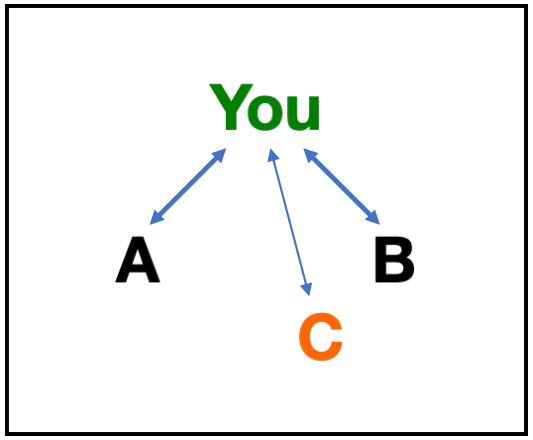
Latent Structure Learning in Anterior Insula

Tatiana Lau

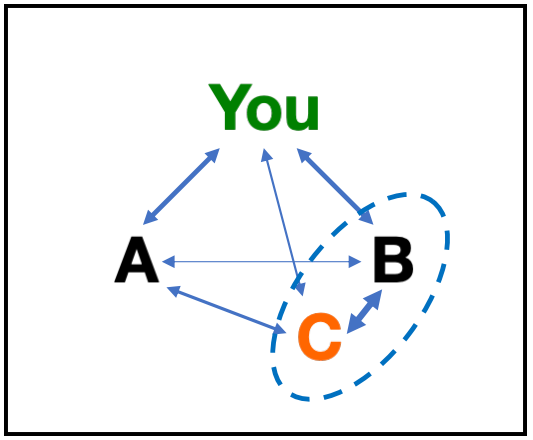
Previous research focused on explicit, single groups

Amodio (2014), Ito & Bartholow (2009), Kubota, Banaji, & Phelps (2012), Golby, Gabrieli, Chiao, Eberhardt (2001), Hart et al. (2000), Cikara & Van Bavel (2014)

How do we gather information to infer “us” and “them”?

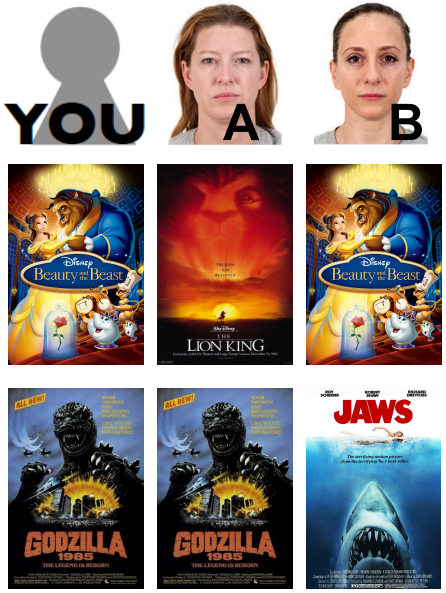


H1: Use dyadic similarity with each person in the environment?



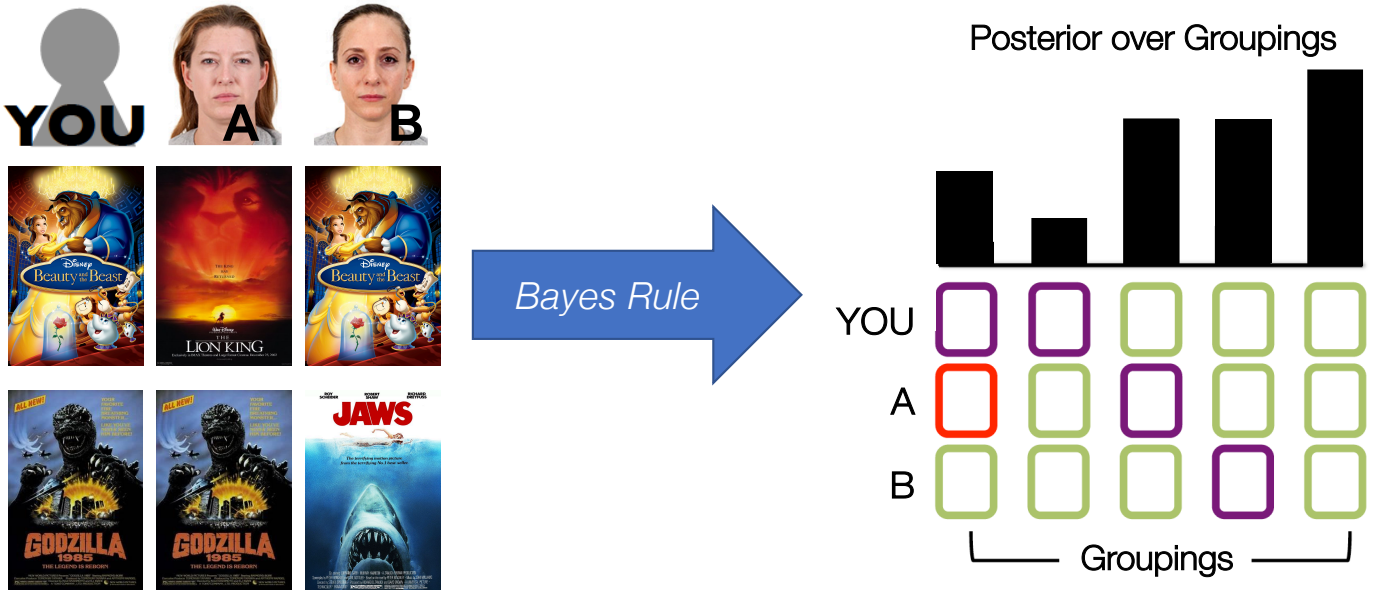
H2: Infer latent group structures amongst people in the environment?

H1: Dyadic Similarity

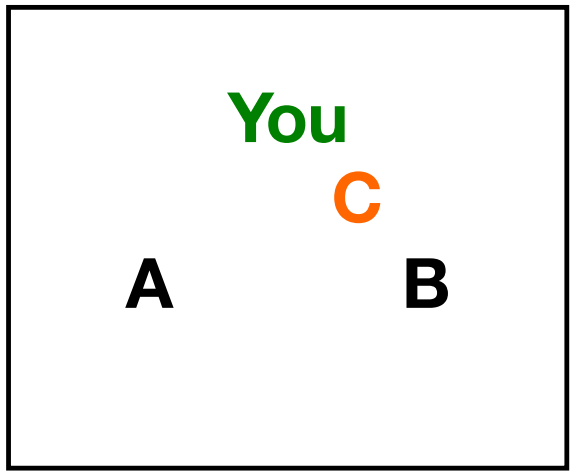


Total Similarity	1	1

H2: Bayesian Latent Structure Learning

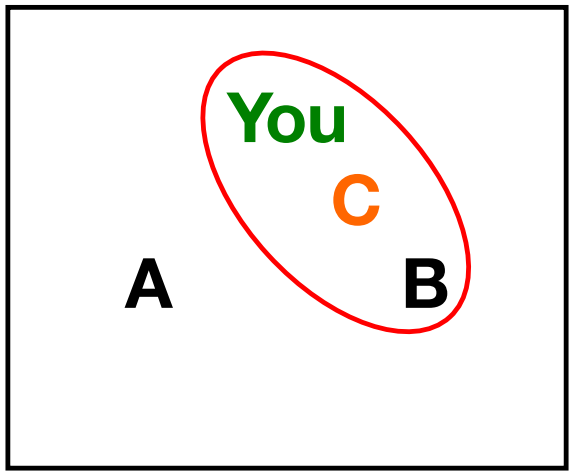


Dyadic Similarity

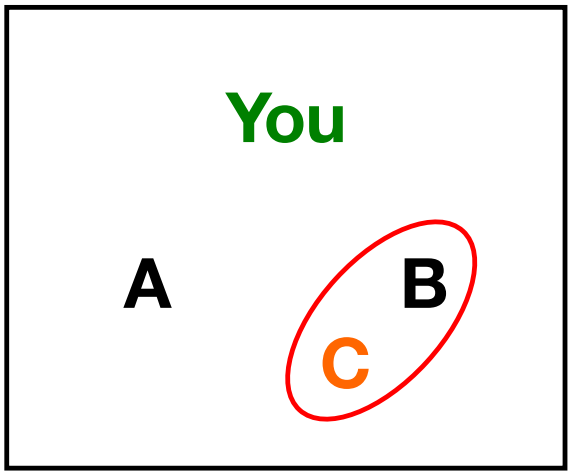


Bayesian Latent Structure Learning

High C-agreement



Low C-agreement



EXPERIMENTAL DESIGN

GMO Labels

Should producers be required to label genetically engineered foods (GMOs)?

6,659,055 votes

Federal Reserve

Should the Federal Reserve Bank be audited by Congress?

1,829,140 votes

Equal Pay

Should employers be required to pay men and women the same salary for the same job?

13,960,765 votes

Should employers be required to pay men and women the same salary for the same job?

Which do you think Carol chose?

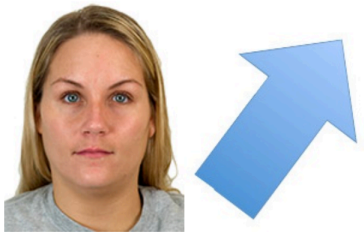
E

NO

I

YES

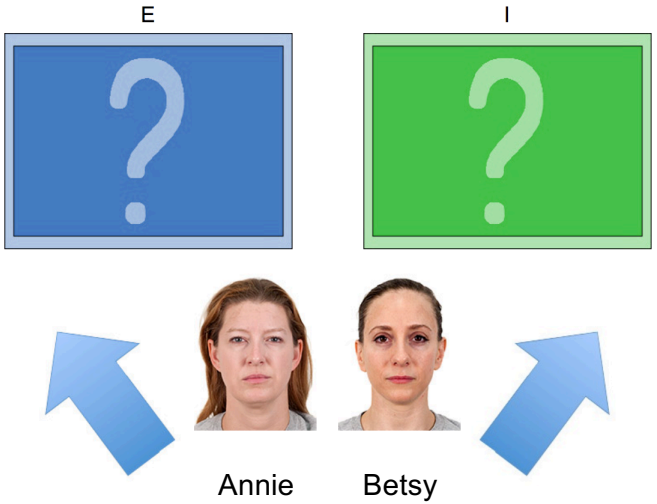
INCORRECT



Carol

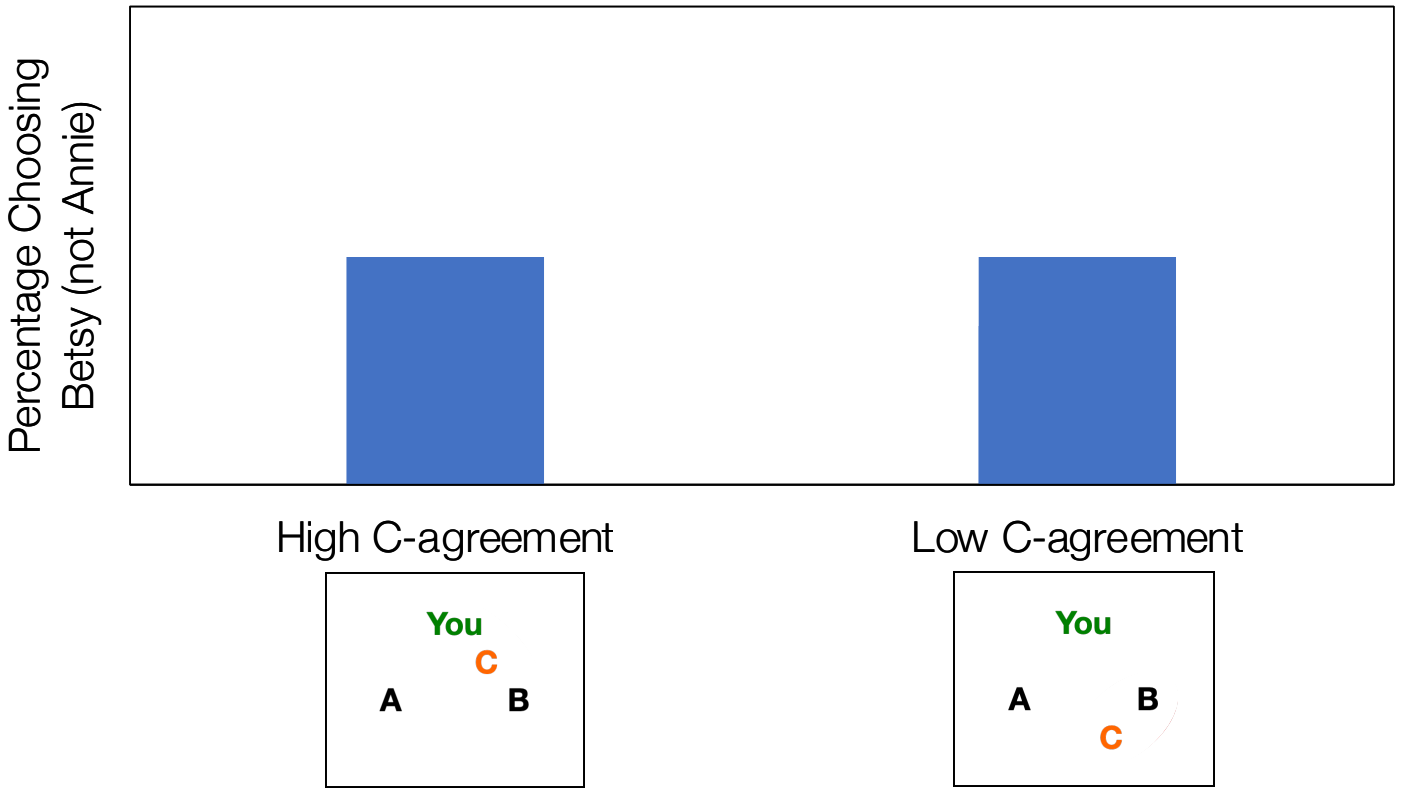
You Annie Betsy Carol

Which one would you choose?
Remember, Annie and Betsy know what's inside the boxes.

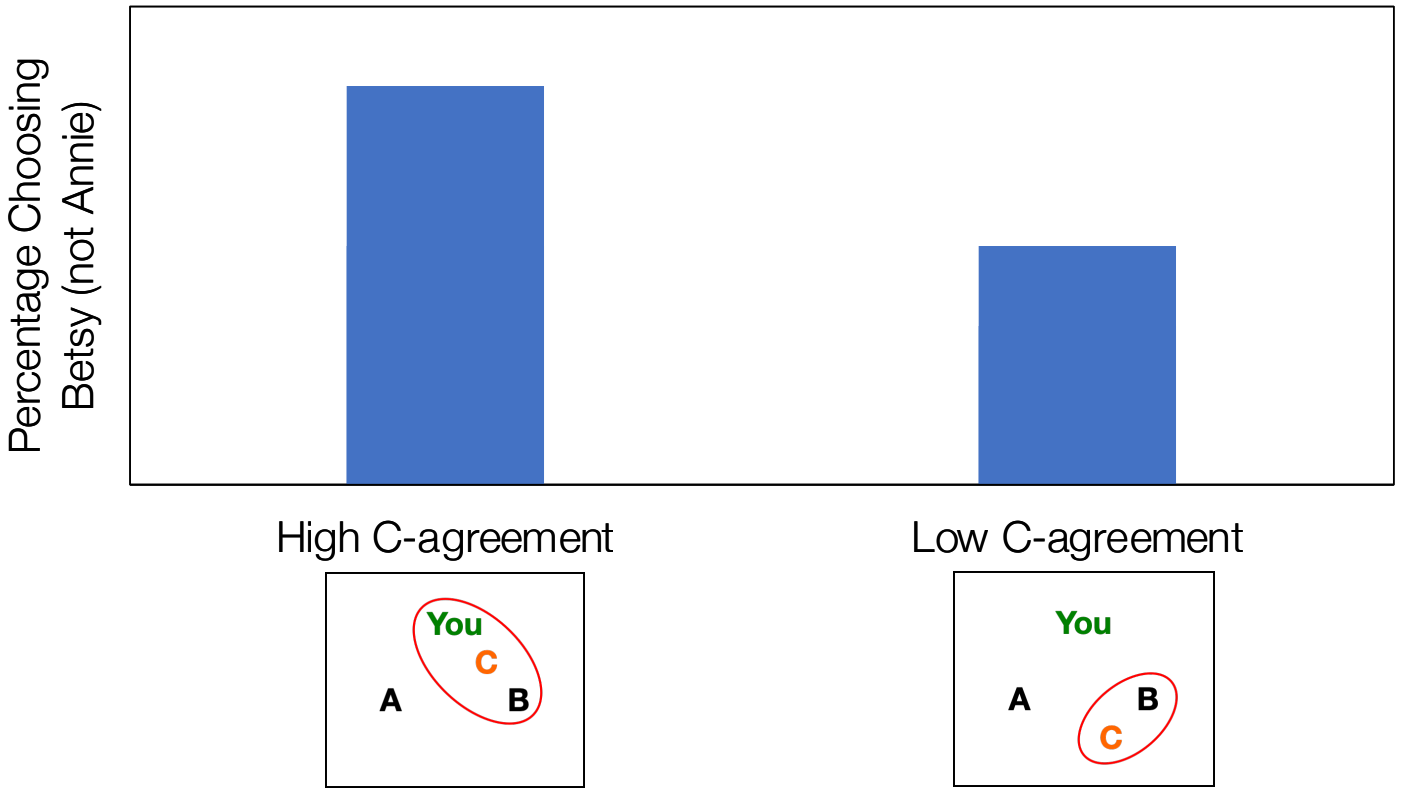


1: Agreement with you
0: Disagreement with you

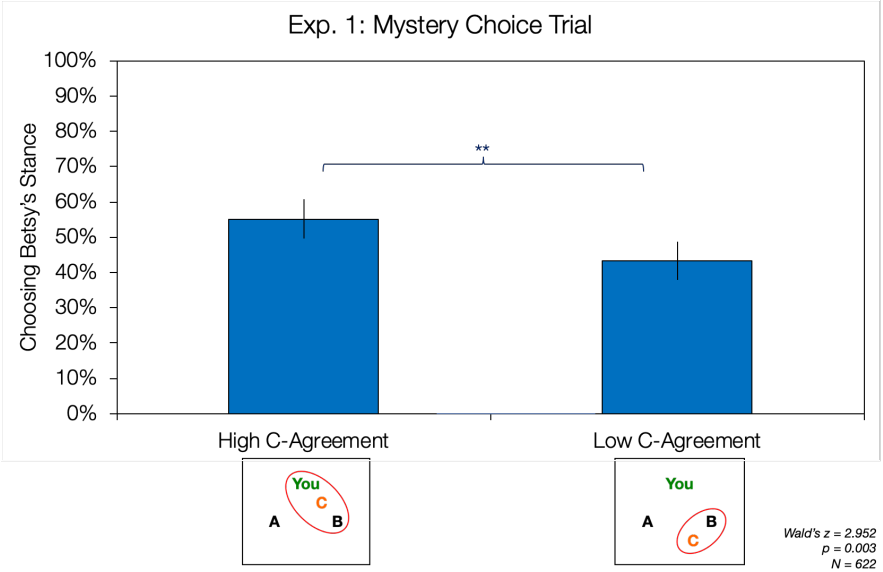
Dyadic Similarity



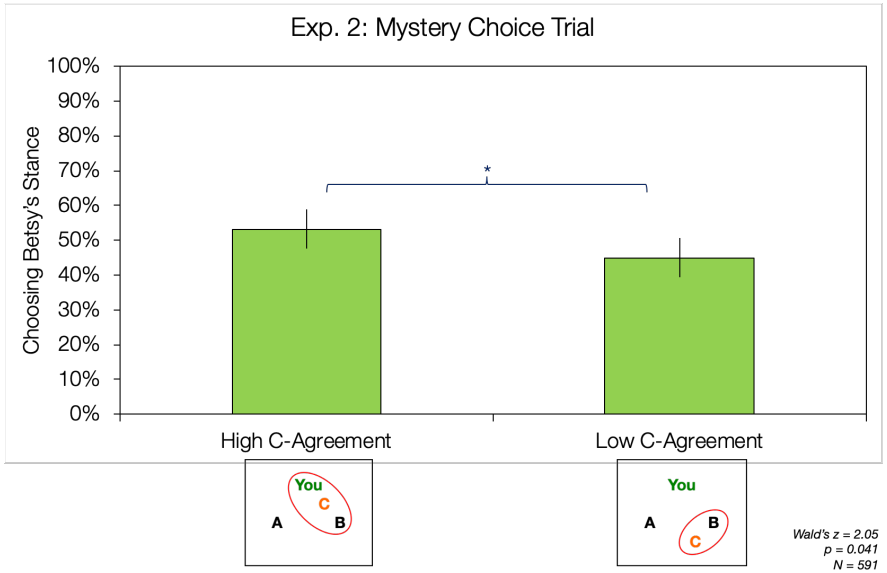
Bayesian Latent Structure Learning



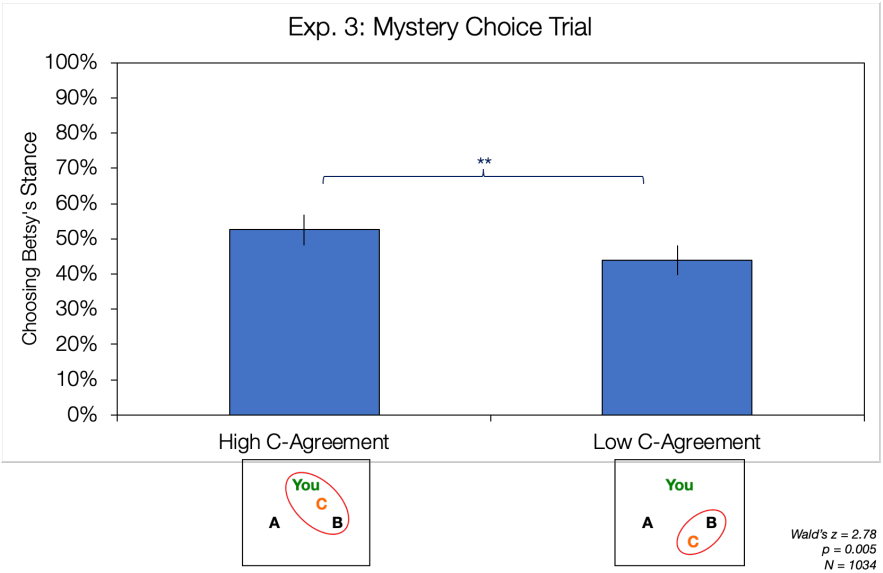
BEHAVIORAL RESULTS



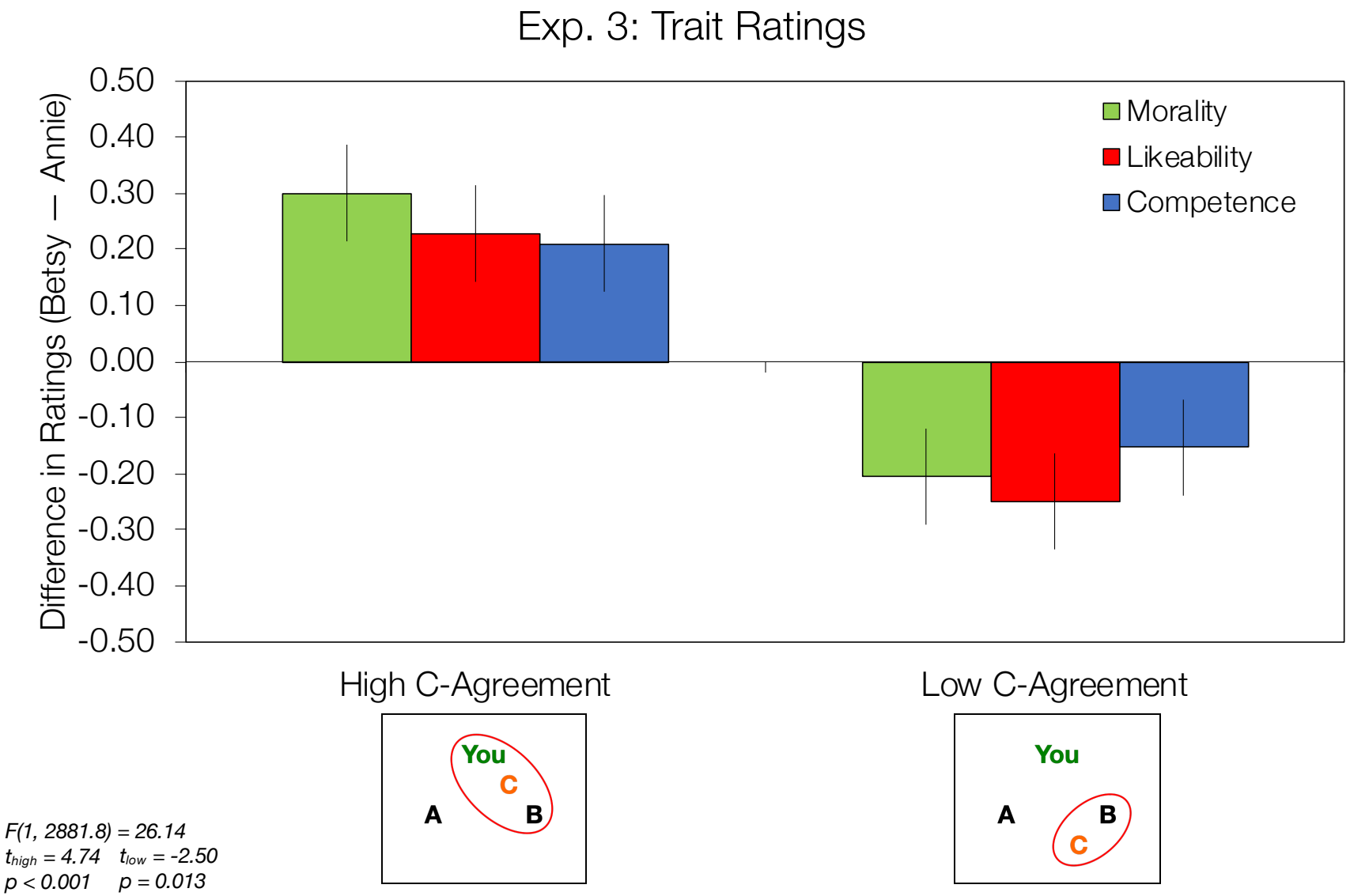
Wald's z = 2.952
p = 0.003
N = 622



Wald's z = 2.05
p = 0.041
N = 591

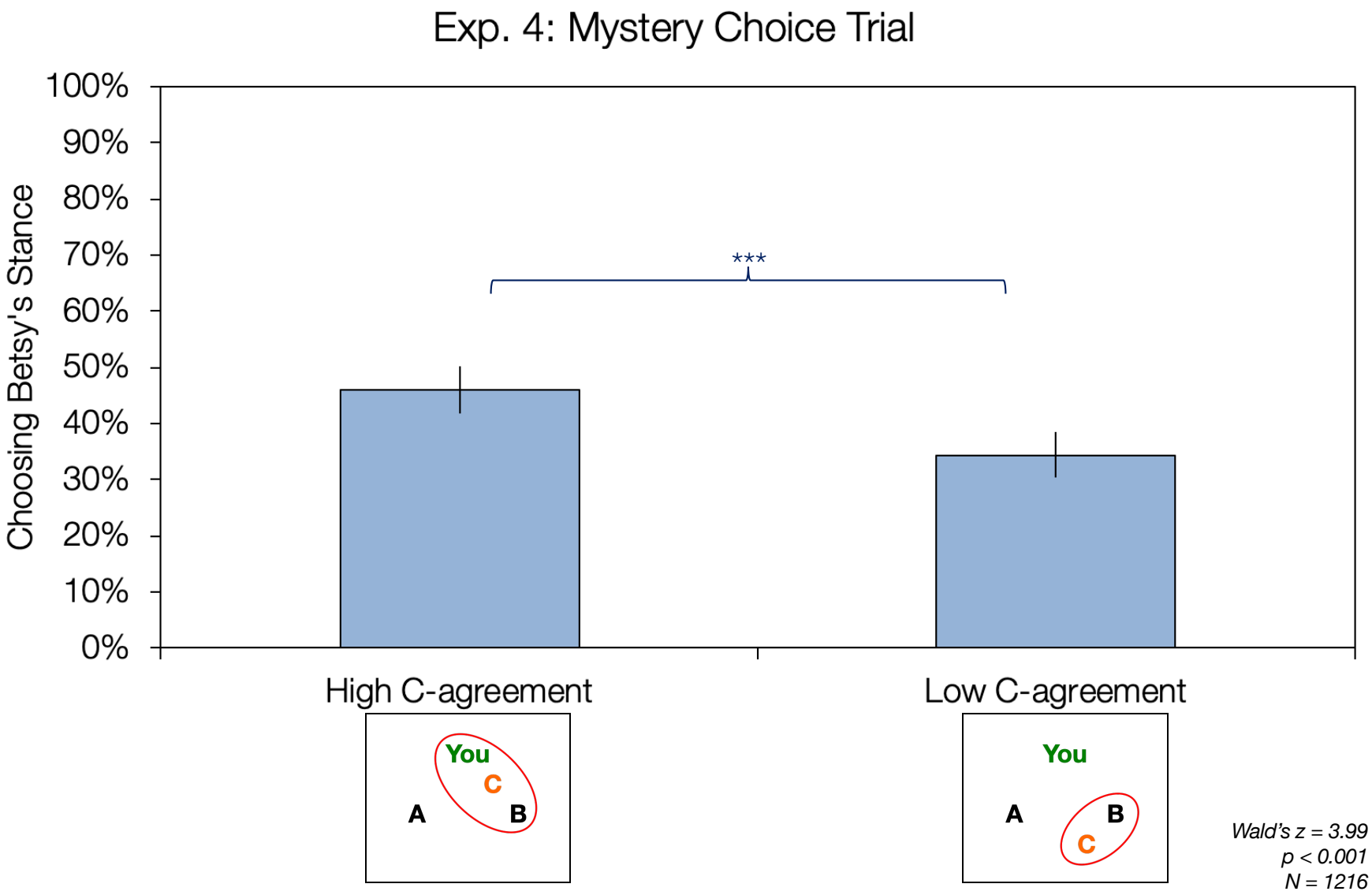


Wald's z = 2.78
p = 0.005
N = 1034

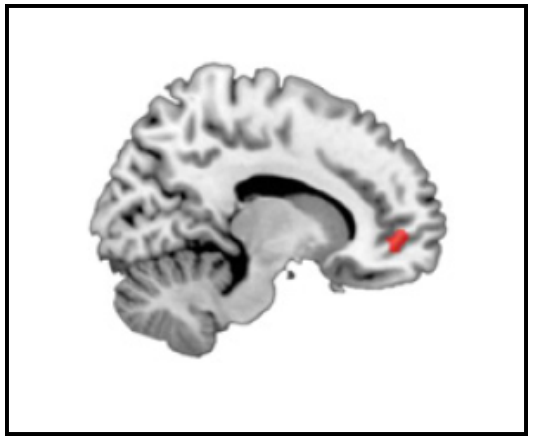


F(1, 2881.8) = 26.14
t_{high} *= 4.74* t_{low} *= -2.50*
p < 0.001 *p = 0.013*

Exp. 4 (Conflicting, Explicit Team Assignments)

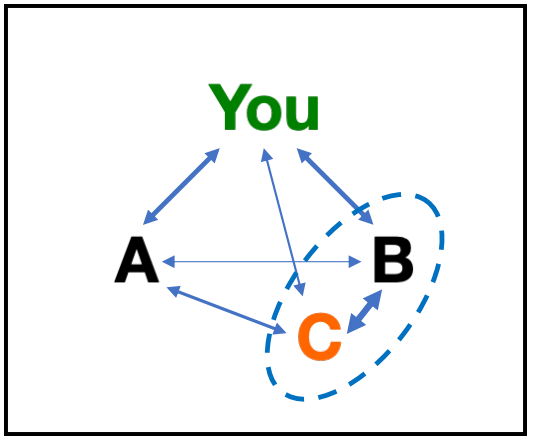

Exp. 4: Mystery Choice Trial
Choosing Betsy's Stance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
***
High C-agreement
Low C-agreement
You
C
A
B
You
A
B
C
Wald's z = 3.99
p < 0.001
N = 1216

Which neural regions track these models?



Dyadic similarity model

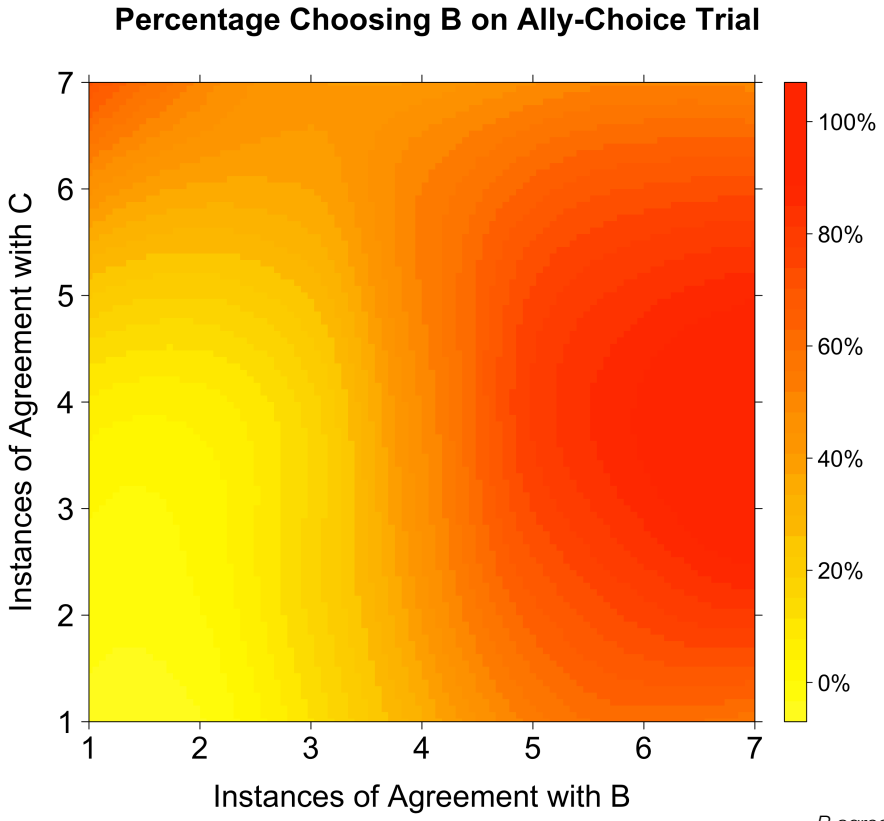
pgACC/mPFC



Latent structure learning model

Ames, Jenkins, Banaji, & Mitchell (2008), Jenkins, Macrae, & Mitchell (2008), Morrison, Decety, & Molenberghs (2012), Cikara, Jenkins, Dufour, & Saxe (2014), Heleven & van Overwalle (2016), Mitchell, Banaji, & Macrae (2005)

fMRI behavioral results



B agreement, b = 2.325, Wald's z = 4.099, p < 0.001
C agreement, b = 1.322, Wald's z = 2.633, p = 0.008

Tracking similarities and latent structure learning

Should employers be required to pay men and women the same salary for the same job?

Which do you think Annie chose?

E

NO

I

YES

You Annie Betsy Carol

Annie

Tracking similarities and latent structure learning

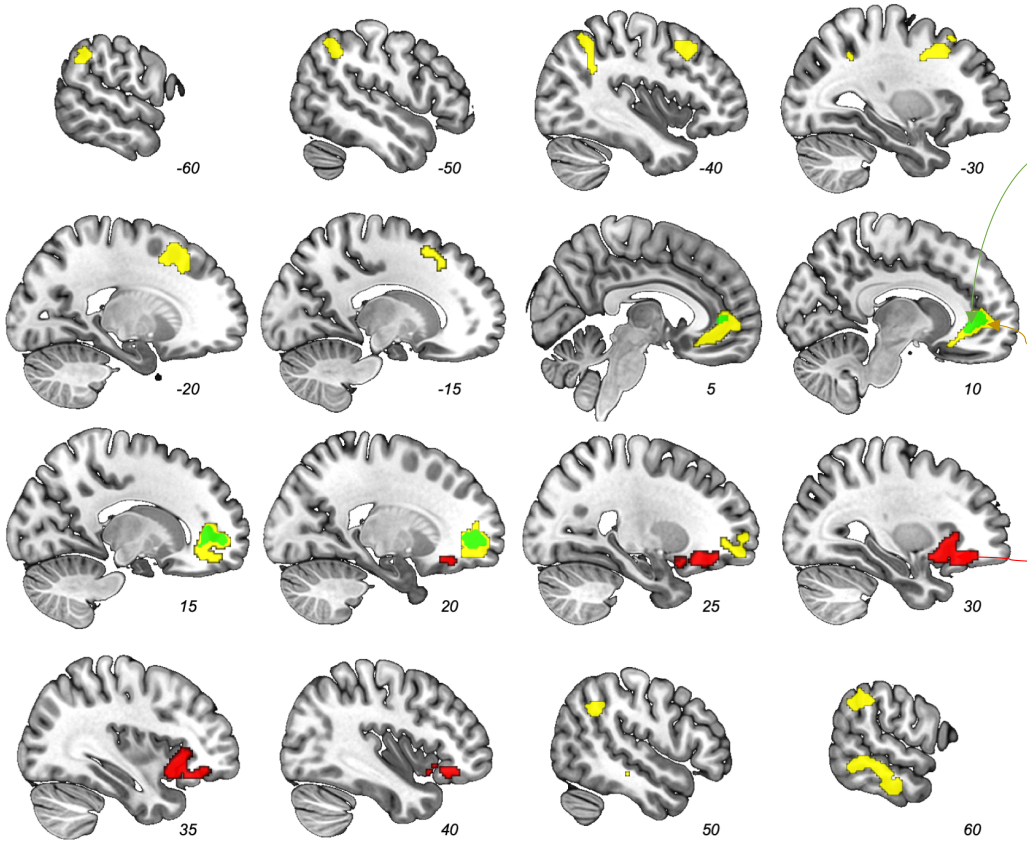
Dyadic Similarity $$S_d(agent, participant) = \frac{\sum_{i=0}^{n-1} Agreement_a + 1}{n+1}$$

Feature Similarity-over-Agents $$S_f(agent, participant) = corr\left(S_{d_{sim}}\right)_{a,p}$$

$$S_{d_{sim}} = \begin{bmatrix} 1 & S_d(A,p) & S_d(B,p) & S_d(C,p) \\ S_d(A,p) & 1 & S_d(A,B) & S_d(A,C) \\ S_d(B,p) & S_d(B,A) & 1 & S_d(B,C) \\ S_d(C,p) & S_d(C,A) & S_d(C,B) & 1 \end{bmatrix}$$

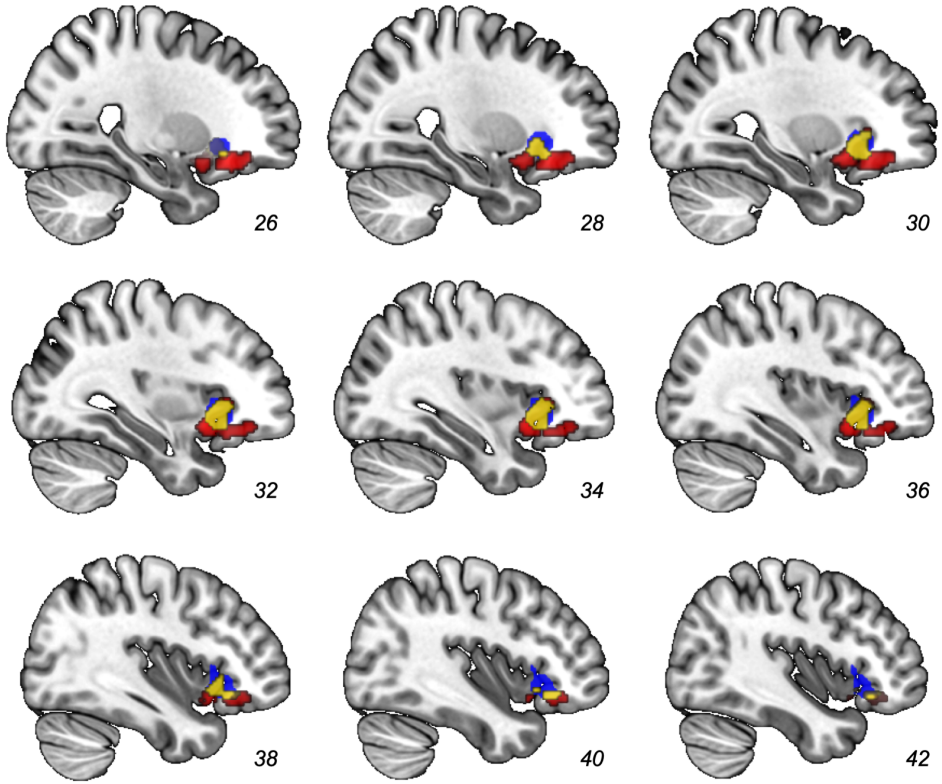
Latent Structure Learning $$P(z_a = z_p | C) = \sum_k P(z_a = k|C) P(z_p = k|C)$$

Tracking similarities and latent structure learning



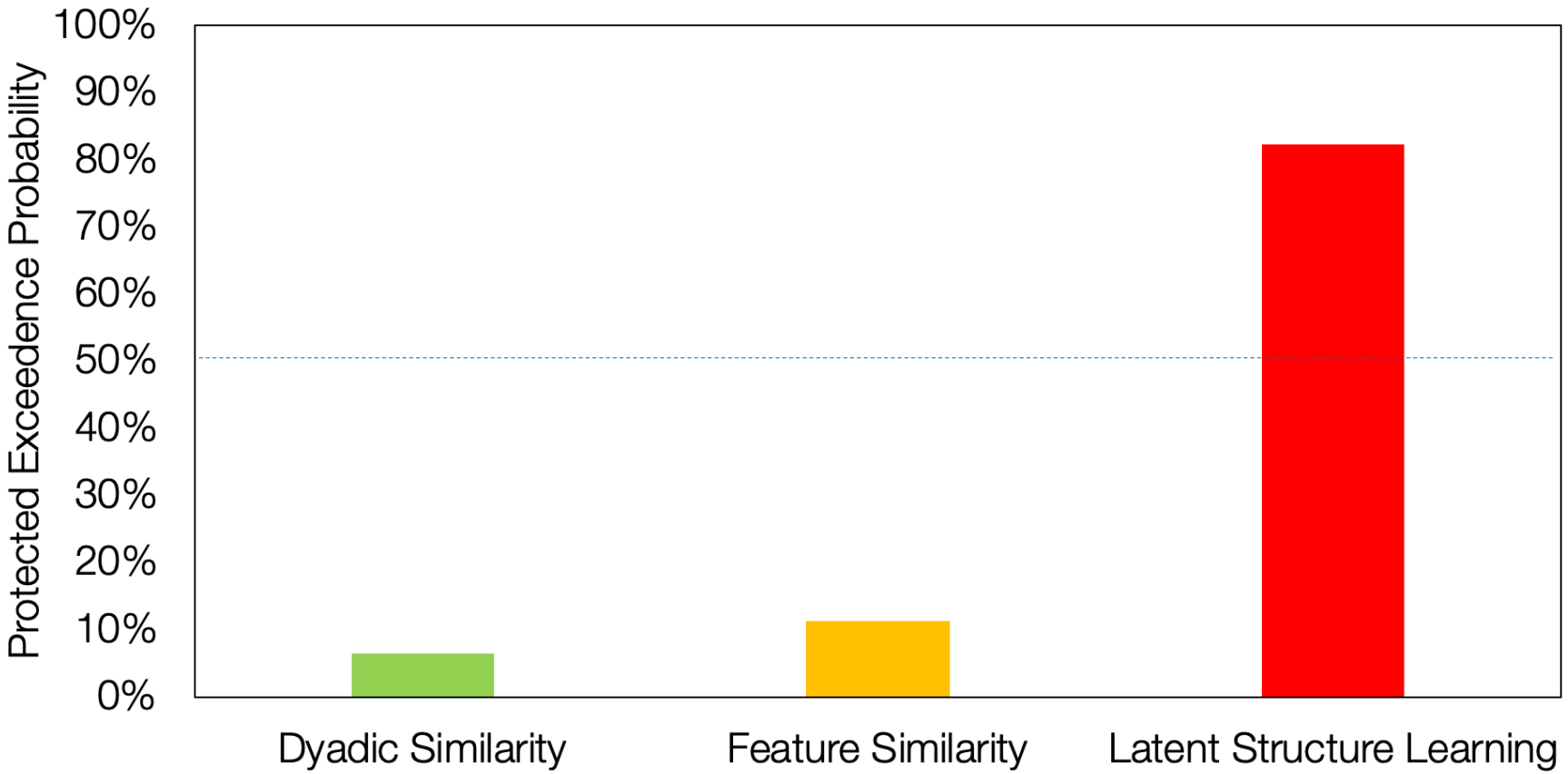
p < 0.05 (FWE Corrected)

Overlap with separately identified ROI

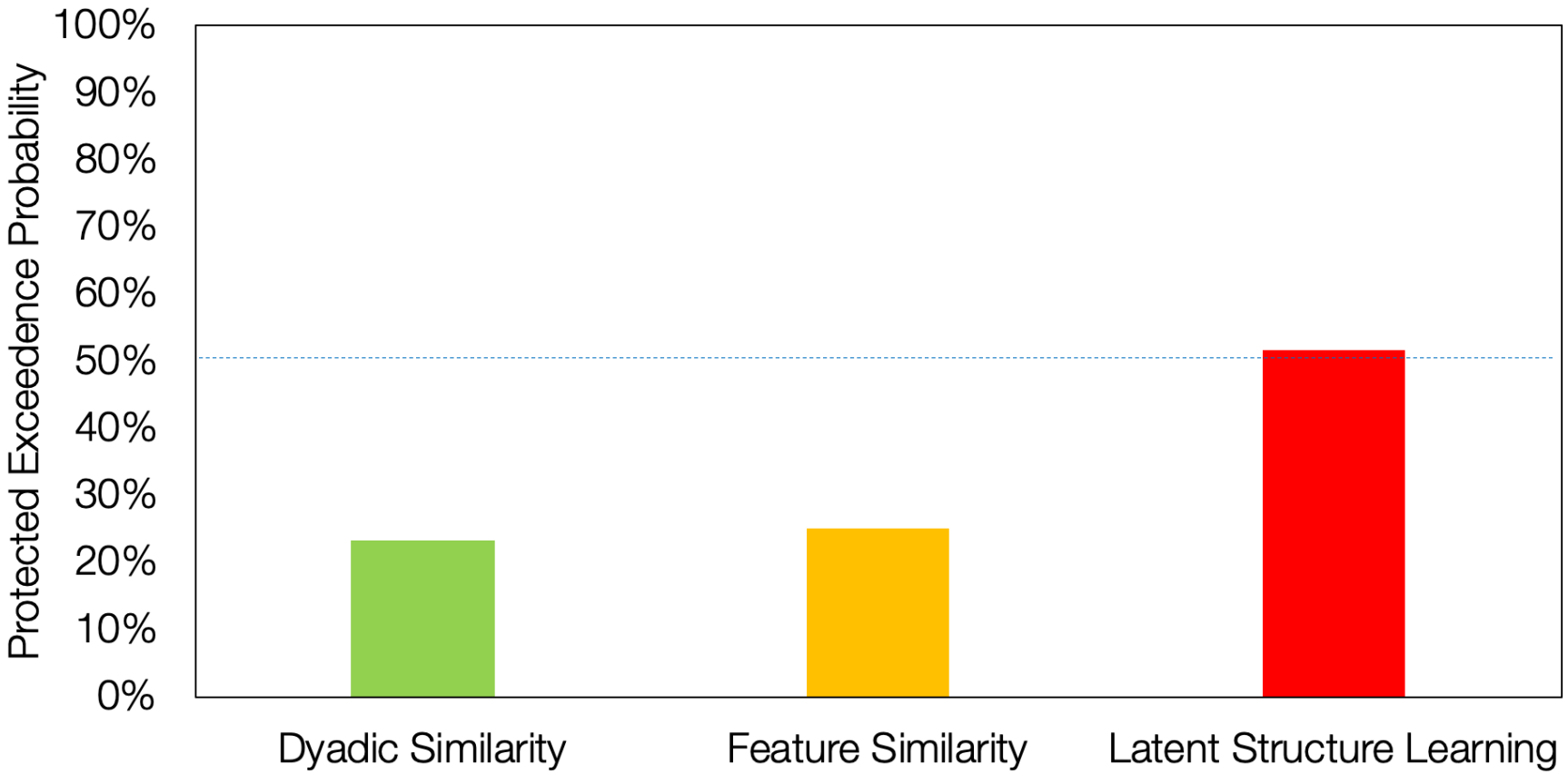


Blue: Tomov, Dorfman, & Gershman (2018), J Neurosci
Yellow: overlap

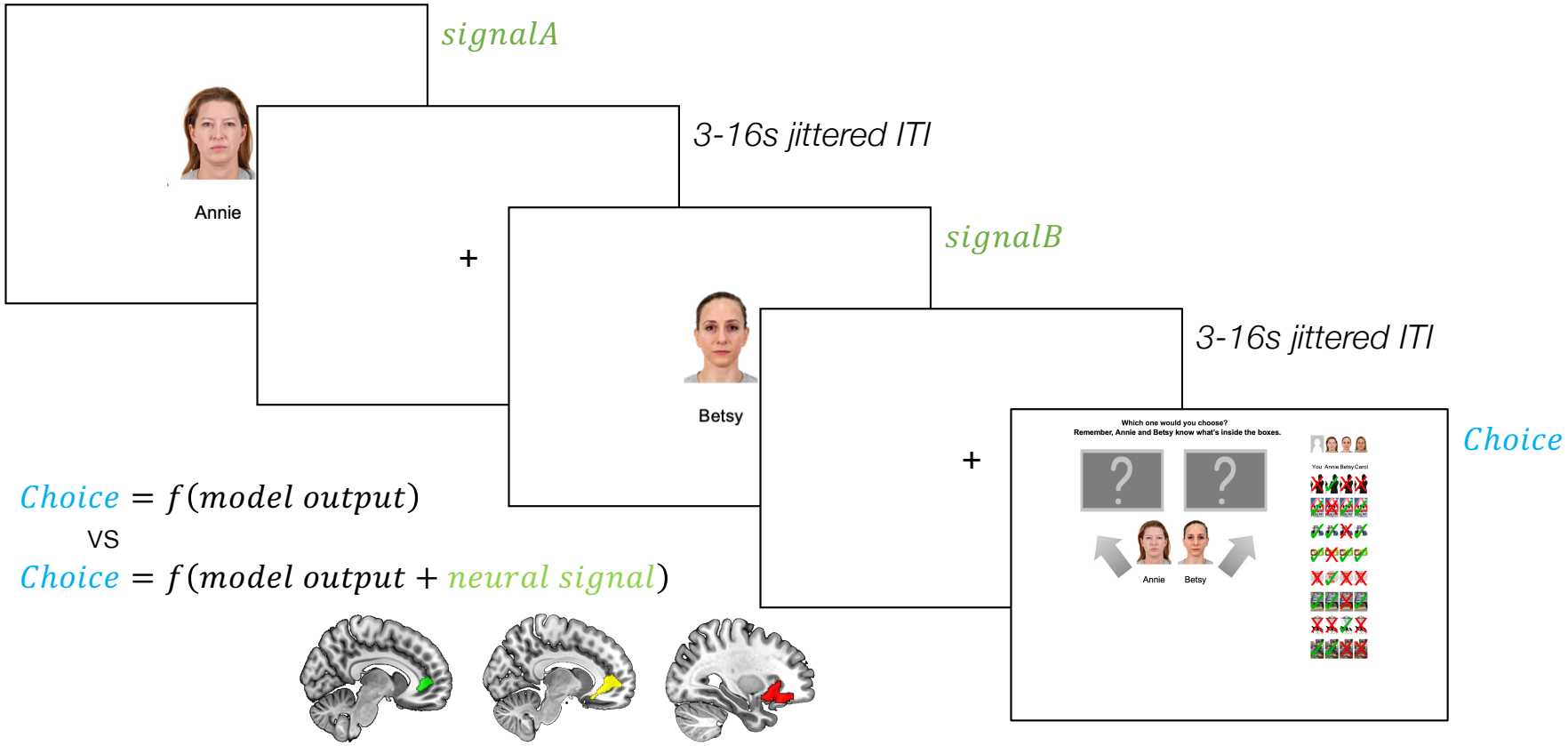
Specificity of the rAI



Specificity of the pgACC



Predicting choice behavior

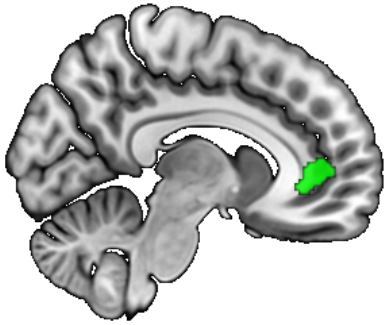


$Choice = f(model\ output)$

VS

$Choice = f(model\ output + neural\ signal)$

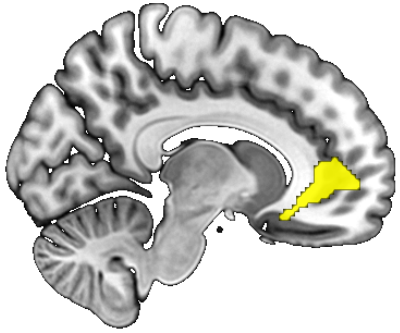
Predicting choice behavior



X

Dyadic similarity model
pgACC/mPFC

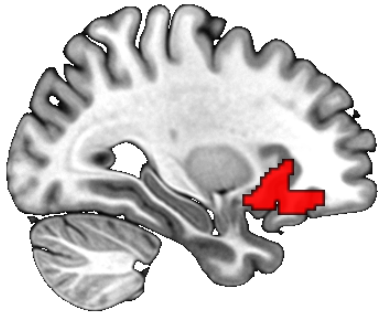
Likelihood Ratio Test, $\chi^2(1) = 1.526$, $p = 0.217$



X

Feature similarity model
pgACC, right/left TPJ,
left SMA, right STS

Likelihood Ratio Tests, $\chi^2(1)$s < 2.112, ps > 0.250



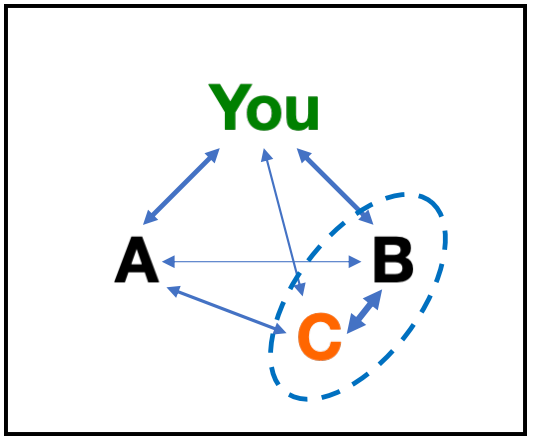
✓

Latent group model
right AI/IFG

Likelihood Ratio Test, $\chi^2(1) = 5.312$, $p = 0.021$

Consequences

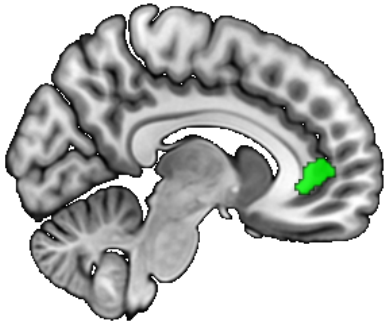
- Ally choices
- Trait judgements
  - Morality
  - Competence
  - Likeability
- Influence despite explicit group membership information conflicting with latent structure



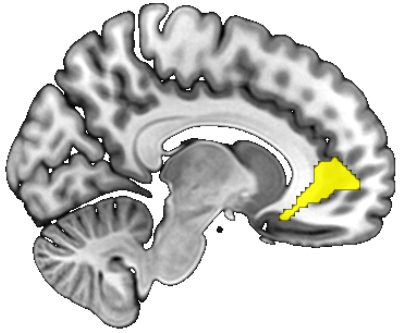
Latent group structures

Lau, Pouncy, Gershman, & Cikara (2018), JEP:G

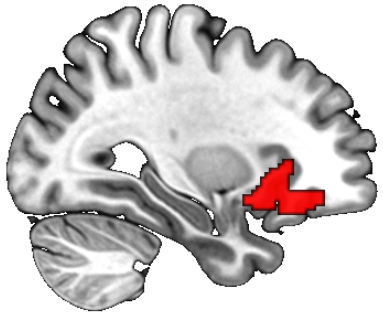
Neural correlates of inferring “us” and “them”



Dyadic similarity model
pgACC/mPFC



Feature similarity model
pgACC, right/left TPJ,
left SMA, right STS



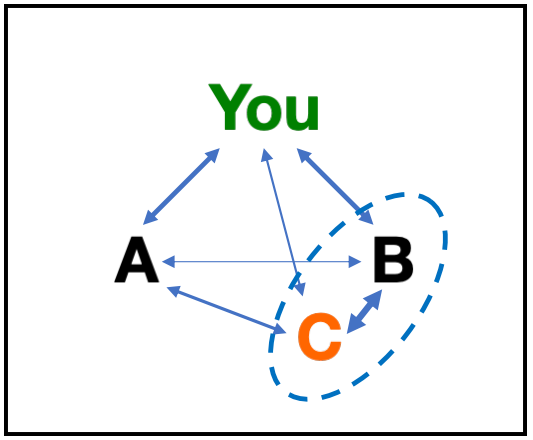
Latent group model
right AI/IFG

Specificity	✓
Choice Behavior	✓

Lau, Gershman, & Cikara (2020), eLife

Bigger Picture

- Balance Theory
- Generalized predictions about others



Latent group structures

Thanks!

Mina Cikara

Sam Gershman

Zach Ingbretsen

Thomas Pouncy

HARVARD
Mind Brain Behavior