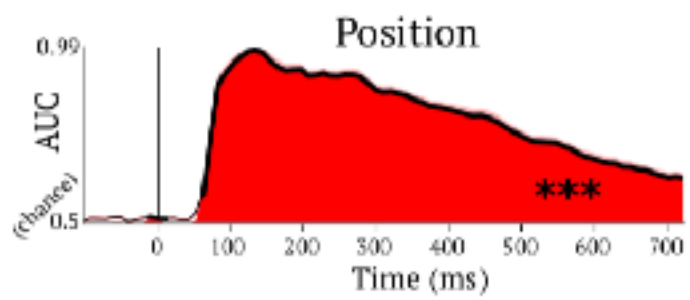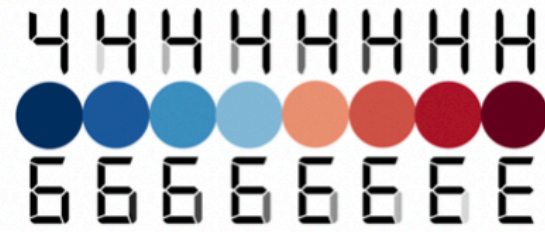
Laura Gwilliams | NYU
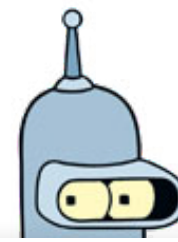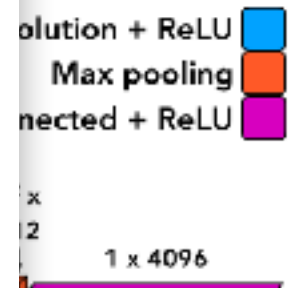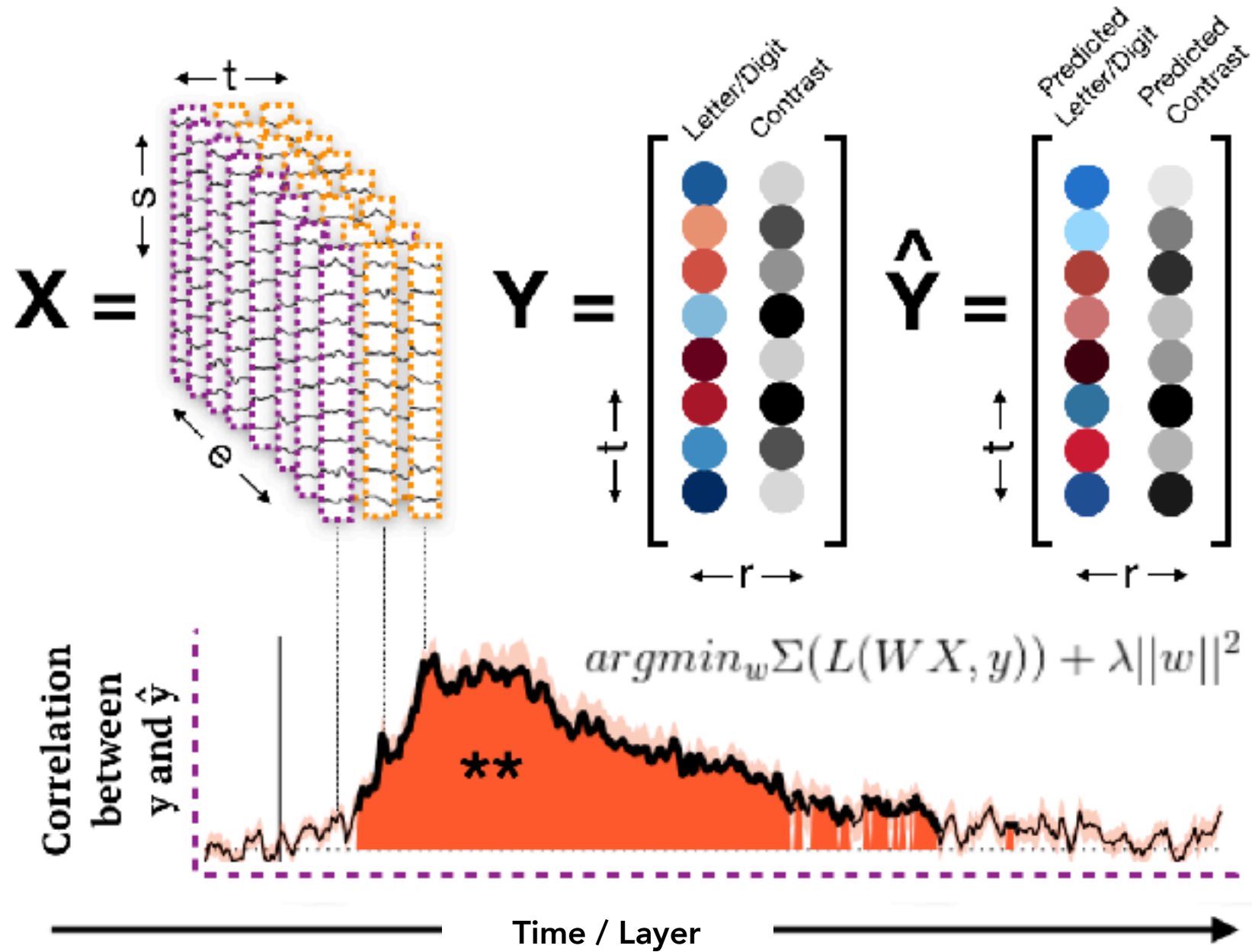
Question 1

How are processing stages organised — what is the architecture?

MEG
Decoding Scores

Position
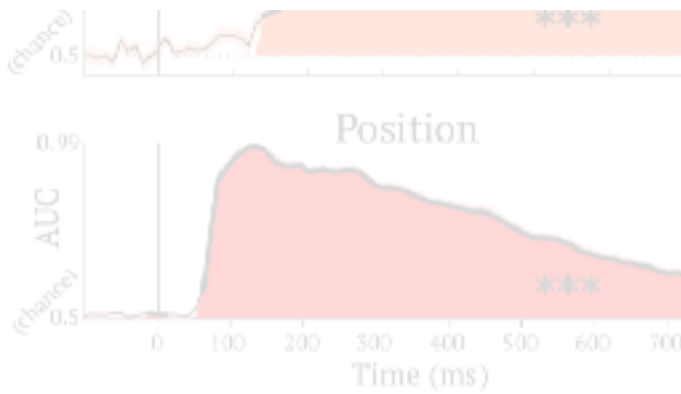
AUC

0.99

0.5

(chance)

***

0   100   200   300   400   500   600   700
Time (ms)

Laura G

MEG
Decoding Scores

Motor Side

AUC
0.87
0.5 (chance)
***

Confidence

R
0.15
(chance)
***

.2 .5 .58

0. .03 .06

***

Position

AUC
0.99
0.5
0.5 (chance)
***

.5 .75 1.
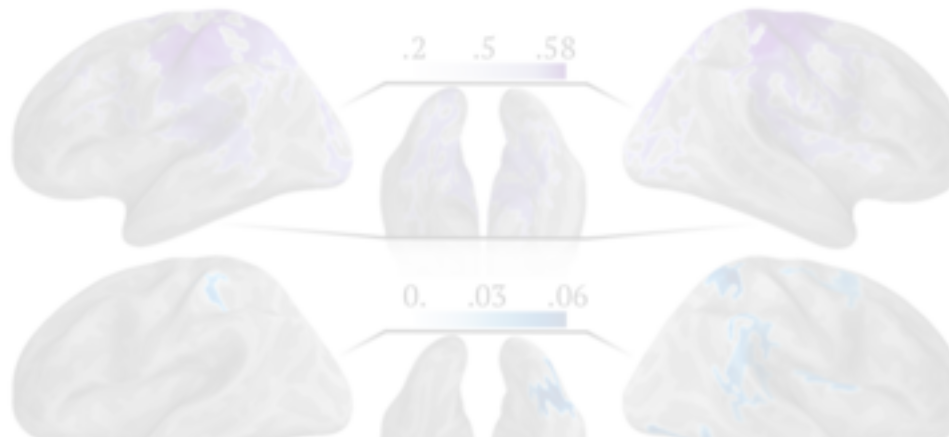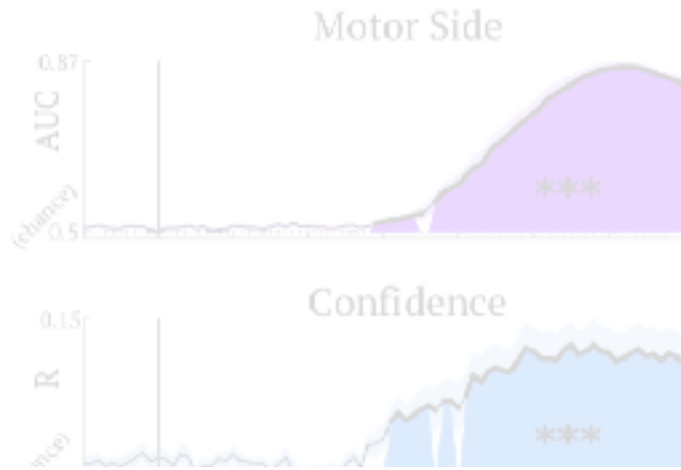
Time (ms)
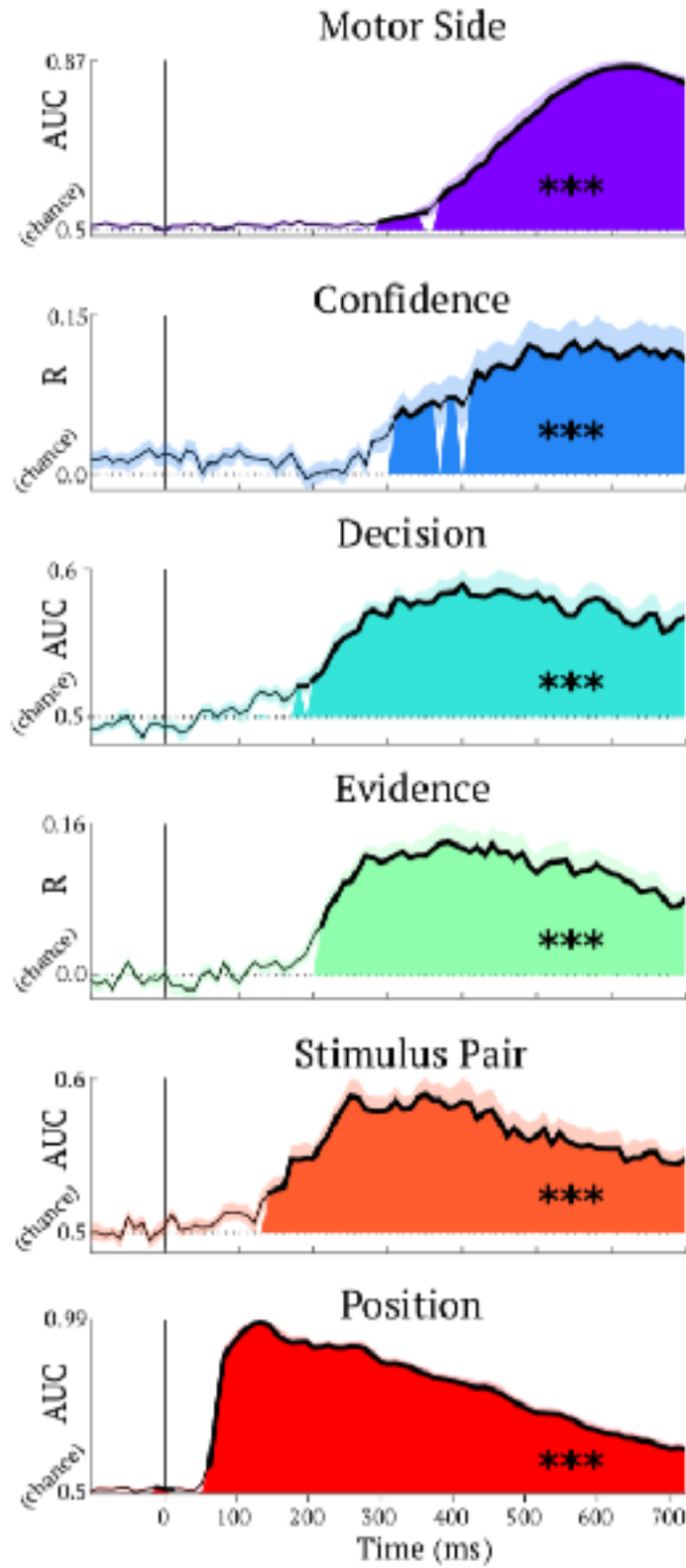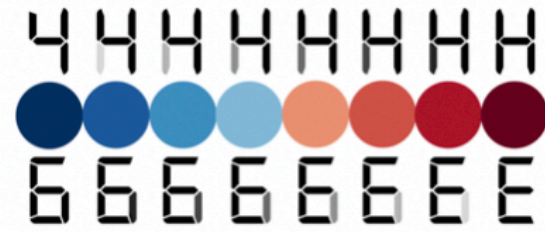0 100 200 300 400 500 600 700

Laura G

MEG Decoding Scores

Laura G
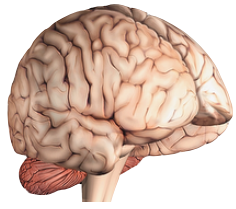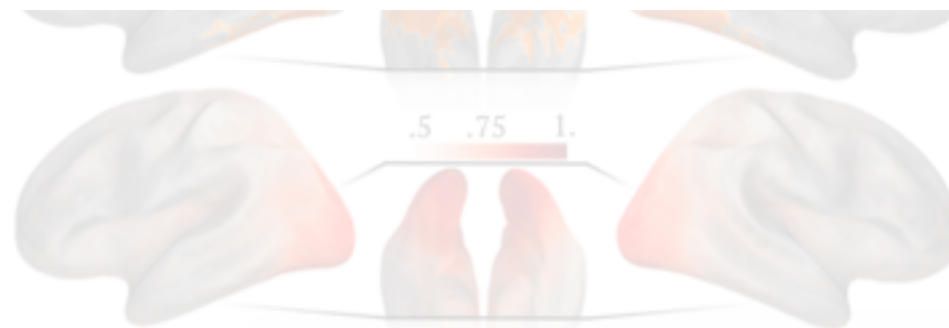
MEG
Decoding Scores

DNN
Decoding Scores

Motor Side

Confidence

Decision

Evidence

Stimulus Pair

Position

Correct Category

Laura G
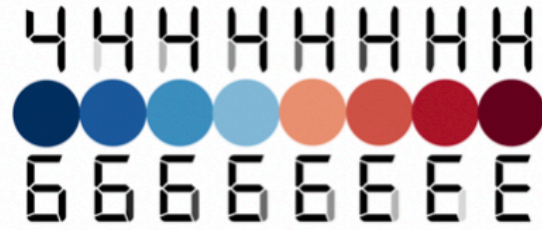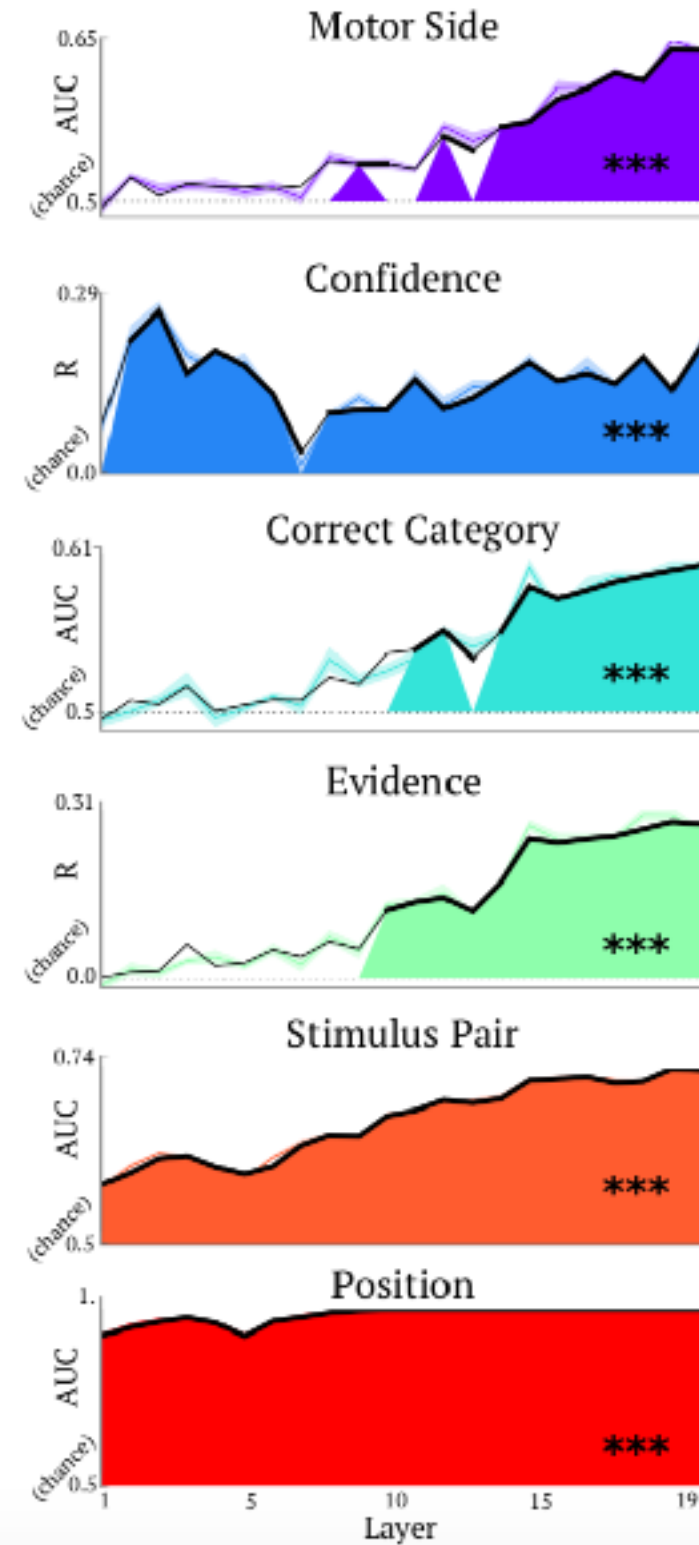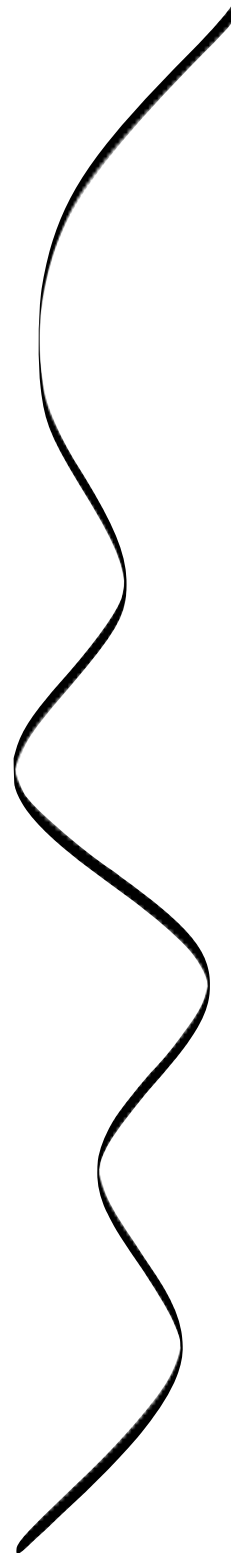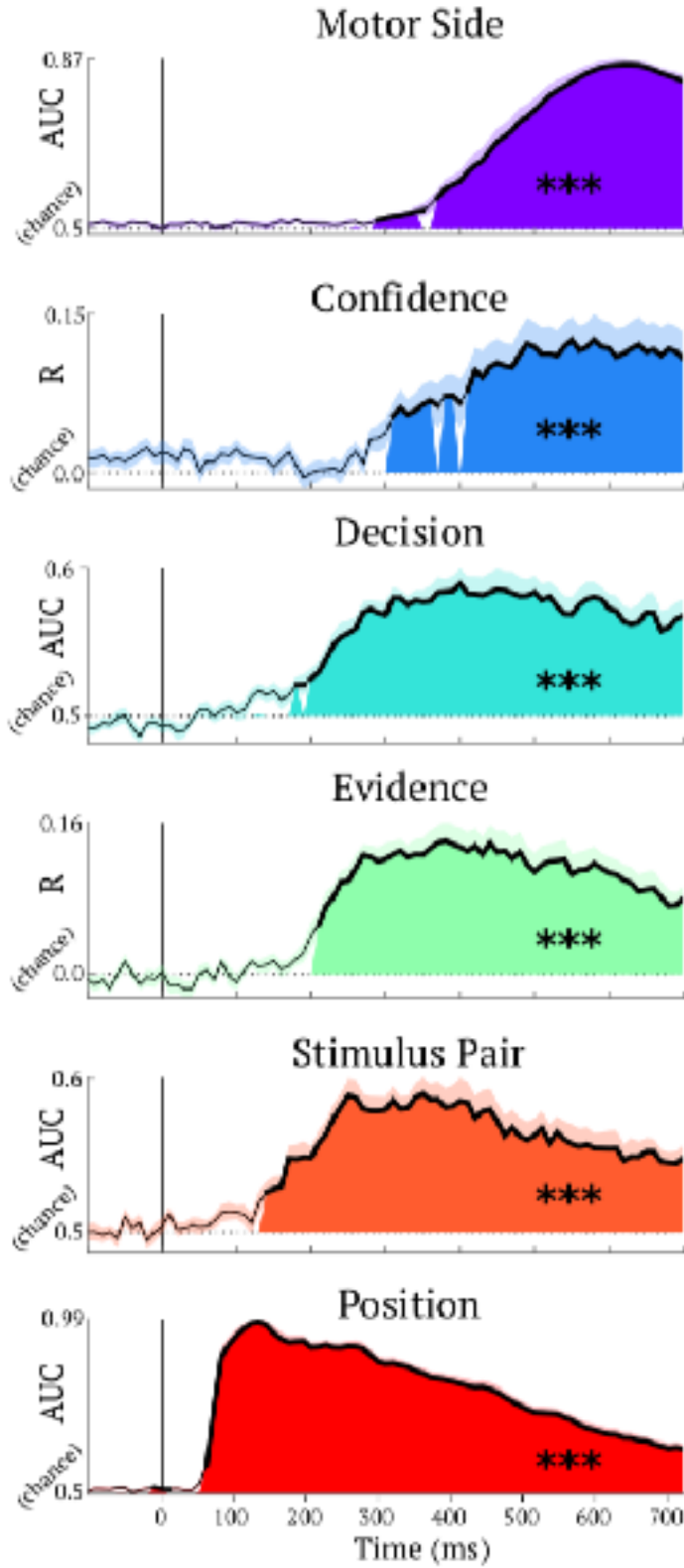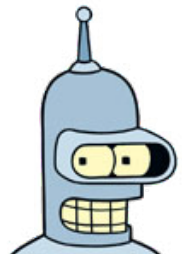
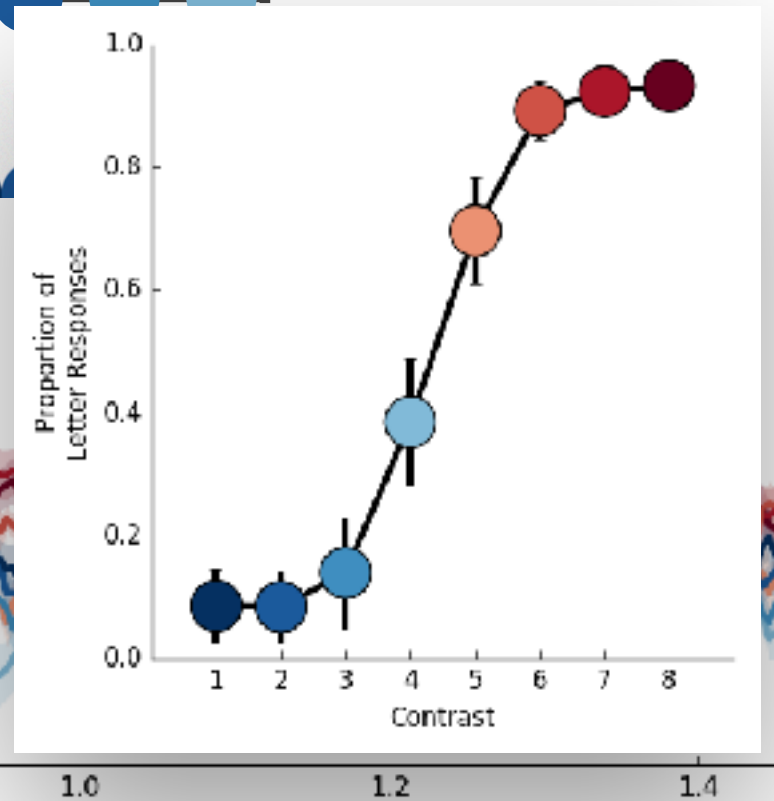# Question 2

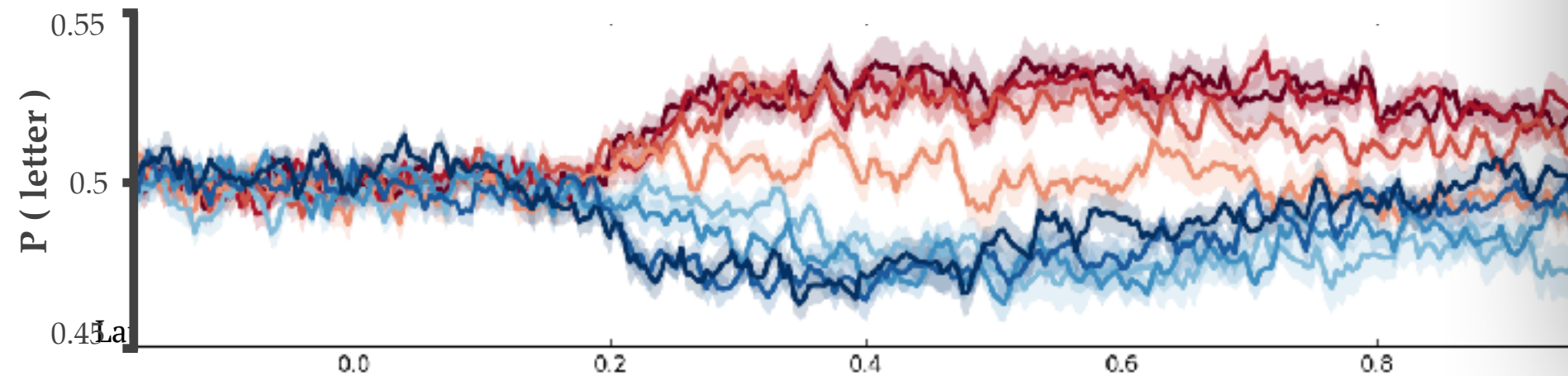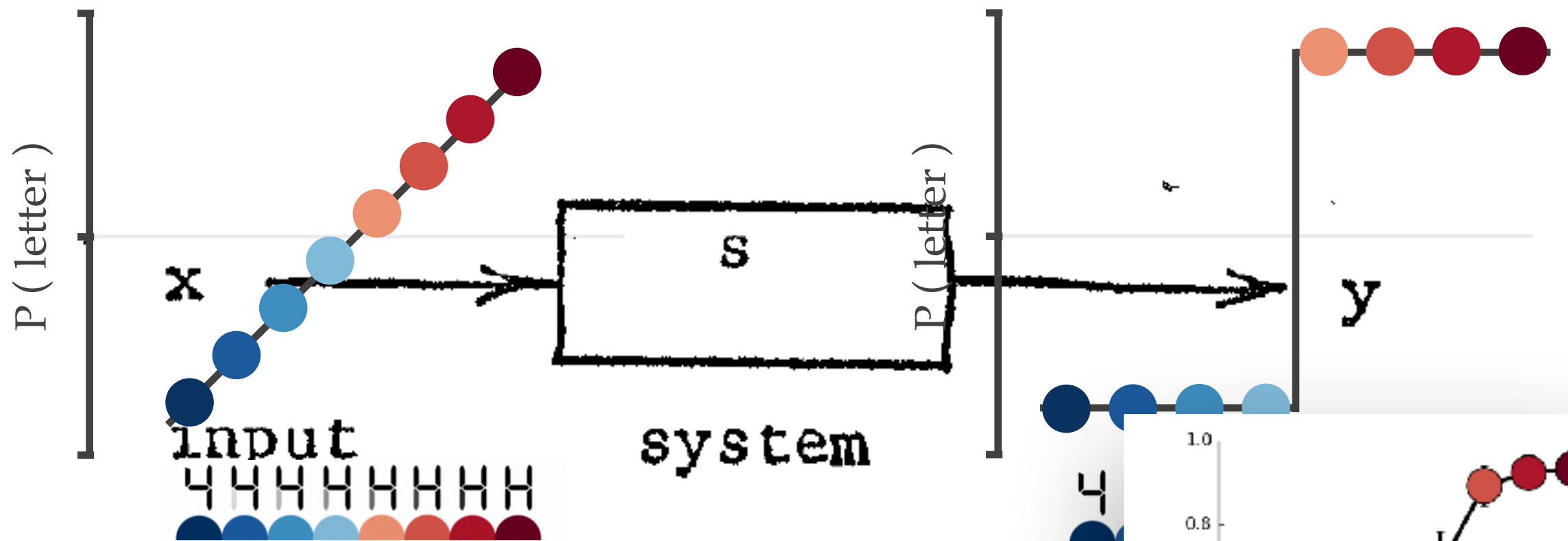# What are the underlying computations?

What are the underlying computations?
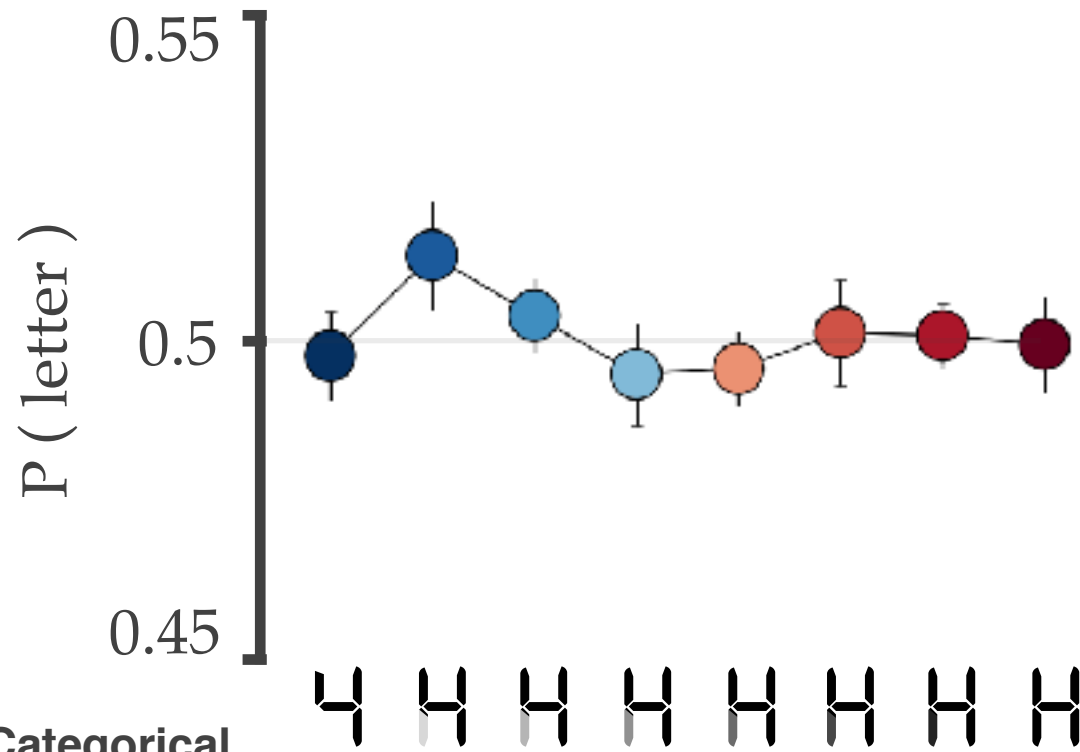

Linear Evidence

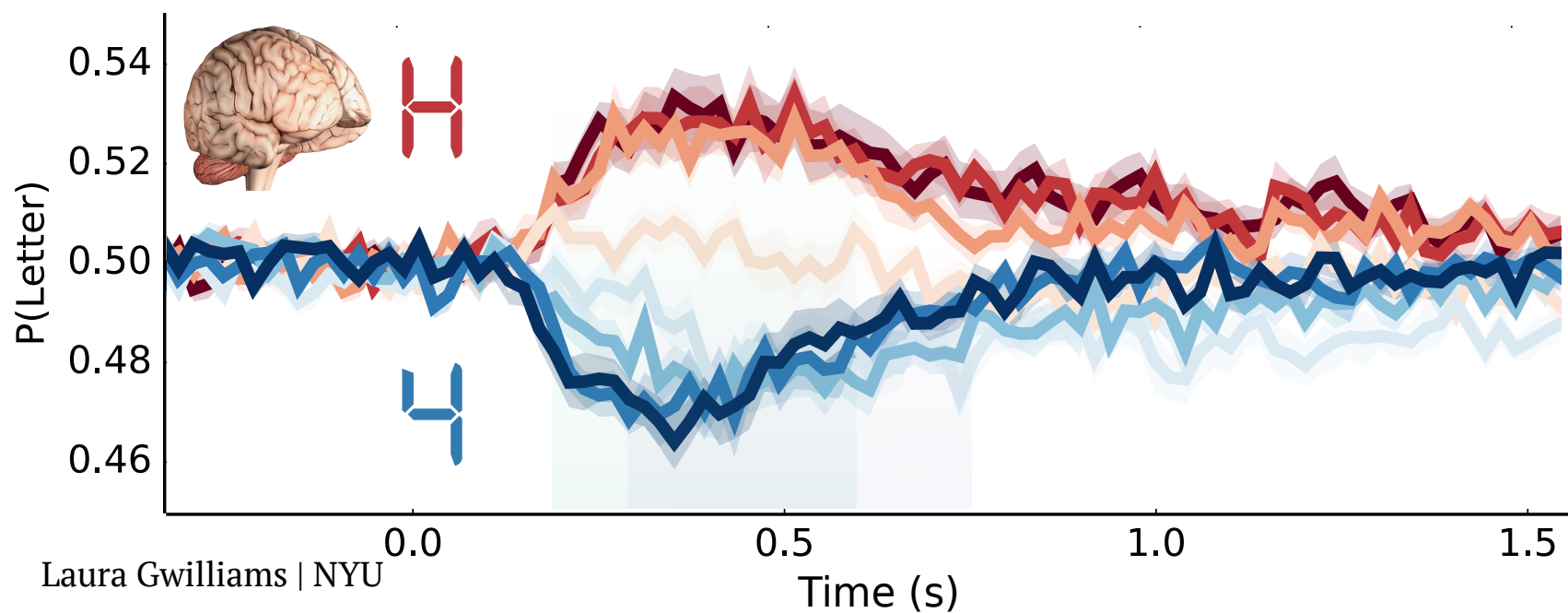**Categorical Percept**

What are the underlying computations?

What are the underlying computations?

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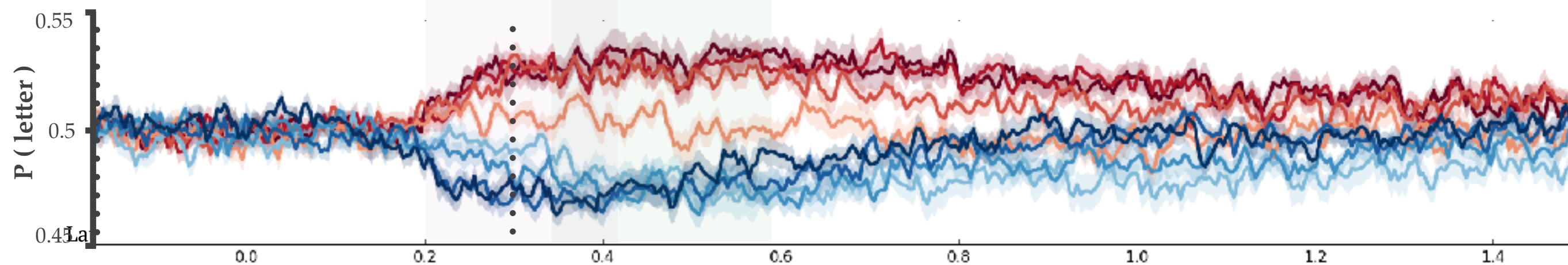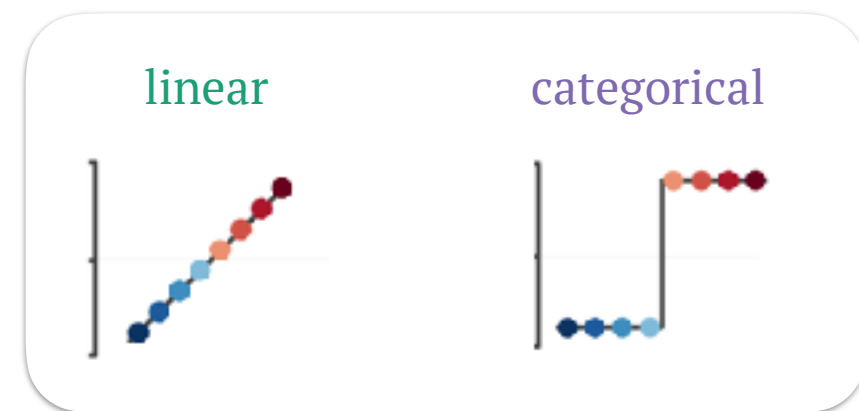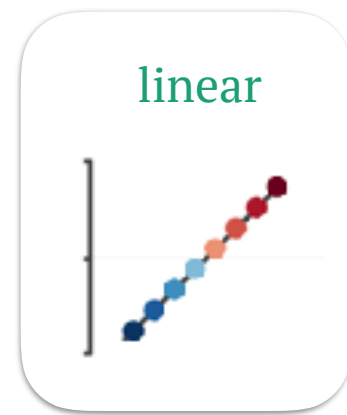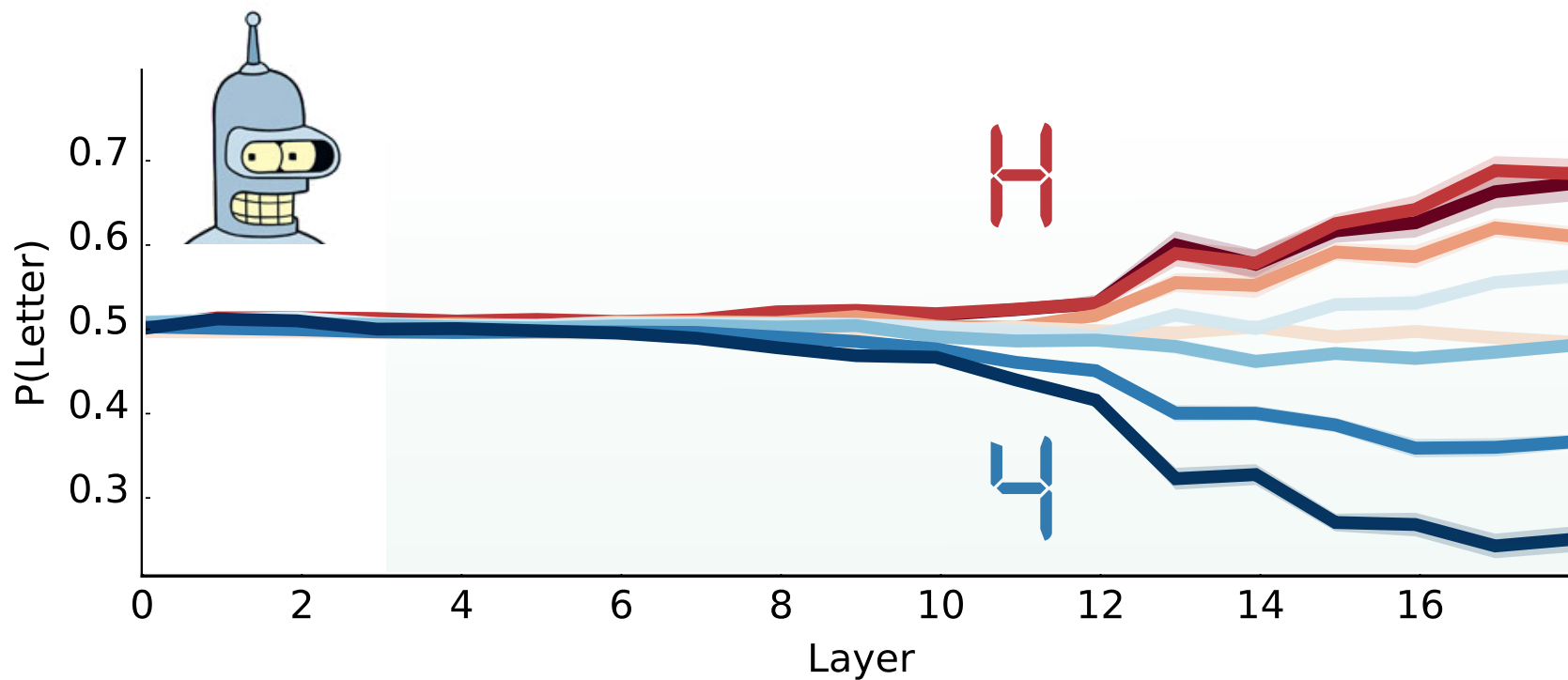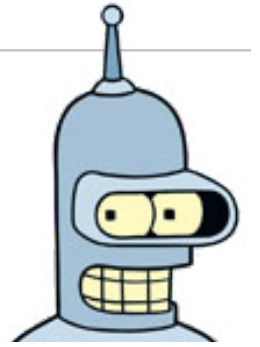
Conclusions

- We replicate the finding that hierarchical representations converge between biological and artificial NNs

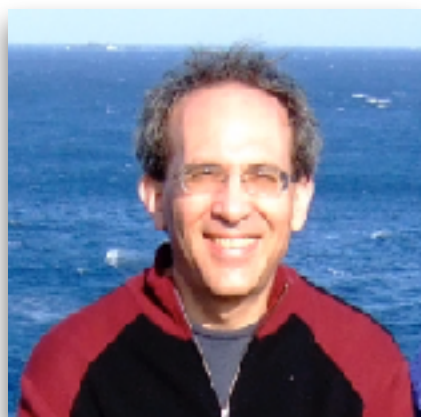- **Performance-optimised models only partially predict neural responses during perceptual decision making**

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With big thanks to:

@GwilliamsL

- Collaborator **Jean-Rémi King**

- My supervisors, **Alec Marantz** and **David Poeppel**, and everyone in the **Neuroscience of Language Lab** and **Poeppel Lab**!

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