



Berkeley
UNIVERSITY OF CALIFORNIA

Representations in development

Celeste Kidd (celestekidd@berkeley.edu)

Psychology, University of California, Berkeley

 @celestekidd

Representations Past, Present, and Future Meeting
Trinity College Dublin, 14 May 2022





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We have a lot left to understand about the composition of conceptual representations.

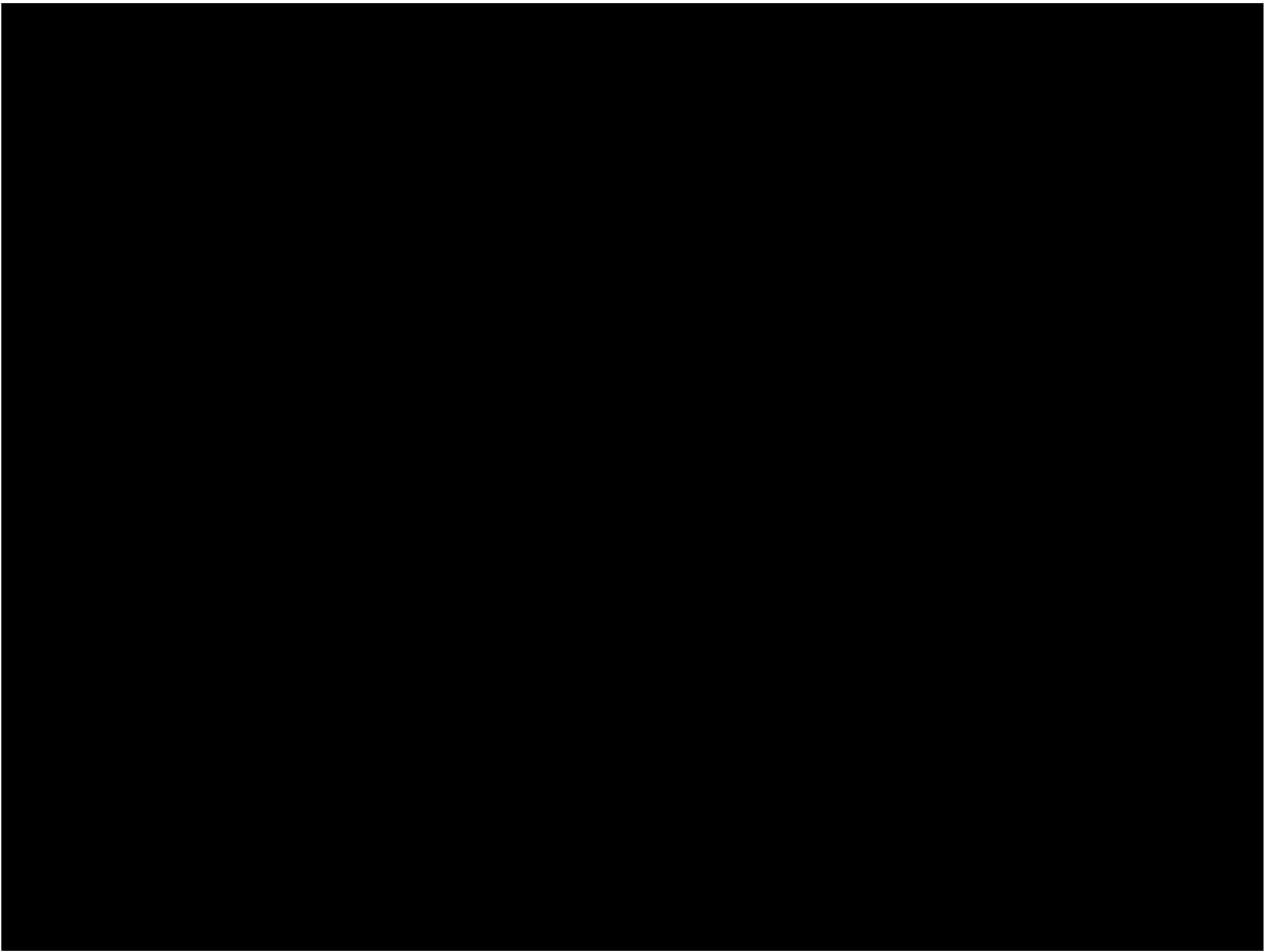
Children's representations
are flexible in ways AI
systems' are not.





I can't really describe the picture but I do see indoor, table, sitting.





<https://photos.app.goo.gl/W5LgXpiPRxb6ycJU7>

User:

Flamingo: This is a sculpture of a fish riding a bicycle.

User: Where is it located?

Flamingo: It is located in a museum in the United Kingdom.

User: Which one?

Flamingo: I am not sure.

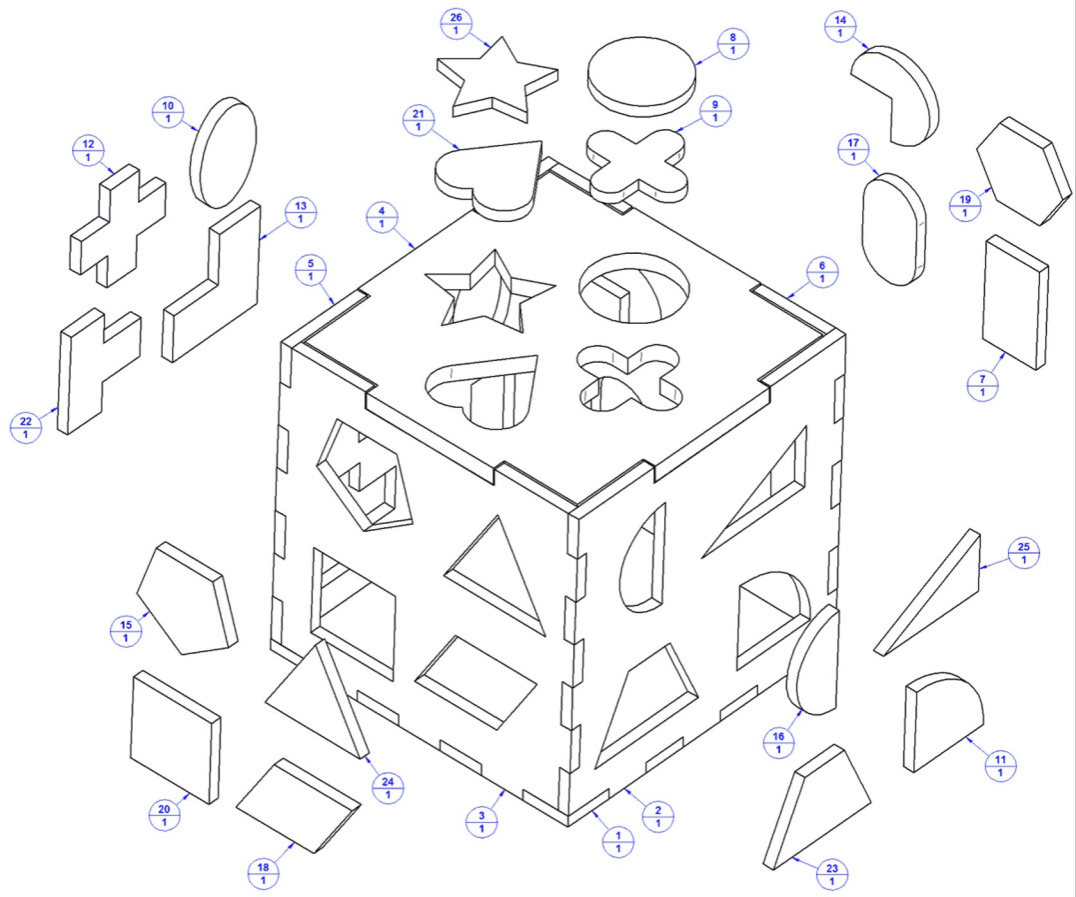
User: Are you sure it's in the United Kingdom?

Flamingo: I am not sure.

(Thank you, Murray.)

1.

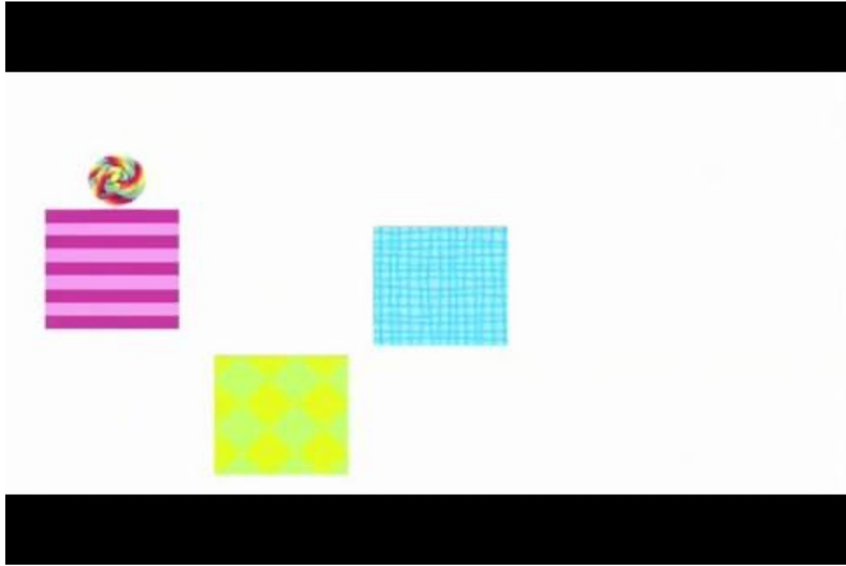
1. Representations
build over time,
starting in infancy.











Kidd et al., *PLOS ONE*, 2012, *Developmental Science*, 2014; Kidd & Hayden, *Neuron*, 2015

A A B A ^{next} ?



Observations

$$\left(\prod_{i=1}^3 p_i^{c_i} \right)$$

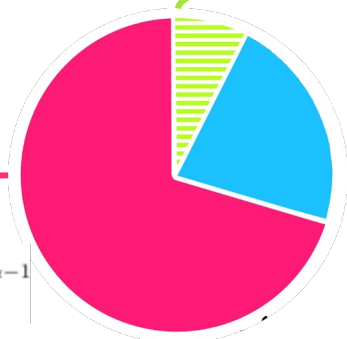
A B C



Prior belief

$$\left(\prod_{i=1}^3 p_i^{\alpha-1} \right)$$

$$\prod_{i=1}^3 p_i^{c_i + \alpha - 1}$$



Updated belief

A

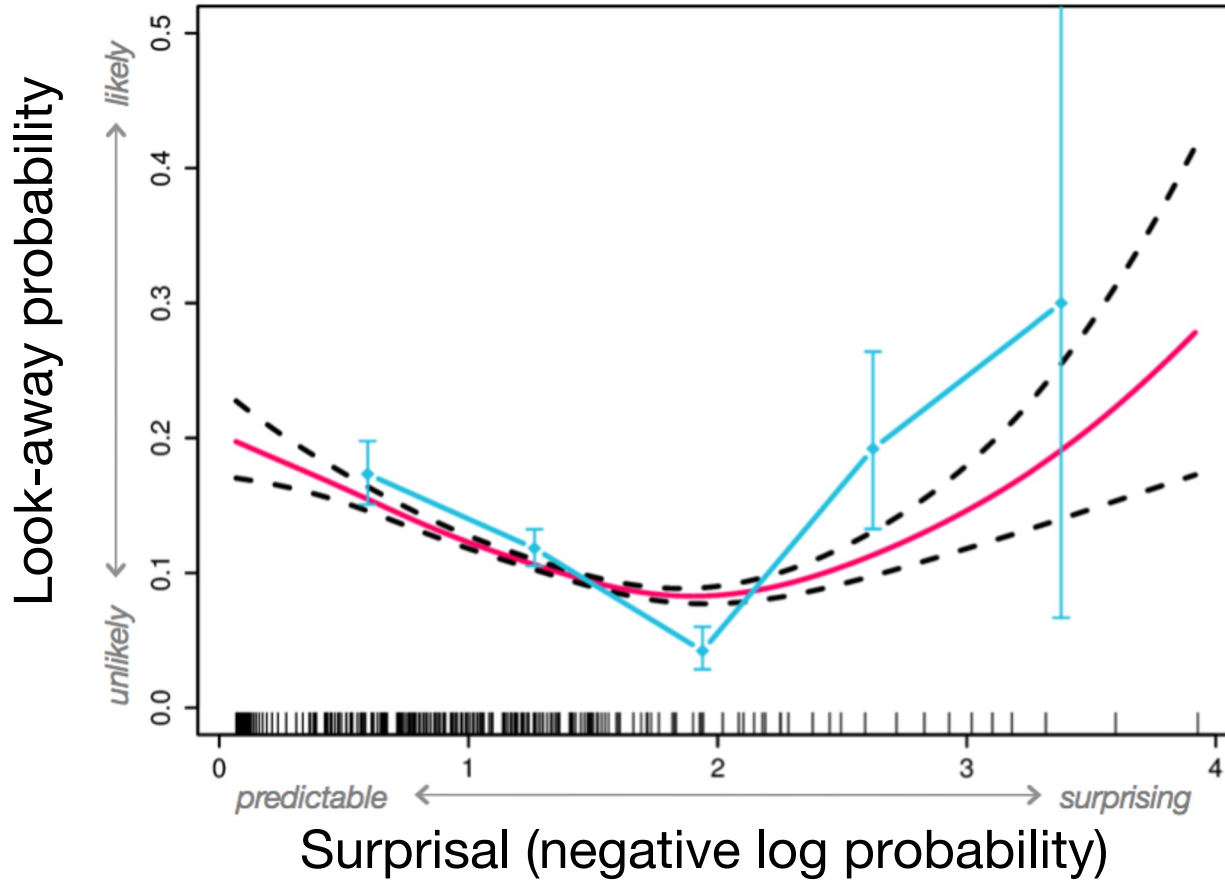
B

C

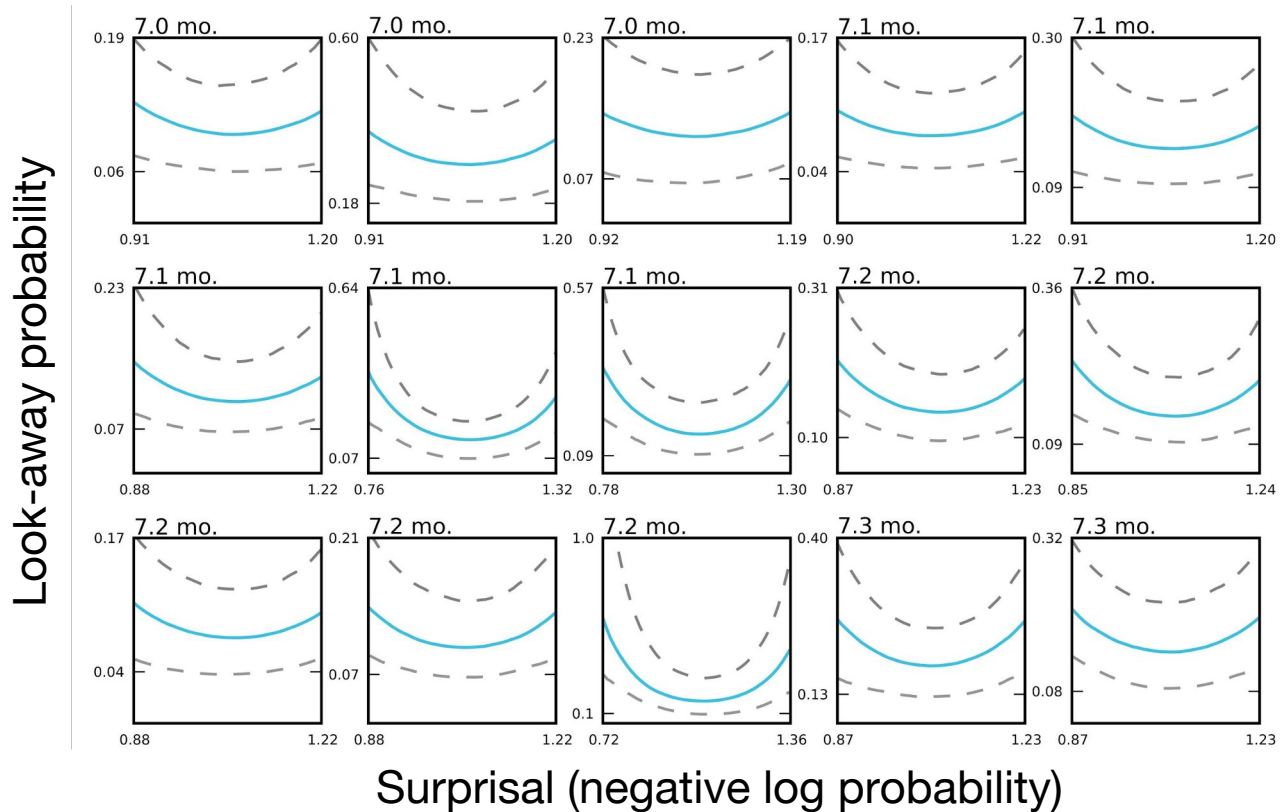
more expected

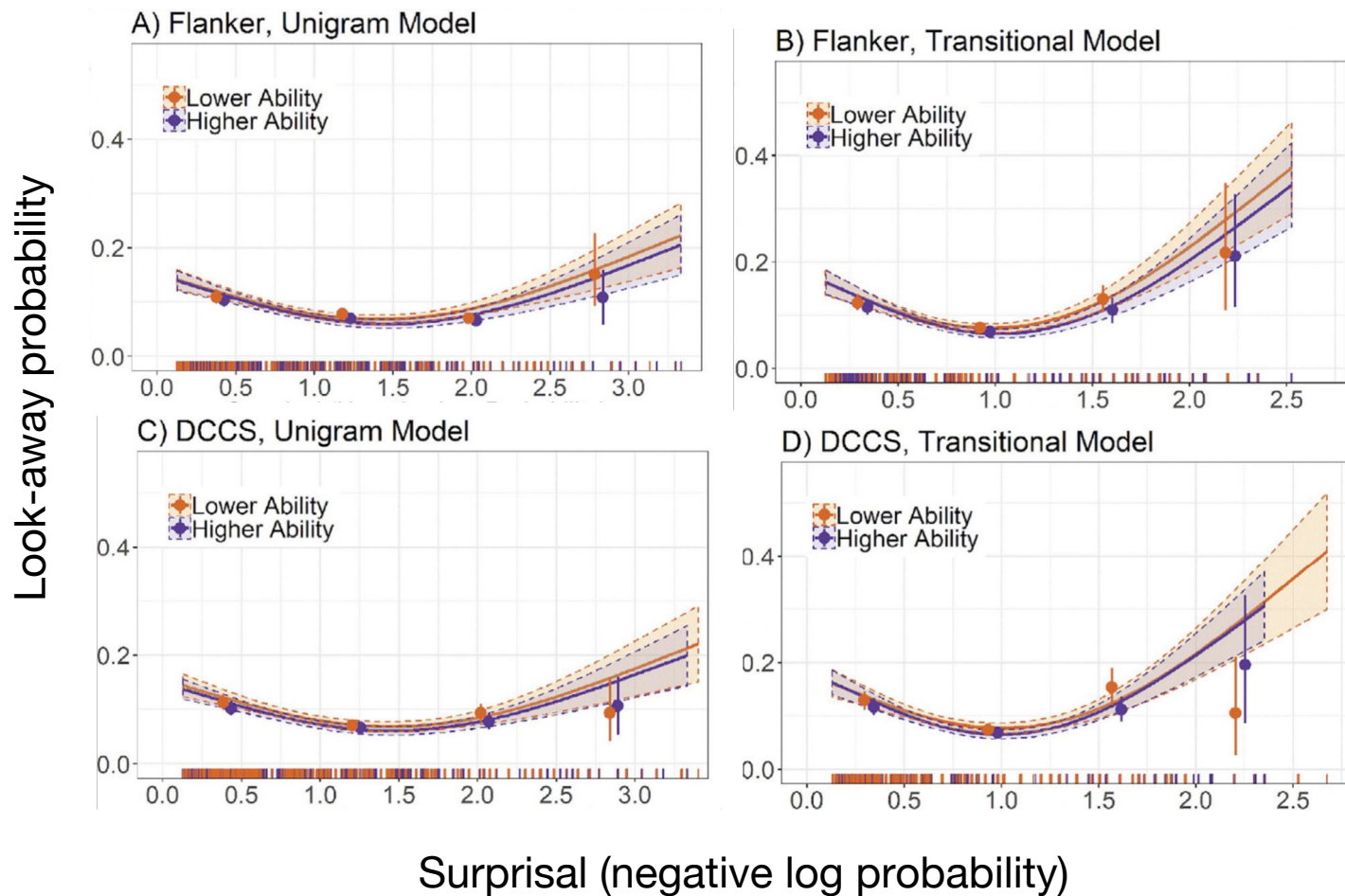
Surprisal (-log prob)

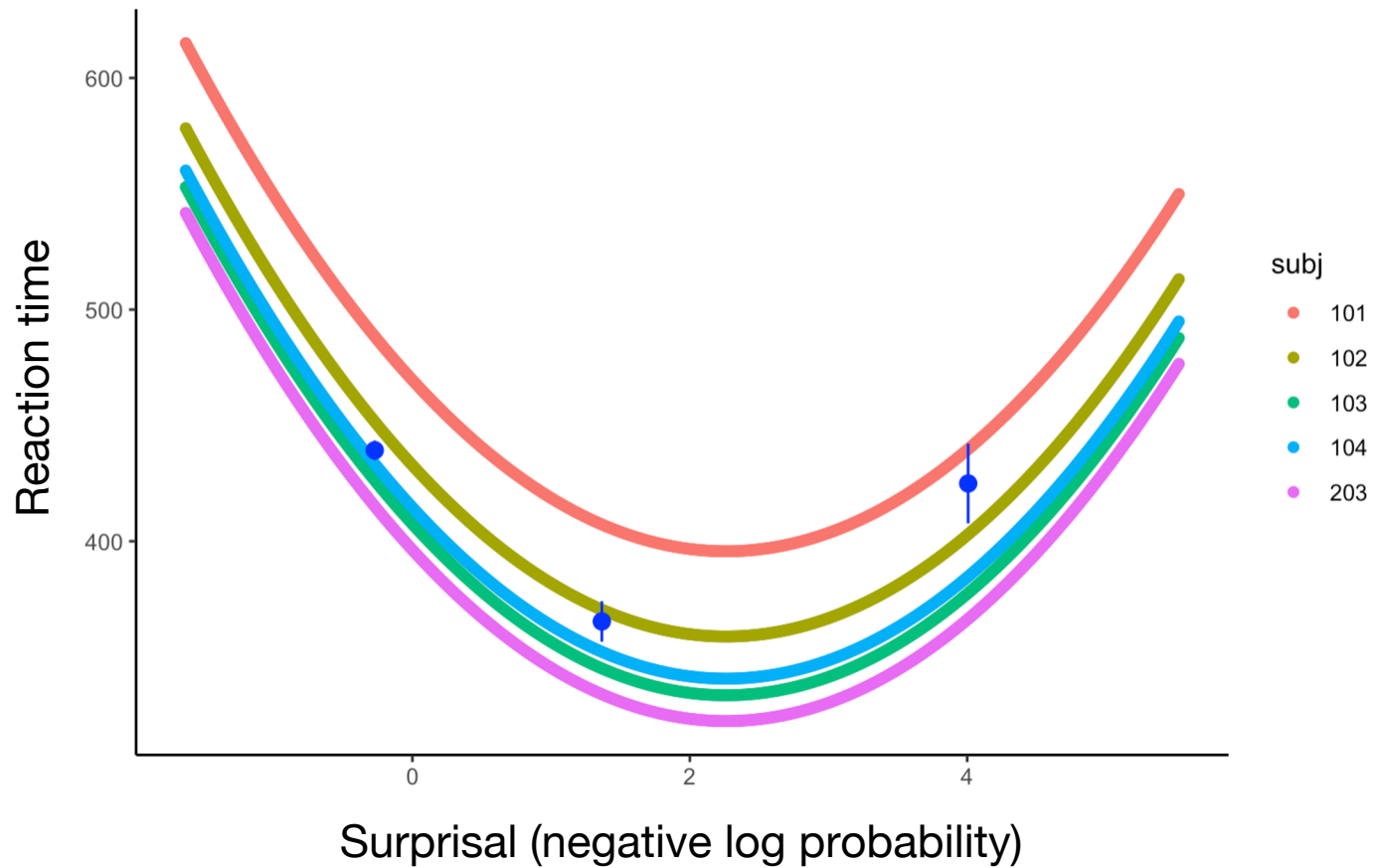
more surprising



Kidd, Piantadosi, & Aslin, *PLOS ONE*, 2012; Kidd & Hayden, *Neuron*, 2015







2. Representations are continuously updated inferences.



Hemmer & Steyvers, *Psychonomic Bulletin & Review*, 2009























3. Representations vary substantially.

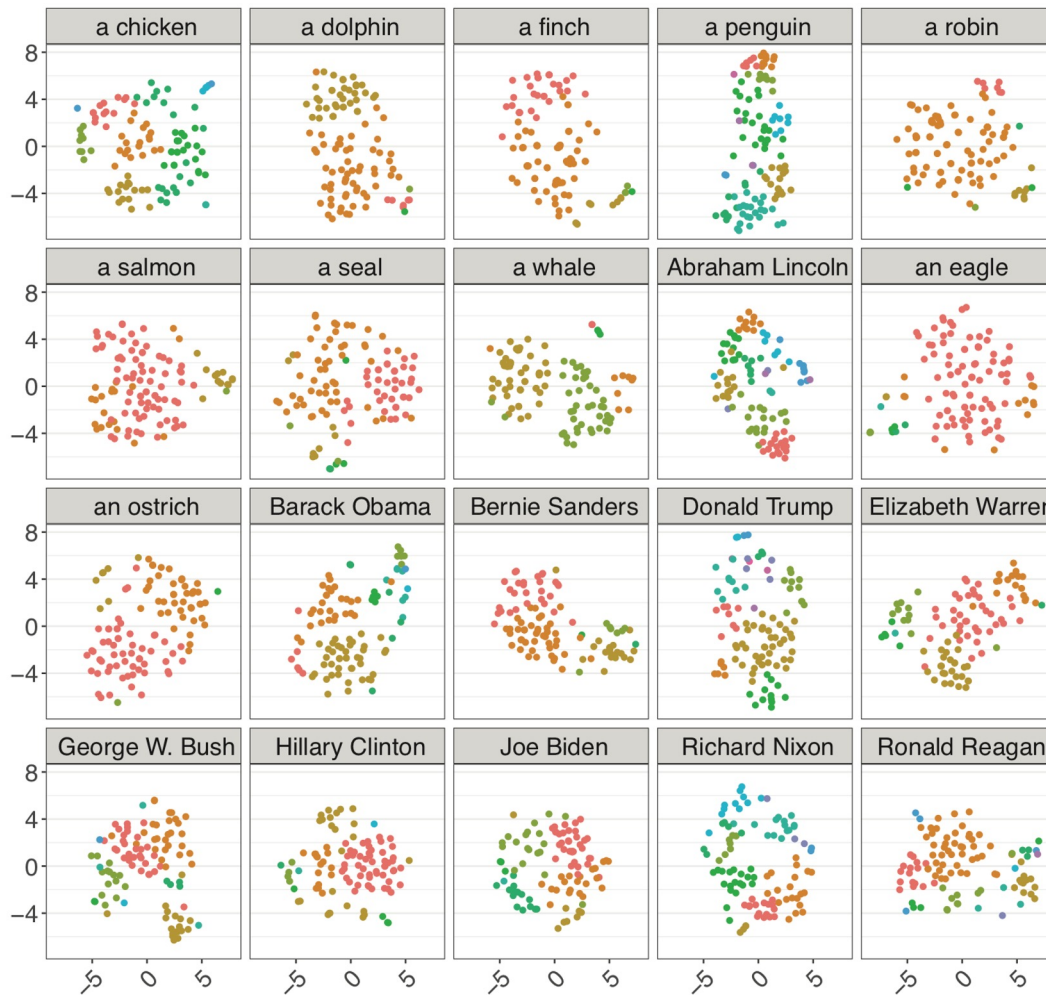


Which is most similar to a
CHICKEN?

penguin
whale

Who is most similar to DONALD TRUMP?

Abraham Lincoln
Richard Nixon



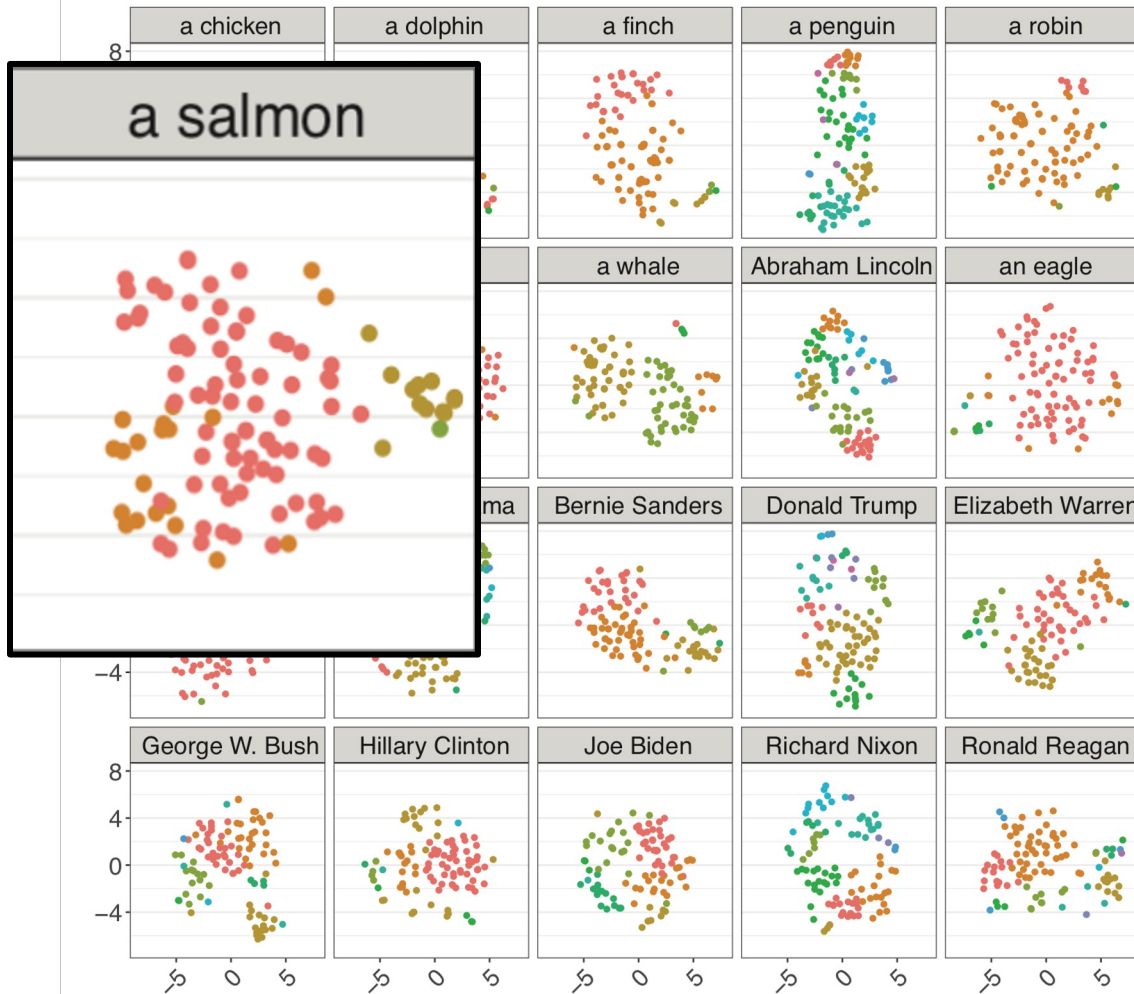
Table

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12



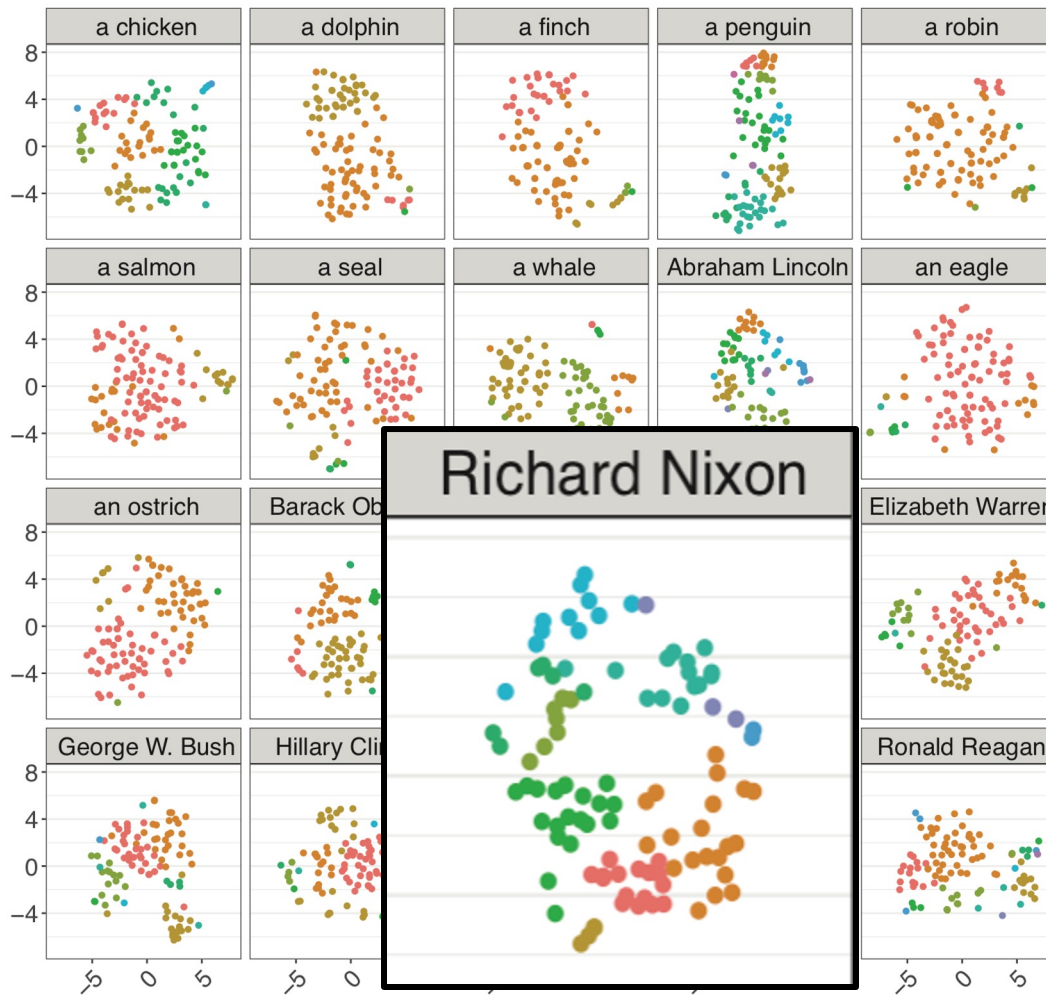
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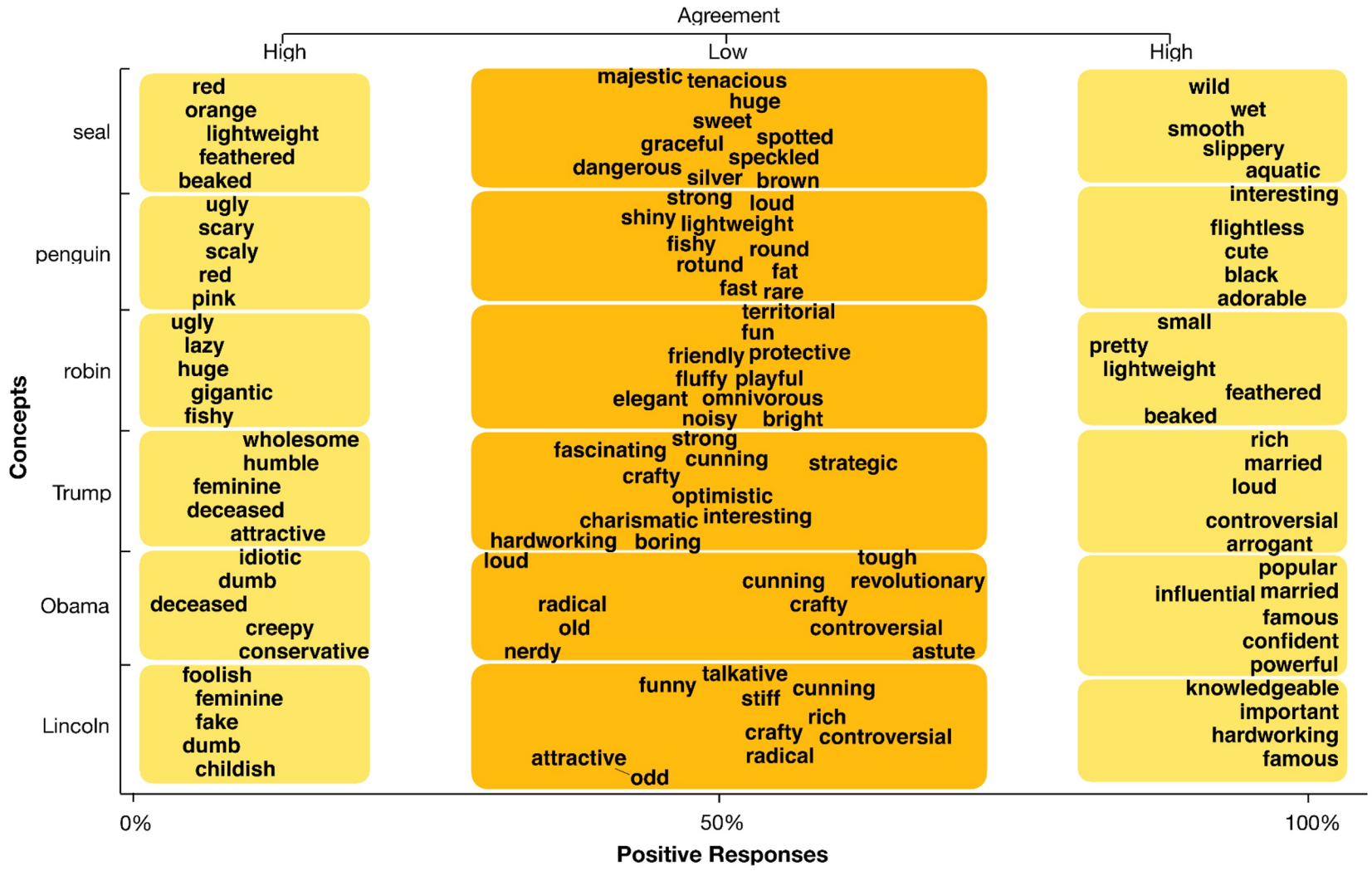
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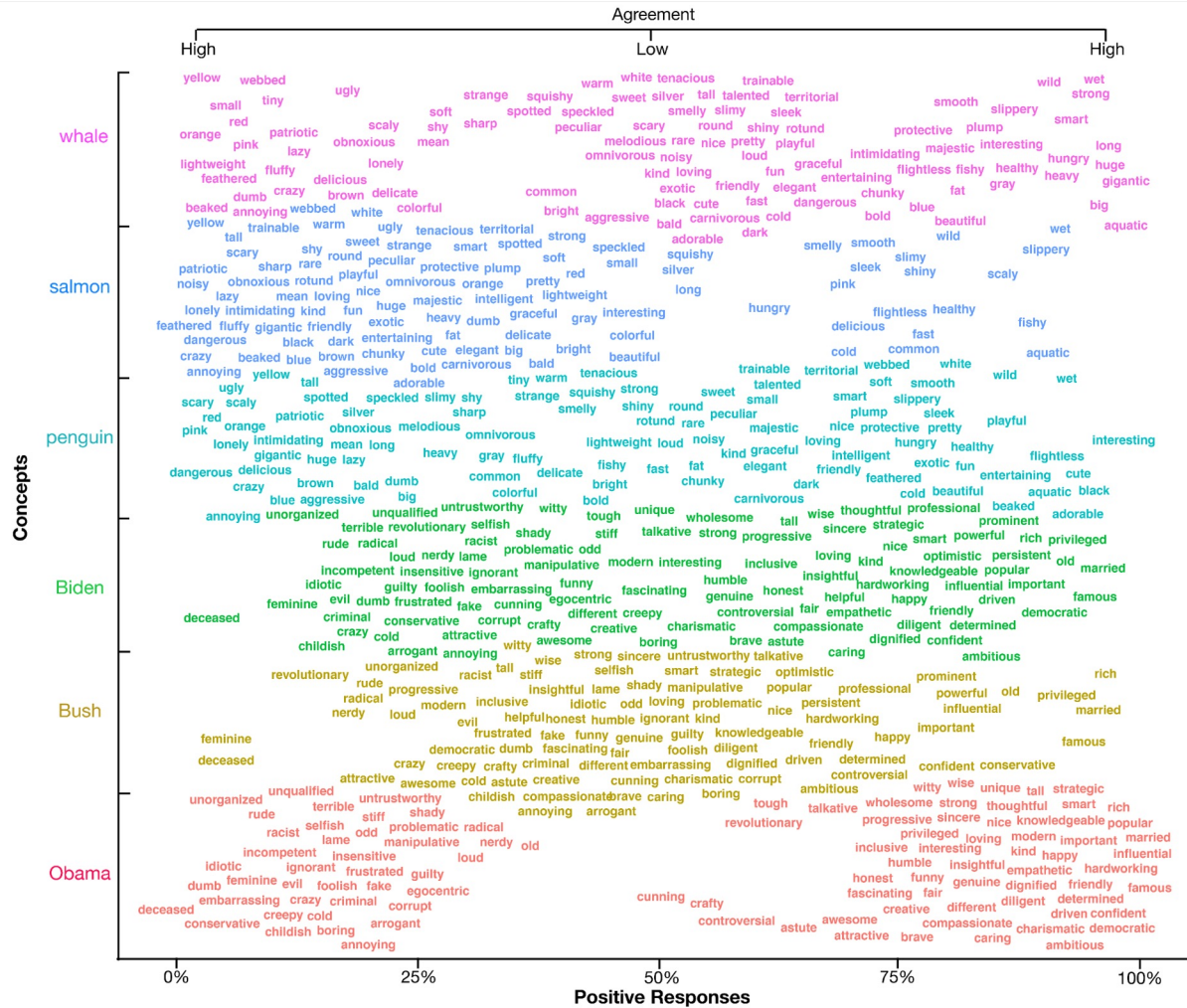
Table

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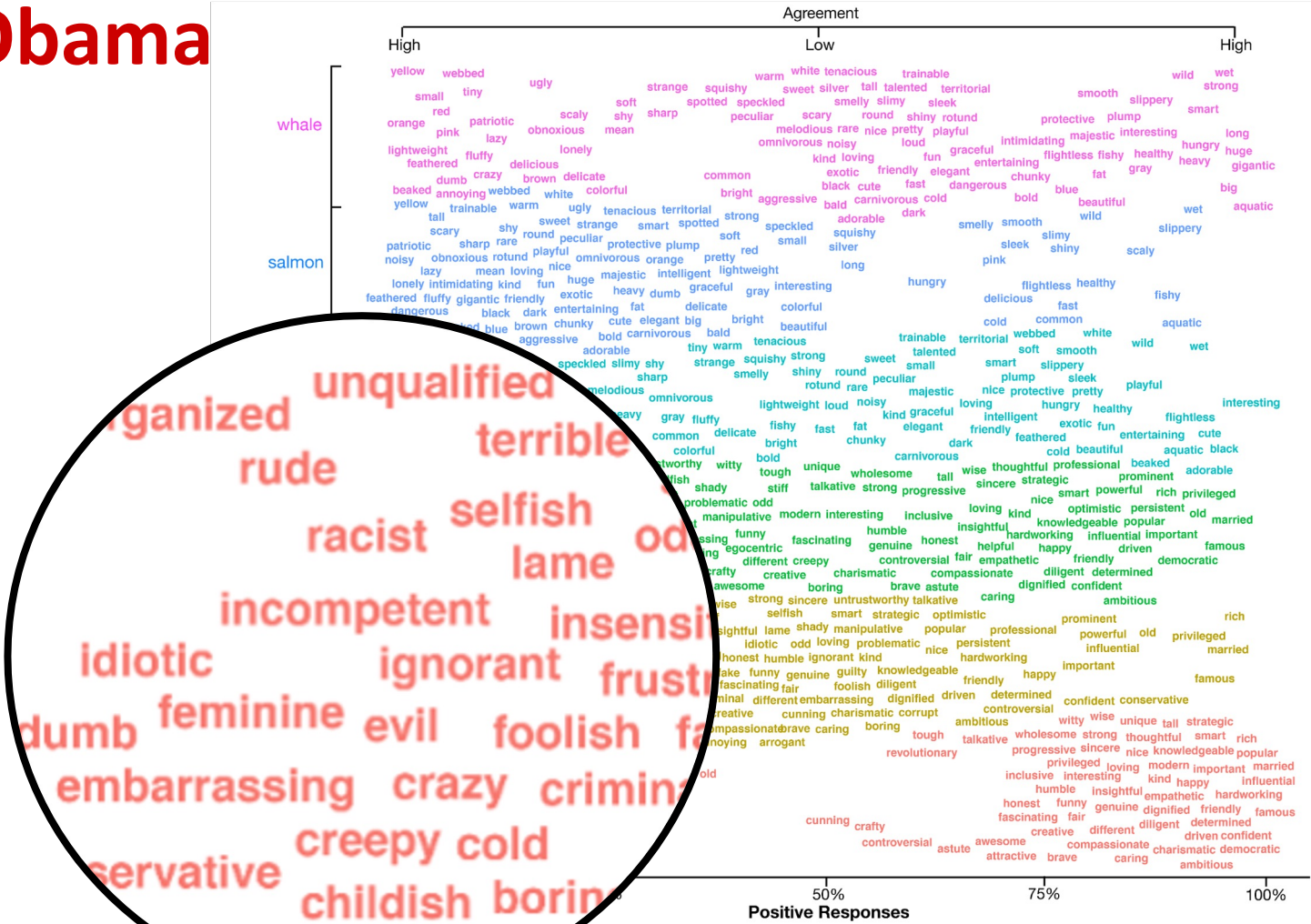




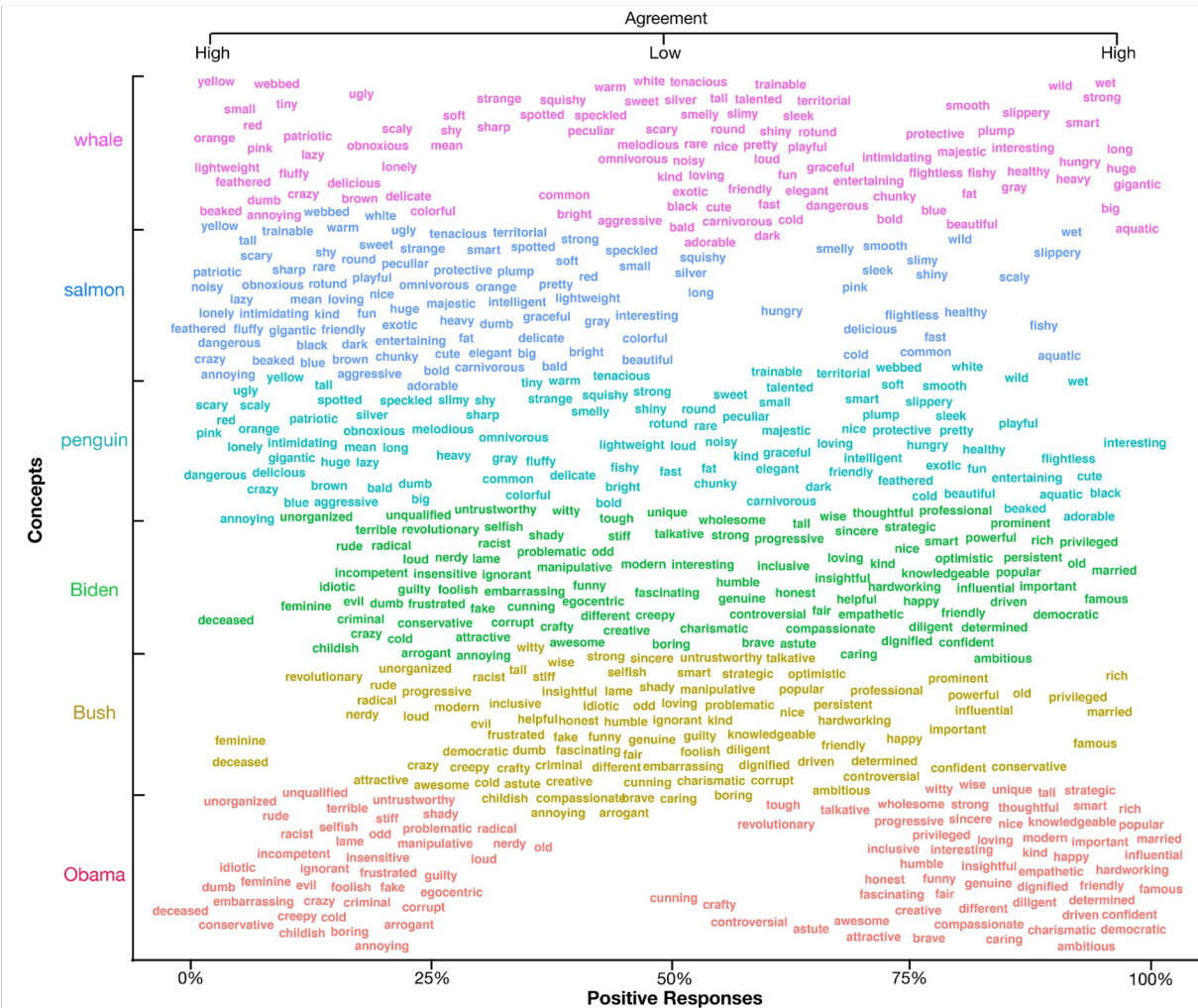
Obama



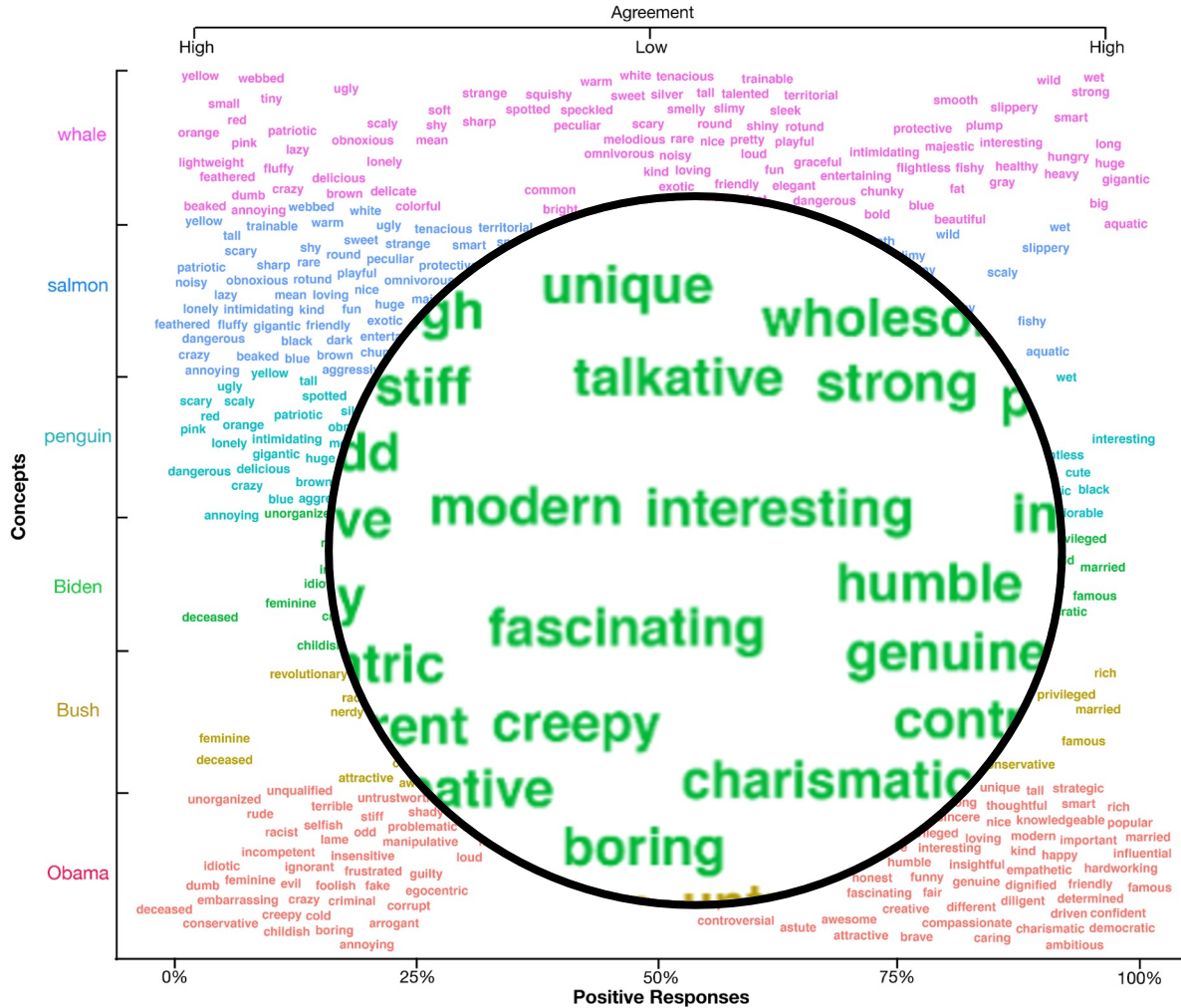
Obama

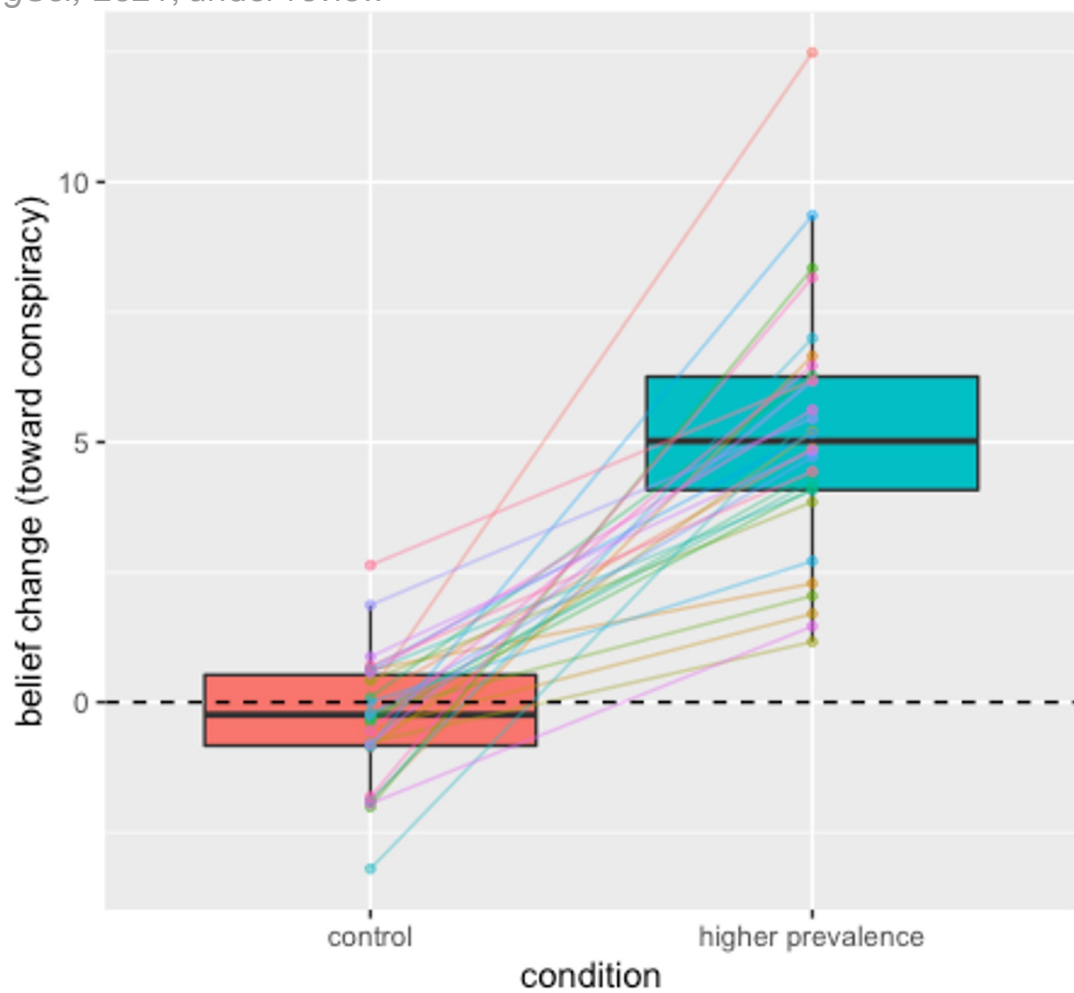


Biden



Biden





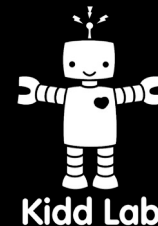
3 claims about representations

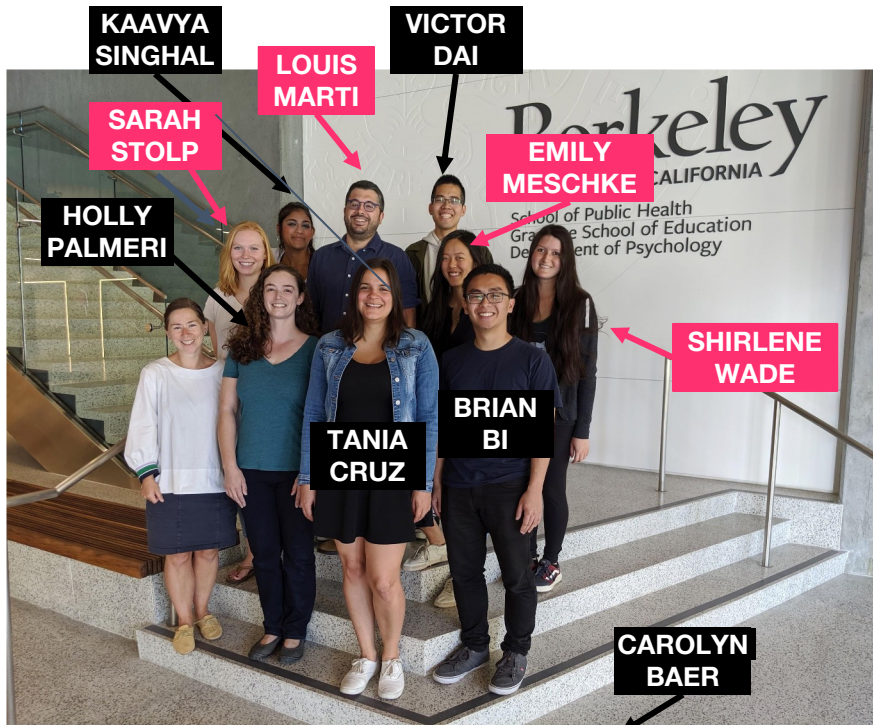
1. Representations build over time.
2. Representations are continuously updated.
3. Representations vary substantially.

Thank you



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DAVID O'SHAUGHNESSY



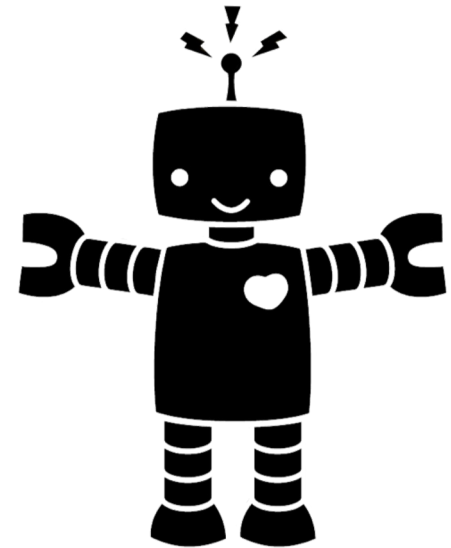
ADAM CONOVER



EVAN ORTICIO



SHENGYI WU



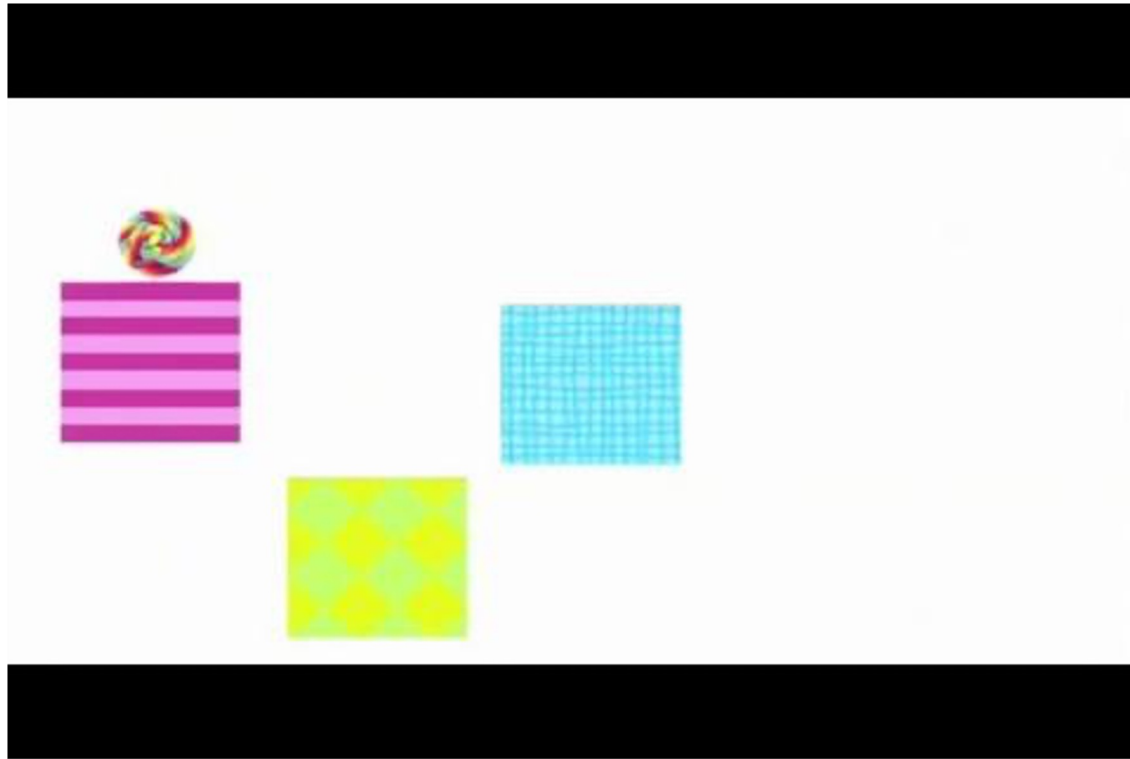
Kidd Lab

@ University of California, Berkeley

Also: **Laura Cubit**, **Ben Hayden**, **Steve Piantadosi**, **Richard Aslin**, **Louisa Benetto**, **Frank Mollica**, Andy Smart, & Alison Gopnik

Representations can
differ substantially
from reality.

We have very little
idea what conceptual
representations look
like in humans.



Kidd et al., *PLOS ONE*, 2012, *Developmental Science*, 2014; Kidd & Hayden, *Neuron*, 2015