

# A Neurocomputational Model of Altruistic Choice and Its Implications

Cendri A. Hutcherson,<sup>1,4,\*</sup> Benjamin Bushong,<sup>1,3</sup> and Antonio Rangel<sup>1,2</sup>

**Yoonseo Zoh**

*2018.05.31*

Computational Clinical Science Laboratory



# Backgrounds

altruism



Why do people behave altruistically?

# Backgrounds



Absence of  
future benefit

Strategic  
Consideration

Why do people behave altruistically?

# Backgrounds

Competition between two systems

(Strombach et al., 2015)



vs.



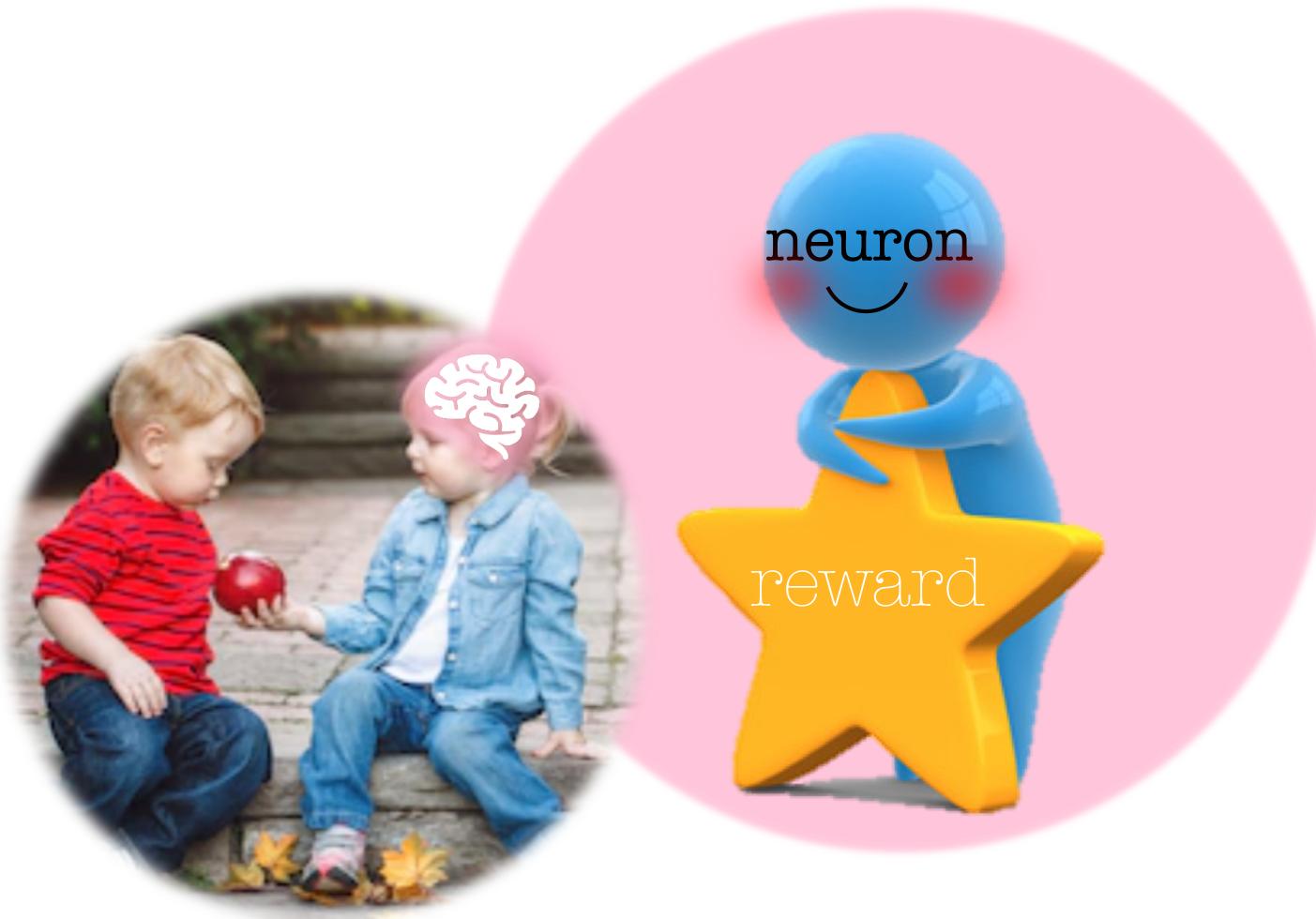
Fast and automatic

slow and deliberative

# Backgrounds

**Altruistic choices are rewarding**

(Strombach et al., 2015 ; Zaki and Mitchell, 2011)



# Goal of the study

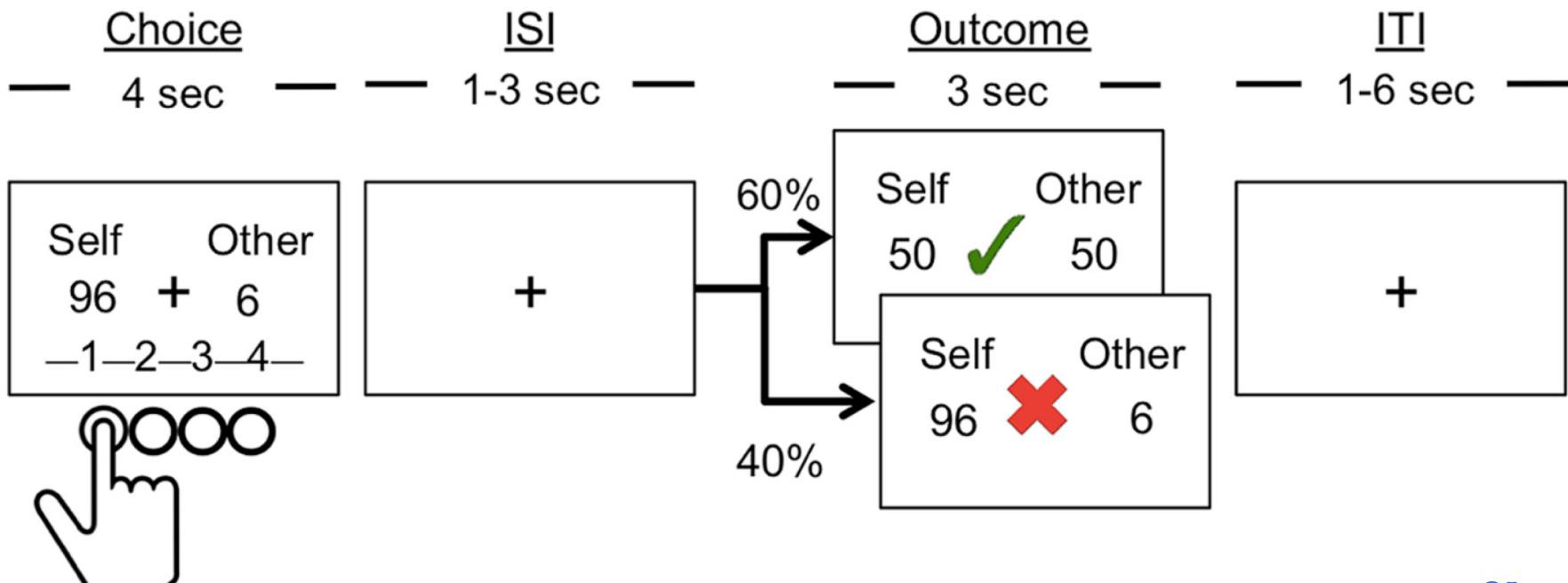
?

# Goal of the study

Develop  
**neurocomputational models**  
of altruistic choice

# Methods

## < Modified Dictator Game >



male subjects (n = 122)

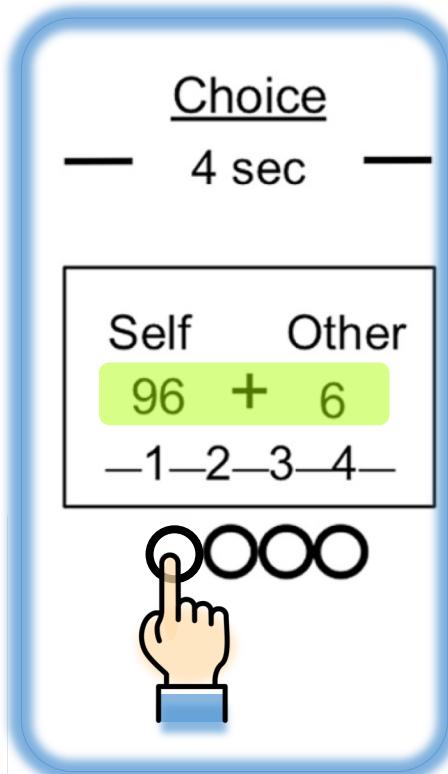
$61 \rightarrow 51$

Active participant (AP): fMRI, 180 trials

Passive participant (PP)

# Methods

< Modified Dictator Game>



## Choice phase

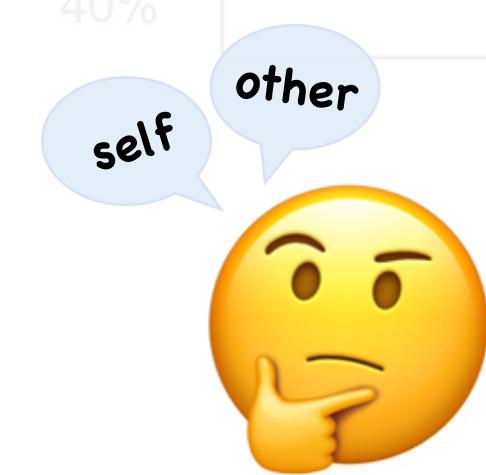
Proposed payment-pair

Default of \$50 to both



→ **Selfish behavior**

→ **Generous behavior**



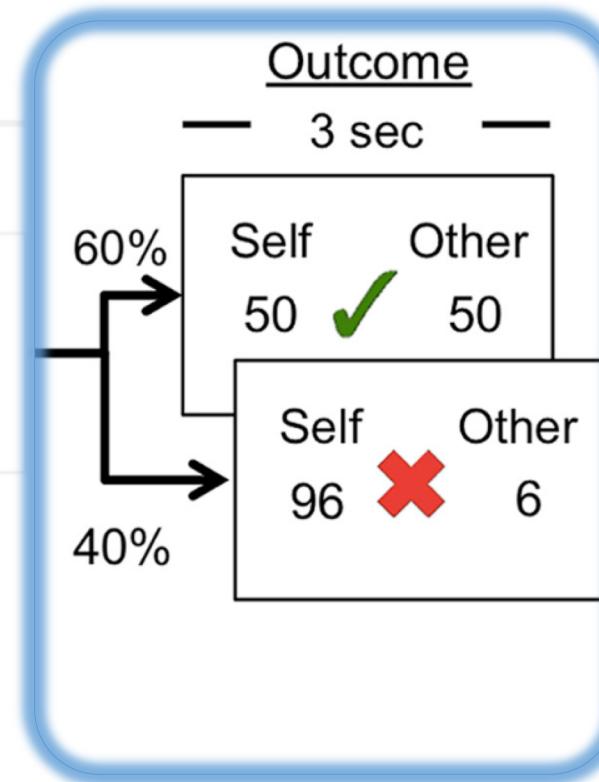
# Methods

< Modified Dictator Game>

## Outcome phase

Choice implemented (60%)

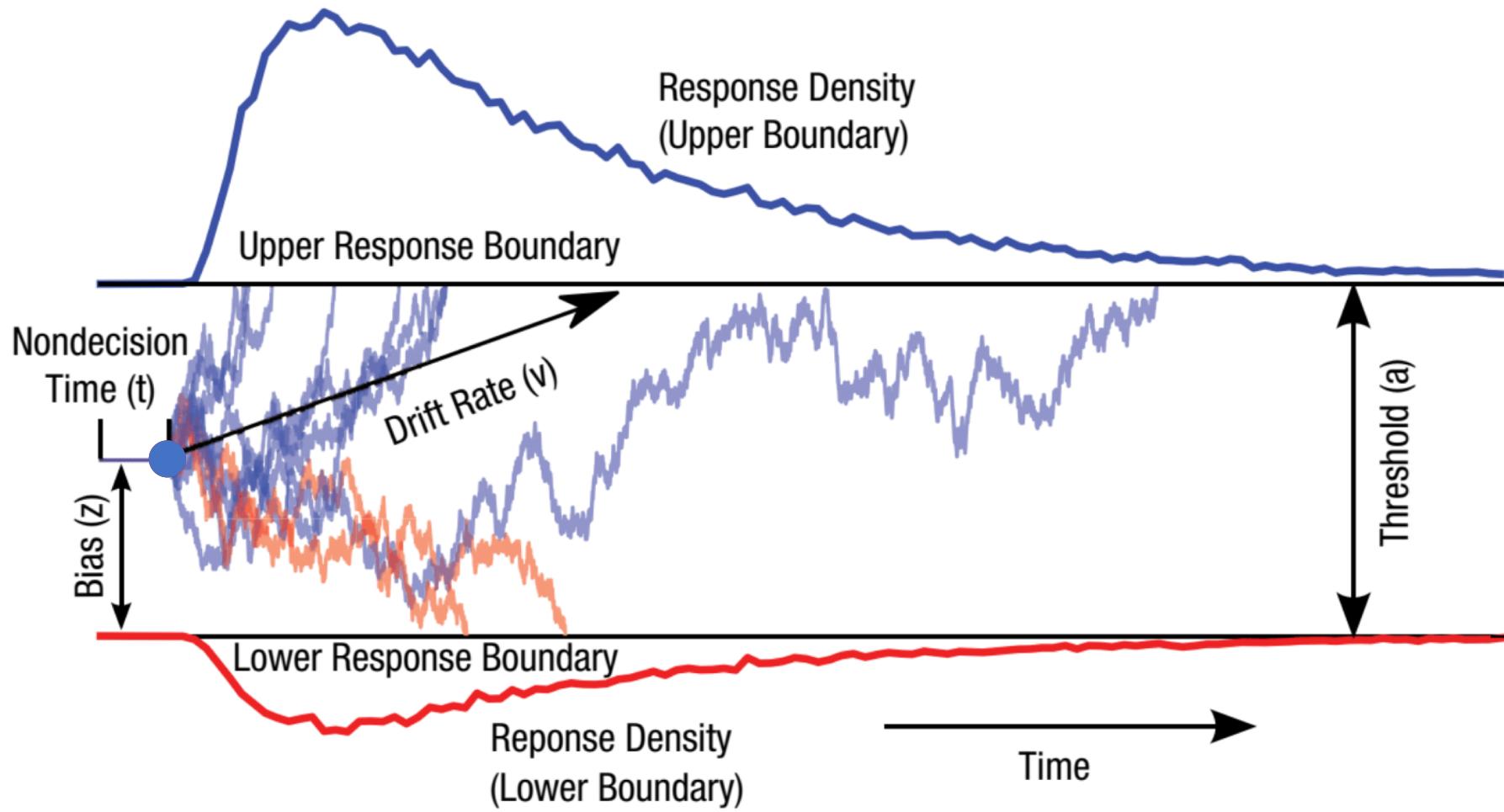
Choice reversed (40%)



Decision  
mistakes

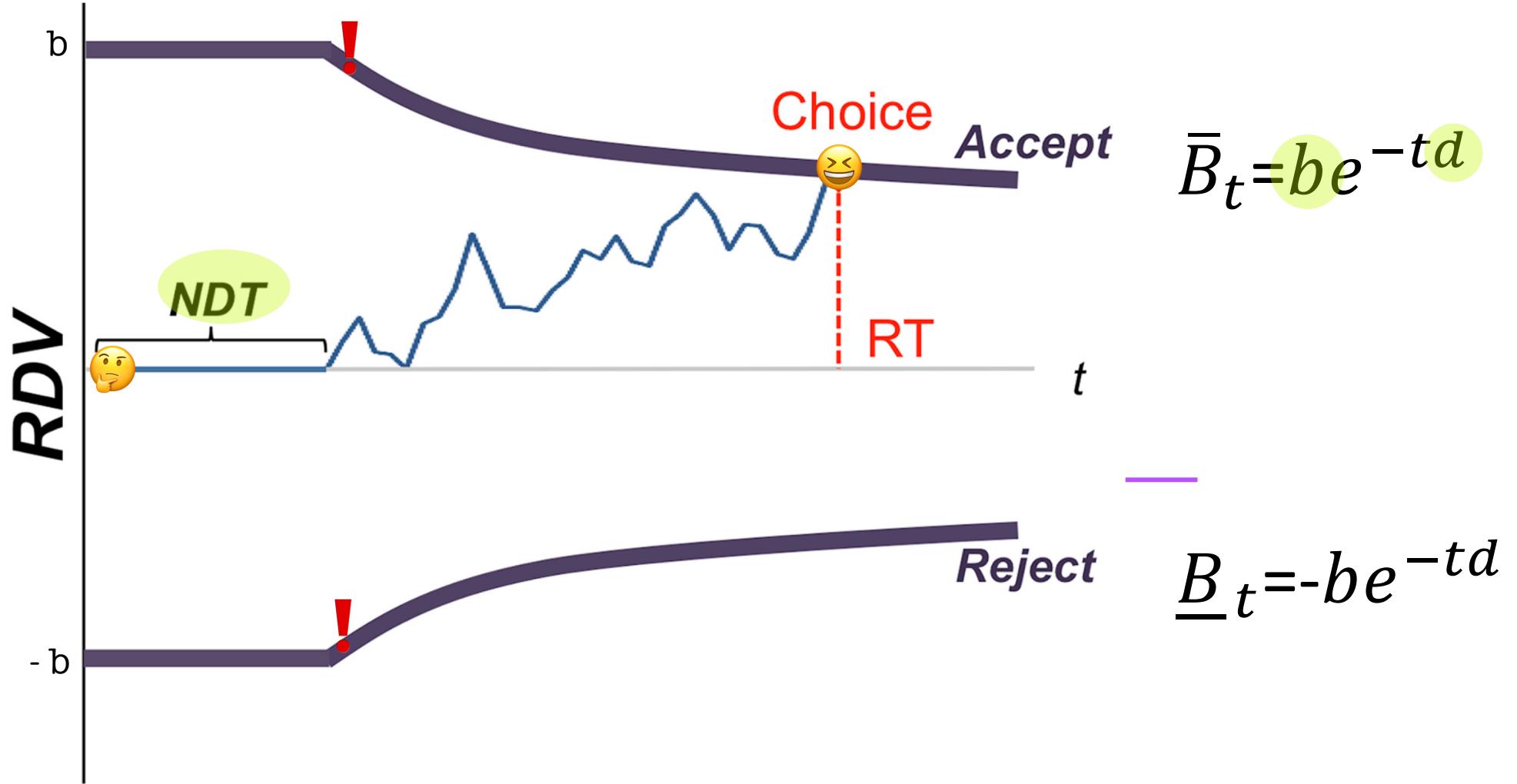
# Methods

< multi-attribute drift diffusion model >



# Methods

## < multi-attribute drift diffusion model >



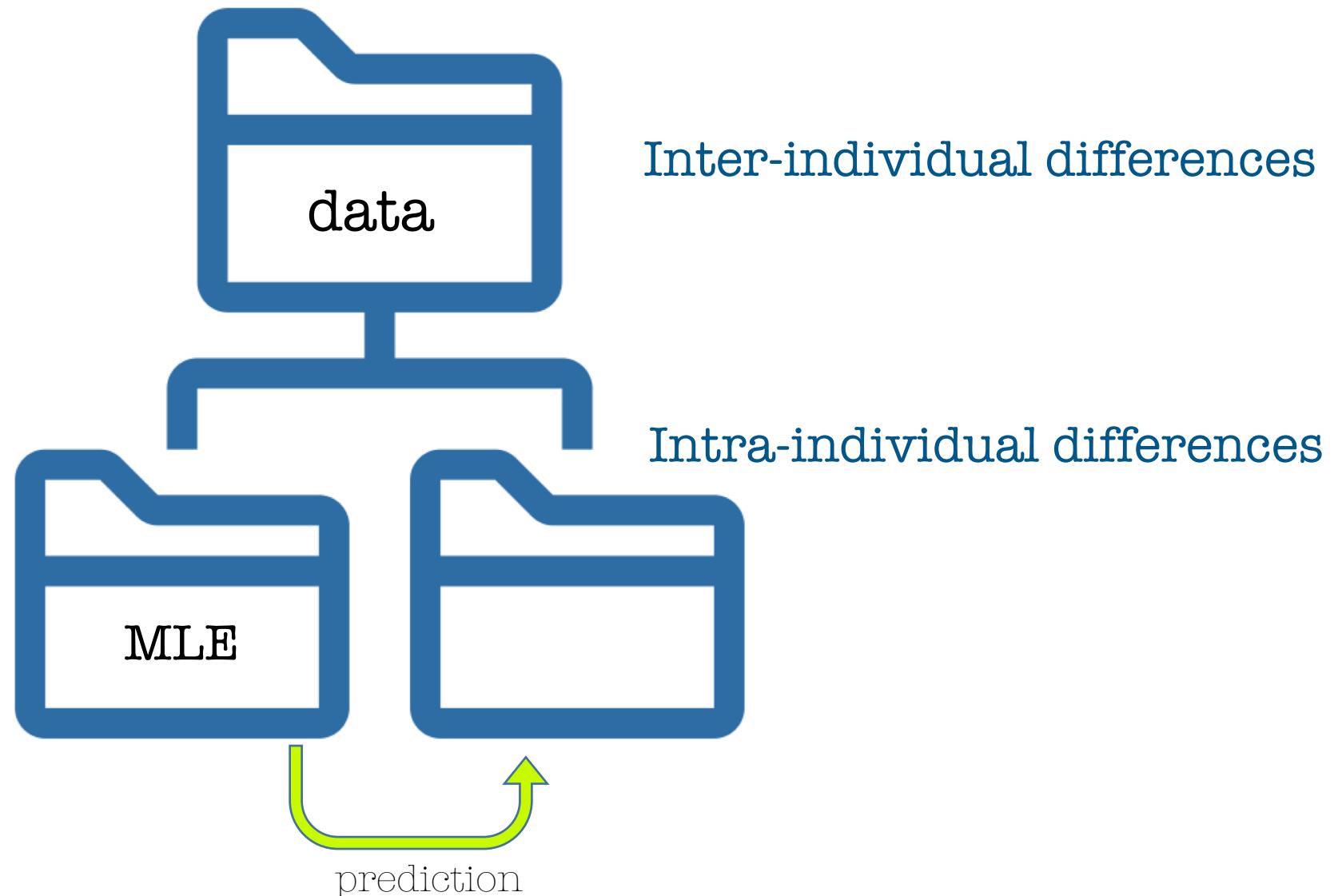
# Results

## Average Choices of Subjects



# Results

## Model Prediction of Choice and RT



# Results

## Model fitting to the data

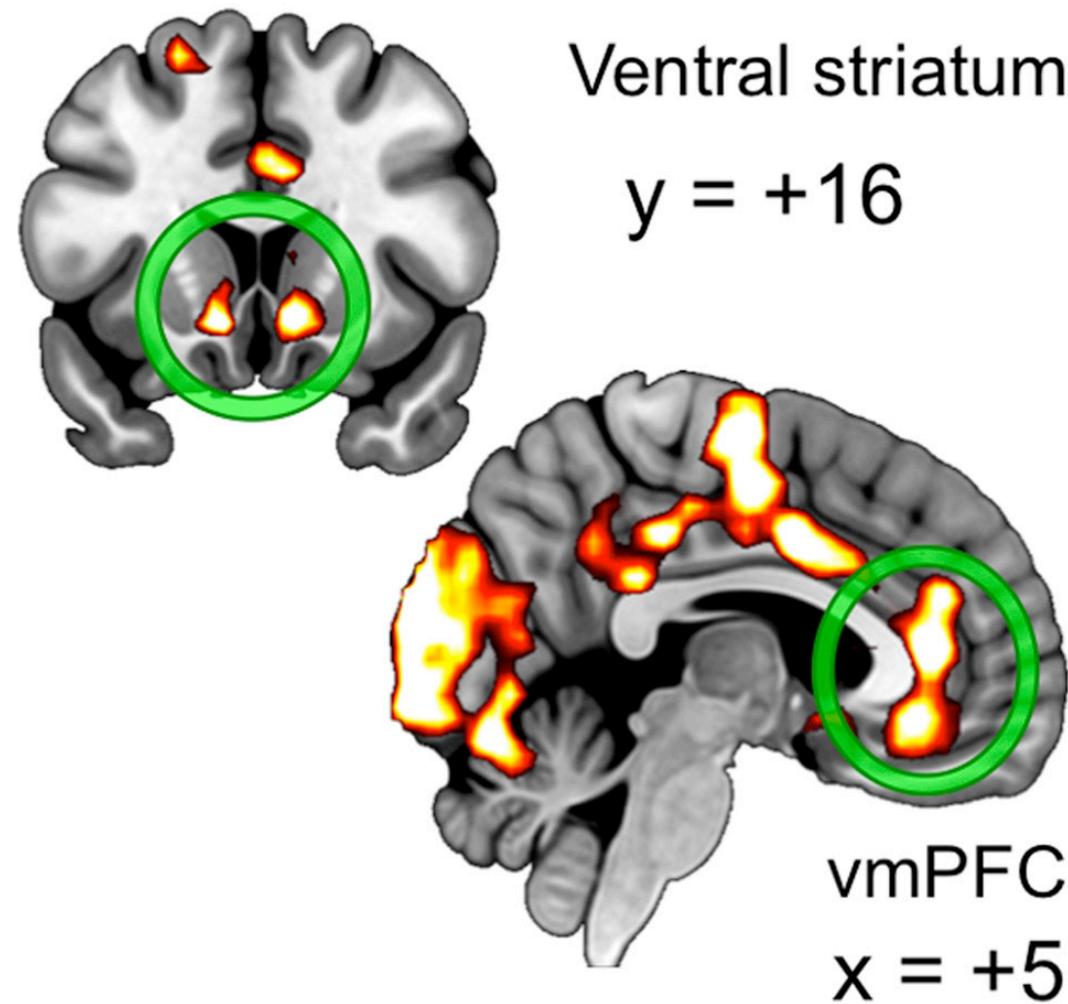
**Table 1. Parameters of the Best-Fitting DDM for Each Subject**

Parameter	Mean	SD	Min	Max
$w_{Self}$	0.006	0.002	0	0.0105
$w_{Other}$	0.001	0.0026	-0.003	0.009
NDT	868 ms	241 ms	300 ms	1,300 ms
$b$	0.23	0.065	0.08	0.32
$d$	0.00046	0.00022	0	0.001

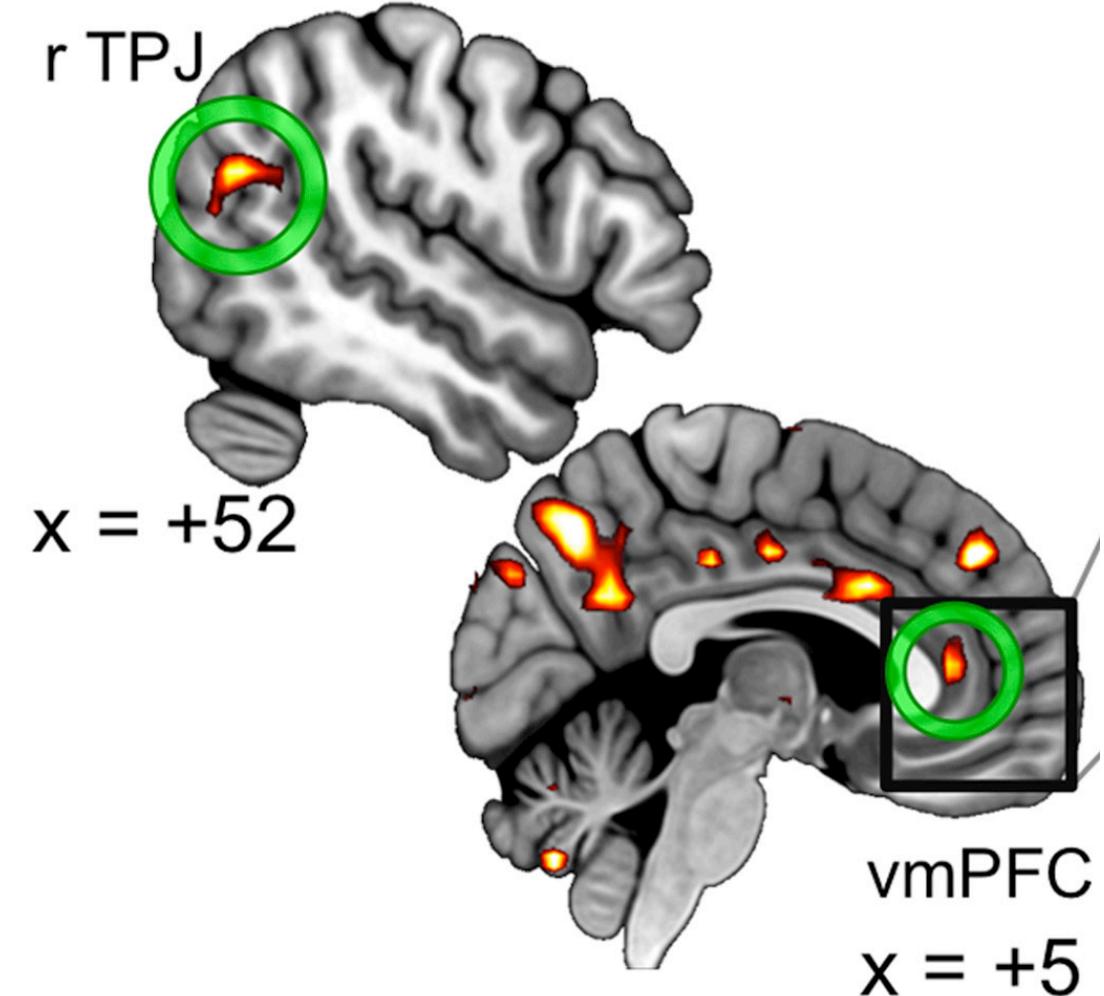
# Results

$$RDV_t = RDV_{t-1} + w_{Self} \cdot (\$Self - \$50) + w_{Other} \cdot (\$Other - \$50) + \varepsilon_t$$

**\$ Self**



**\$ Other**

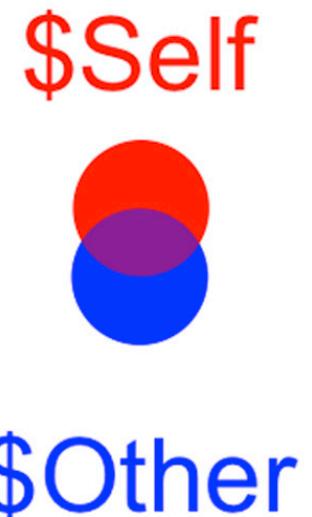
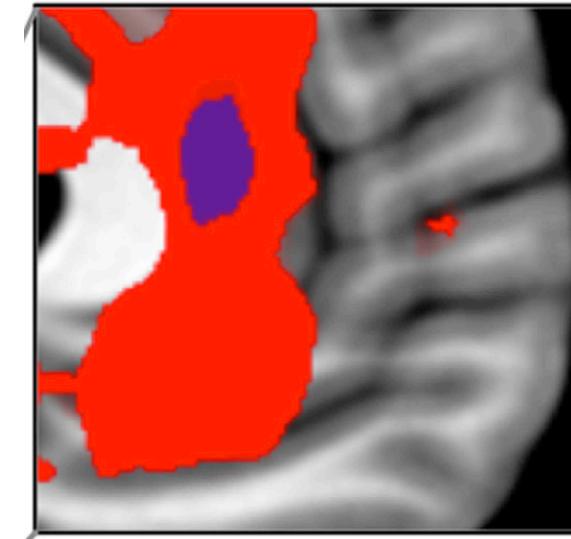
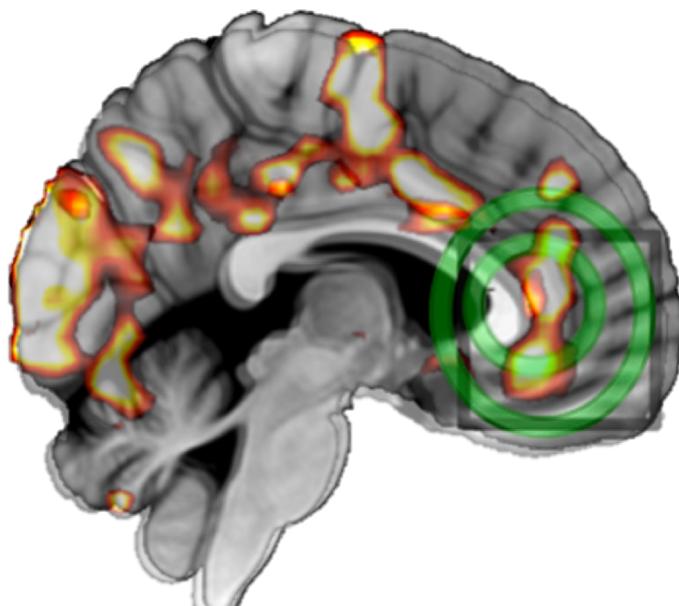


# Results

$$RDV_t = RDV_{t-1} + w_{Self} \cdot (\$Self - \$50) + w_{Other} \cdot (\$Other - \$50) + \varepsilon_t$$

**\$ Self and \$ Other**

vmPFC



Separate attributes

→ combined into  
an **integrated value signal**

# Results

## Model Implications



RT of Generous vs. Selfish Choice



Neural Response to Generous vs. Selfish Choice



Model Parameters and Generosity



Error Choices and Generosity

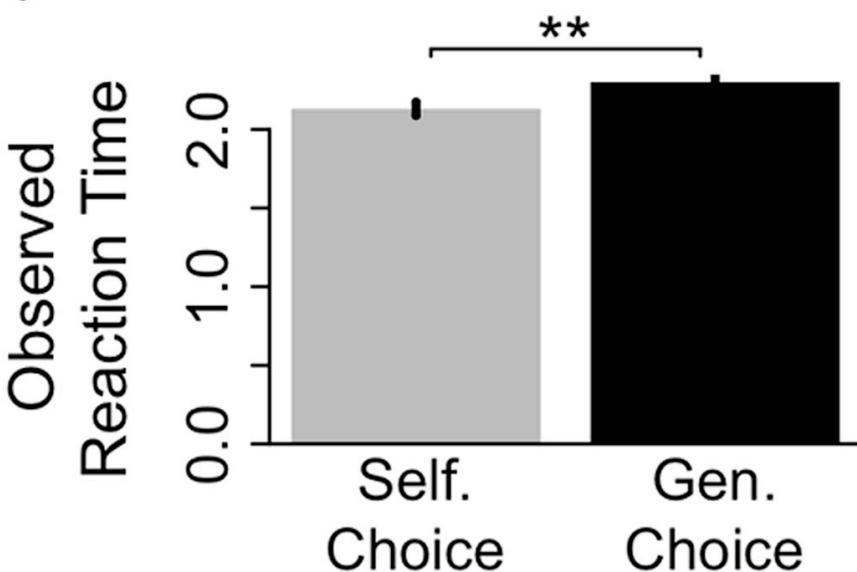
# Results

## Model Implications



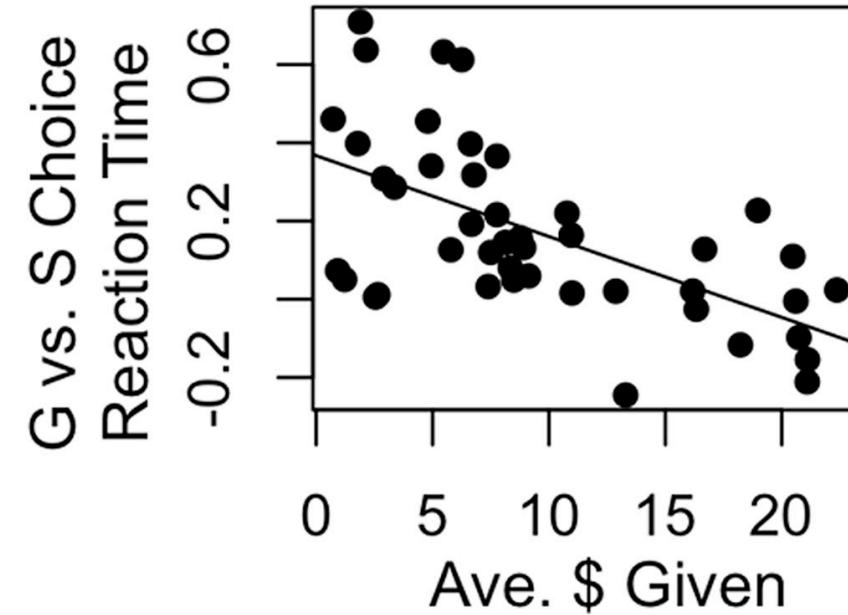
RTs are longer for Generous Choices,  
Particularly for more selfish Individuals

C



$$RT_G = 2,300 \text{ ms}$$
$$RT_S = 2,131 \text{ ms}$$
$$t_{43} = 4.97, p < 0.0001$$

D



$$r_{42} = -0.60$$
$$p < 0.0001$$

# Results

## Model Implications



RT of Generous vs. Selfish Choice



Neural Response to Generous vs. Selfish Choice



Model Parameters and Generosity



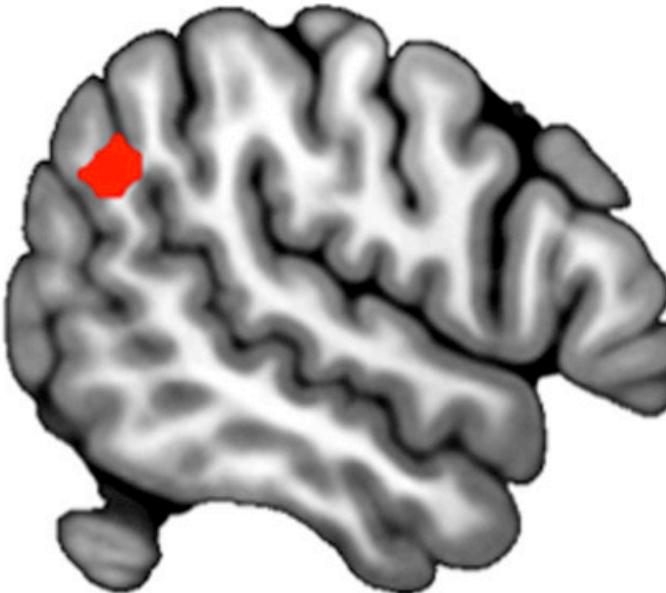
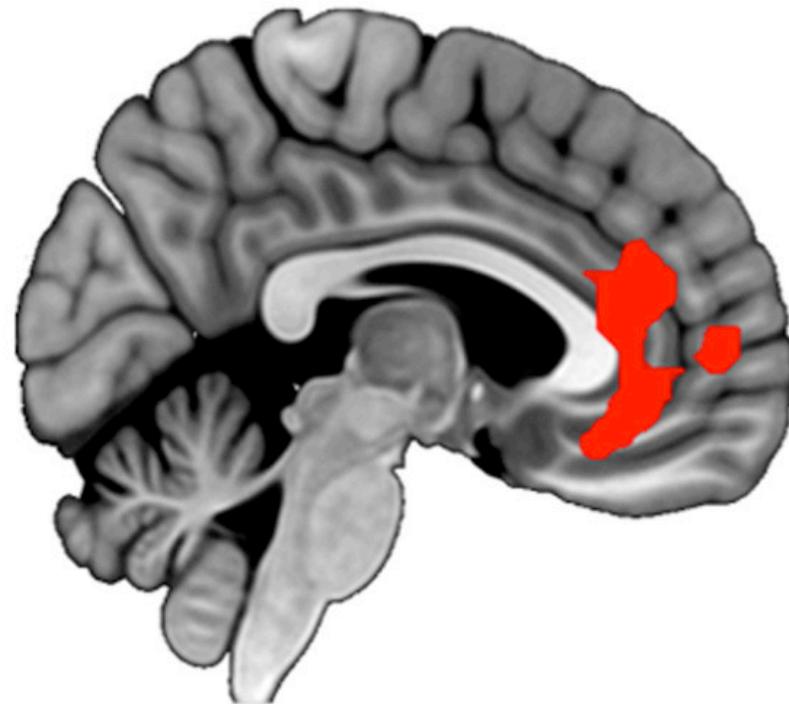
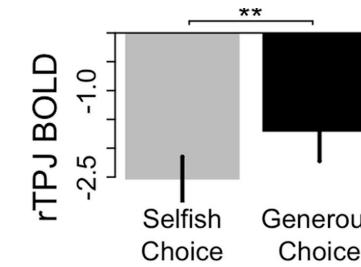
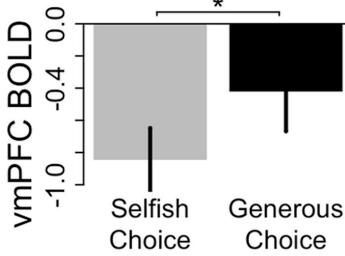
Error Choices and Generosity

# Results

## Model Implications



Neural Response in Valuation and Comparison regions  
is higher for generous choices



~~Self-control?~~

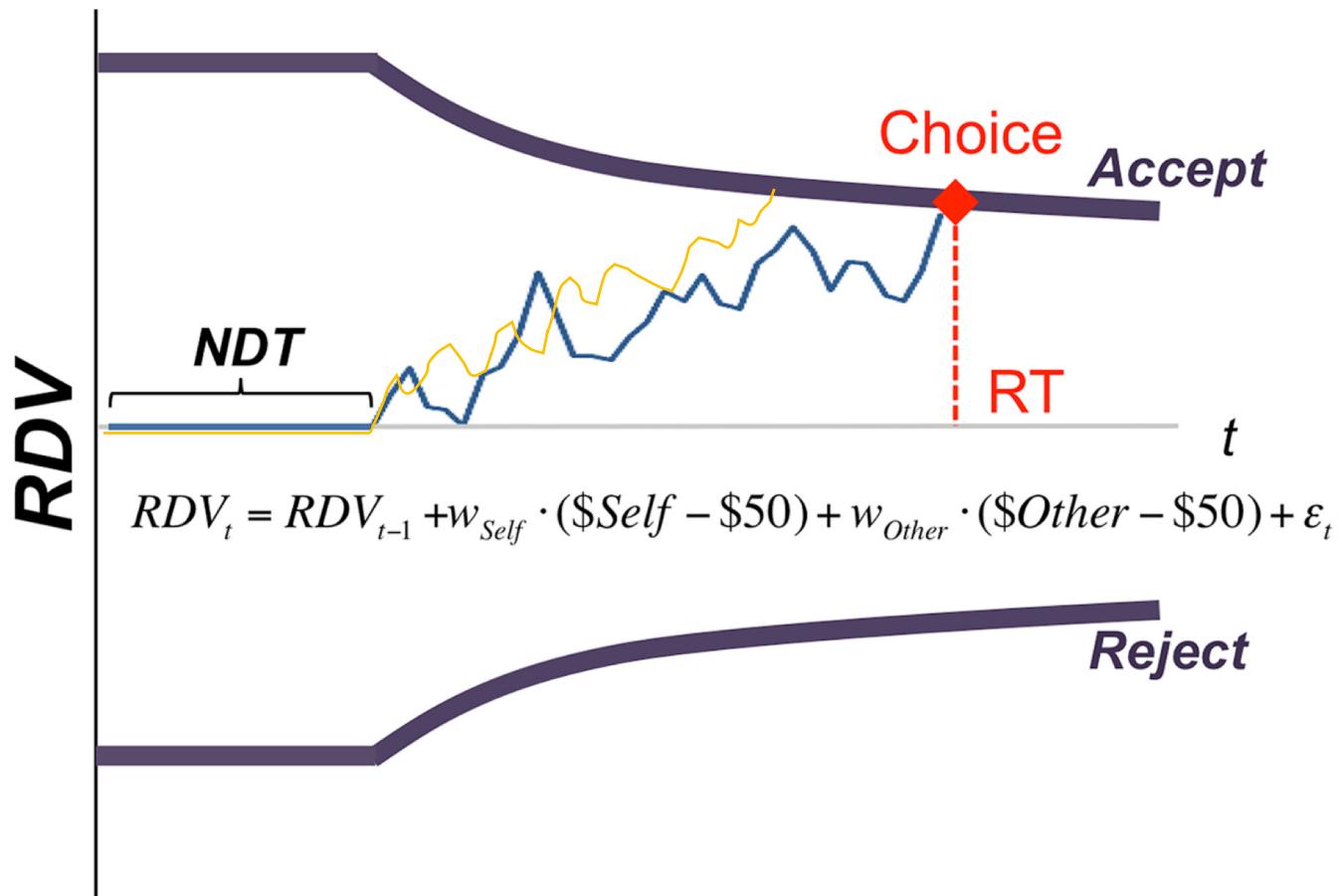
~~Rewarding ?~~

# Results

## Model Implications



Neural Response in Valuation and Comparison regions  
is higher for generous choices

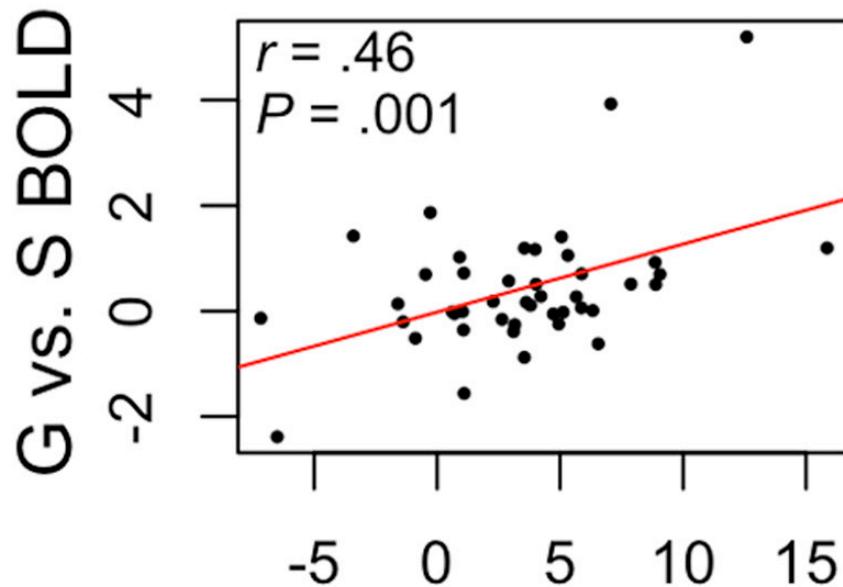


# Results

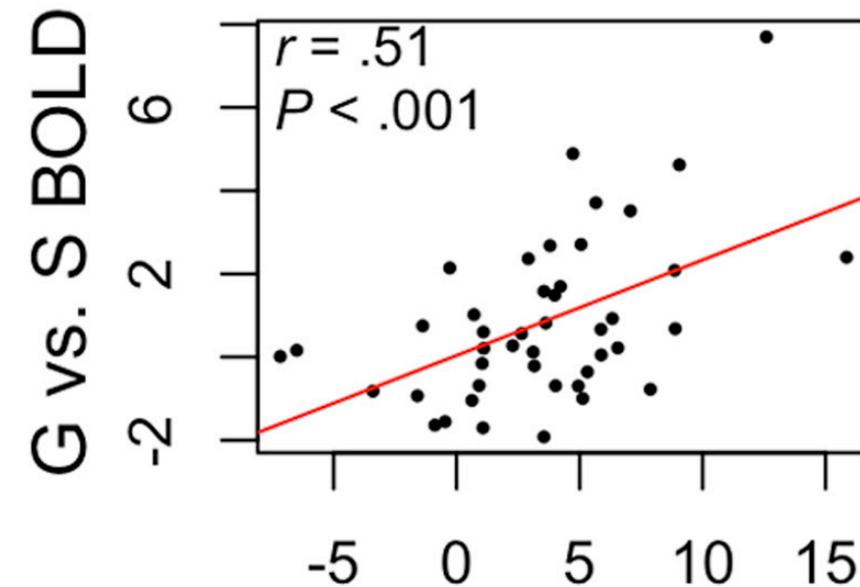
## Model Implications



Neural Response in Valuation and Comparison regions  
is higher for generous choices



Pred. Comparator  
G vs. S choice  
(a.u.)



Pred. Comparator  
G vs. S choice  
(a.u.)

# Results

## Model Implications



RT of Generous vs. Selfish Choice



Neural Response to Generous vs. Selfish Choice



Model Parameters and Generosity



Error Choices and Generosity

# Results



## Model Implications

Relationship between  
Model Parameters and Generosity

$w_{self}$

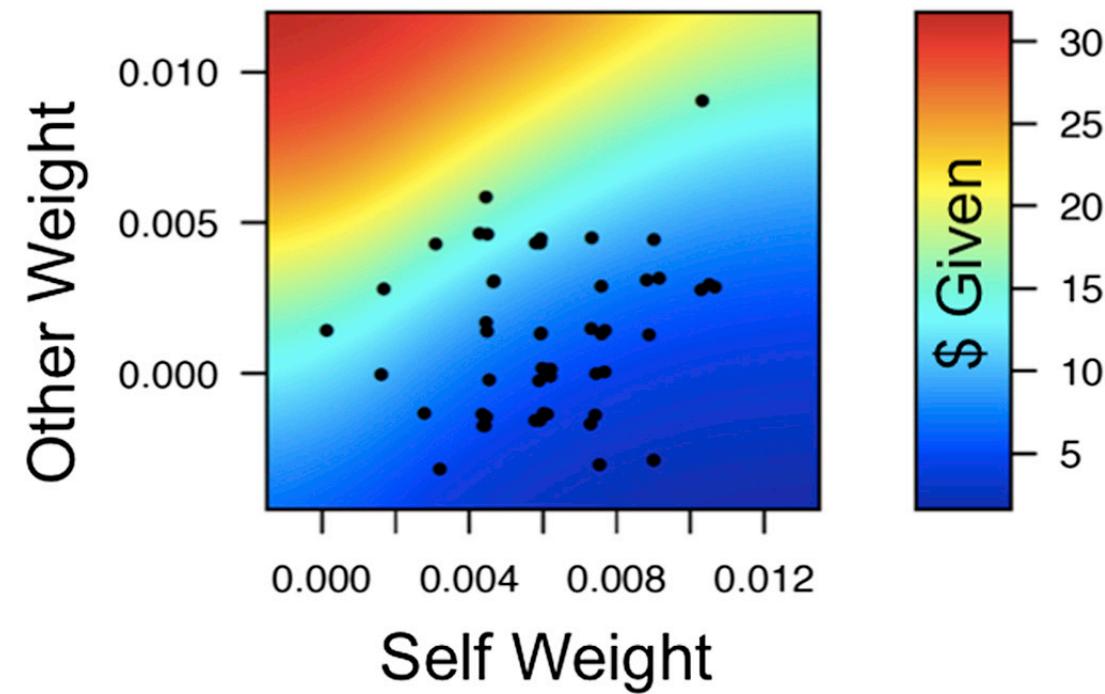
$w_{other}$

$b$

$d$

A

Average  
Generosity



# Results



## Model Implications

Relationship between  
Model Parameters and Generosity

$w_{self}$

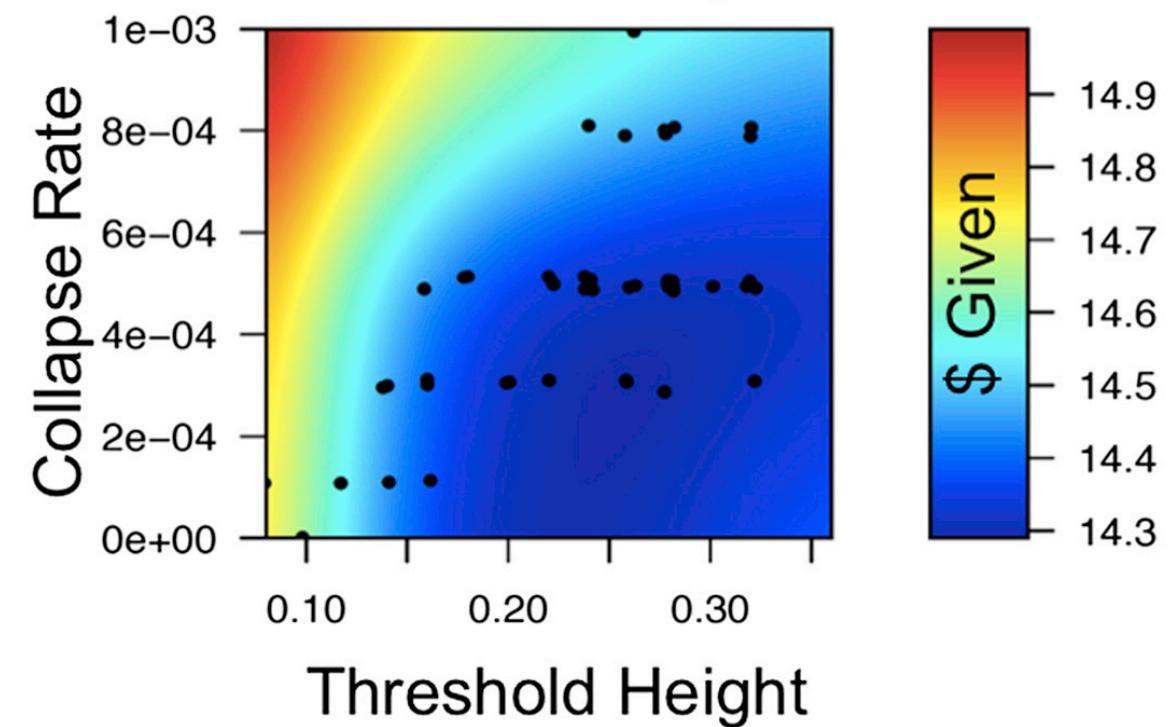
$w_{other}$

$b$

$d$

B

Average  
Generosity



# Results

## Model Implications



RT of Generous vs. Selfish Choice



Neural Response to Generous vs. Selfish Choice



Model Parameters and Generosity



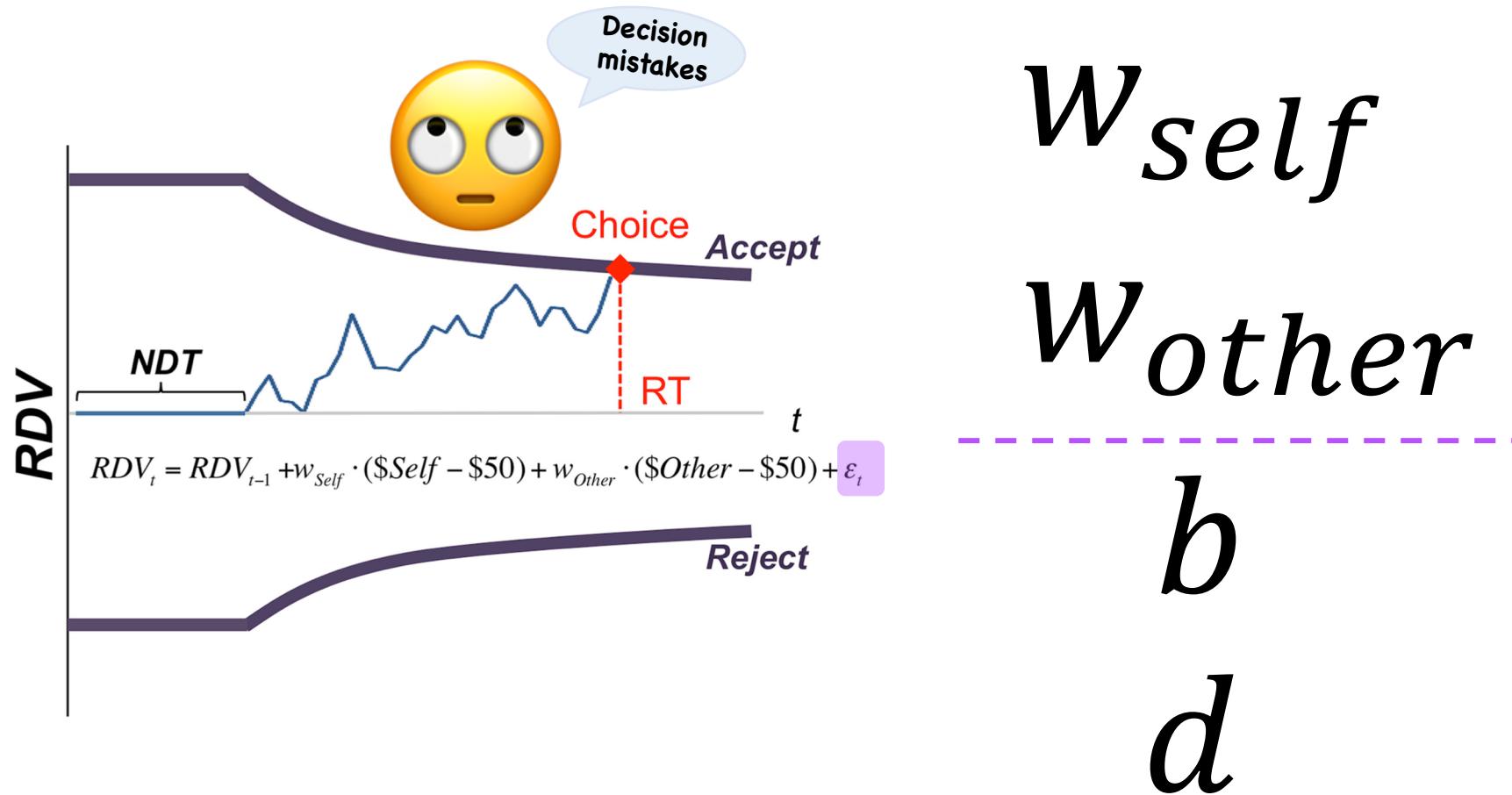
Error Choices and Generosity

# Results

## Model Implications



Errors are more likely  
to involve generous choices



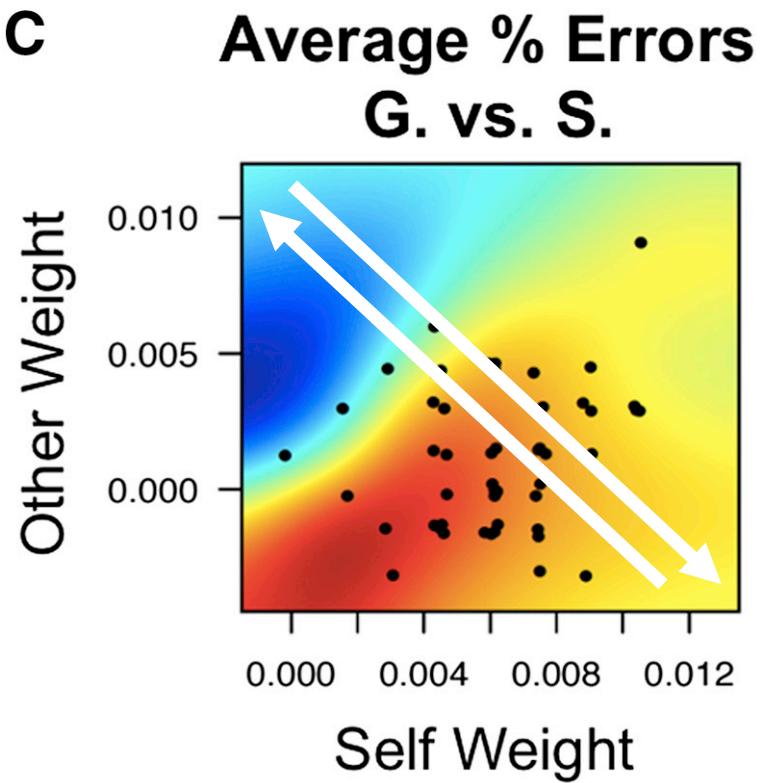
# Results

## Model Implications

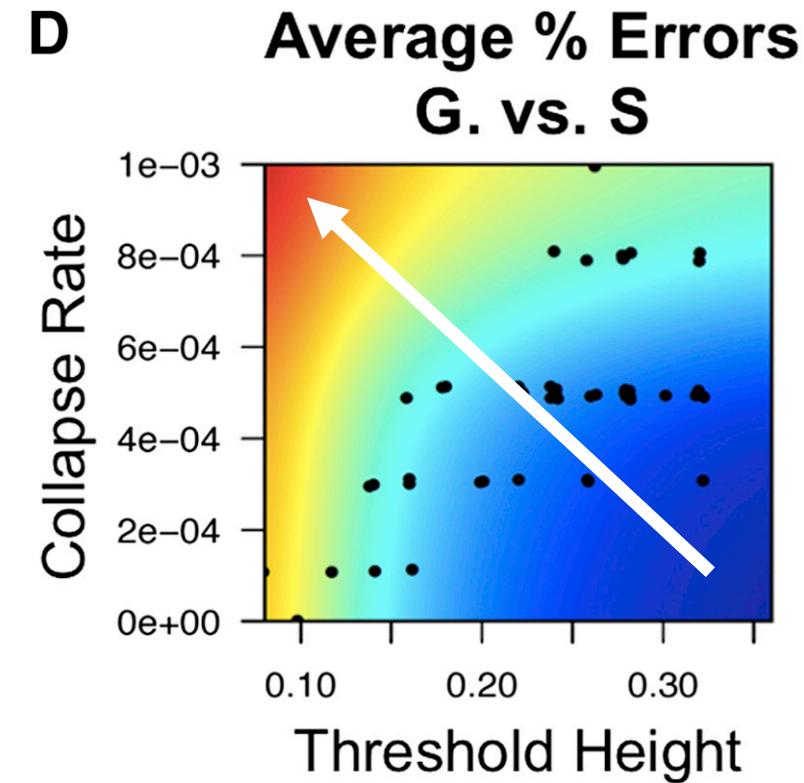


Errors are more likely  
to involve generous choices

C



D

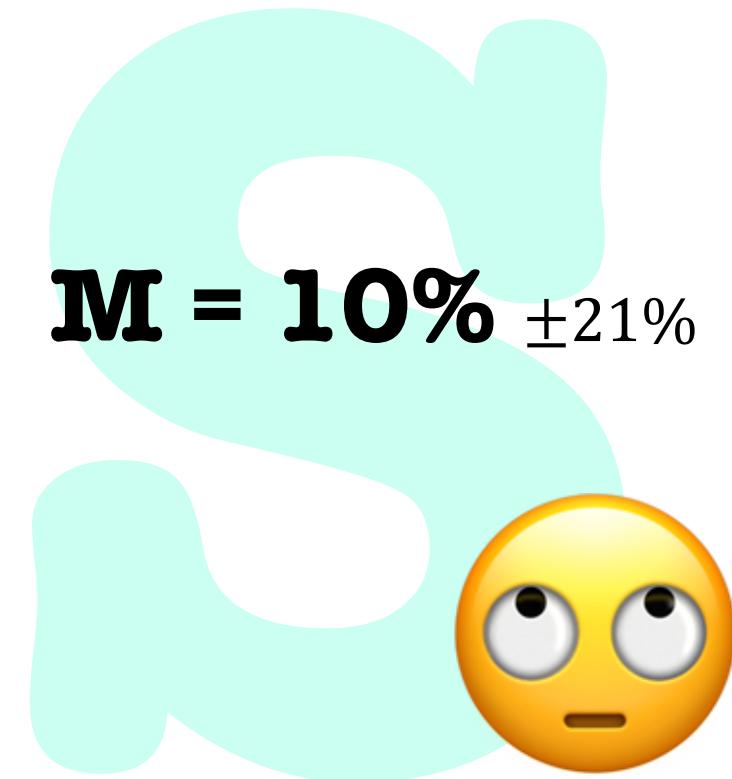
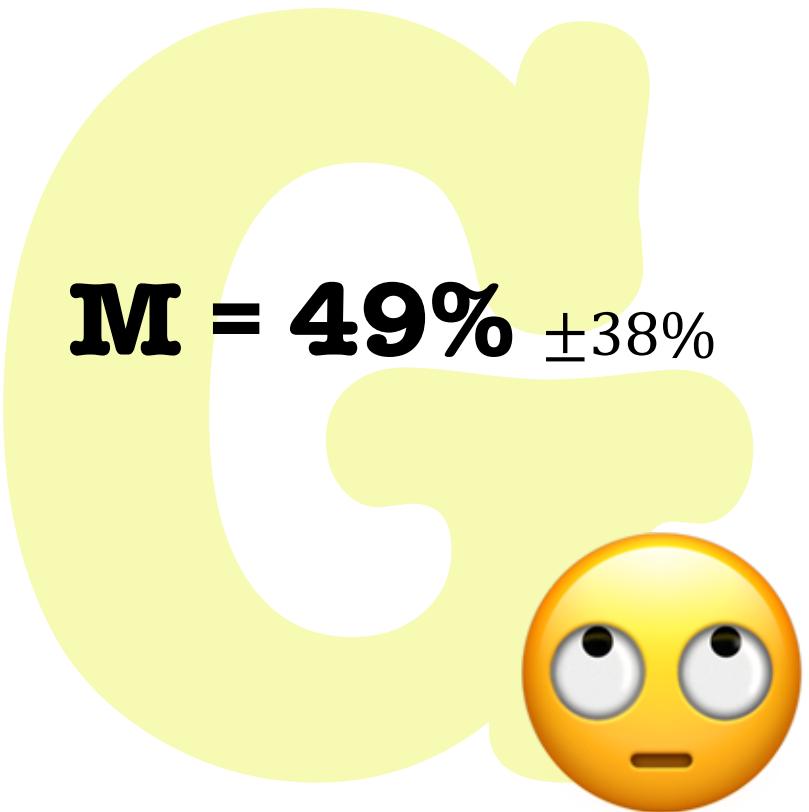


# Results

## Model Implications



Errors are more likely  
to involve generous choices

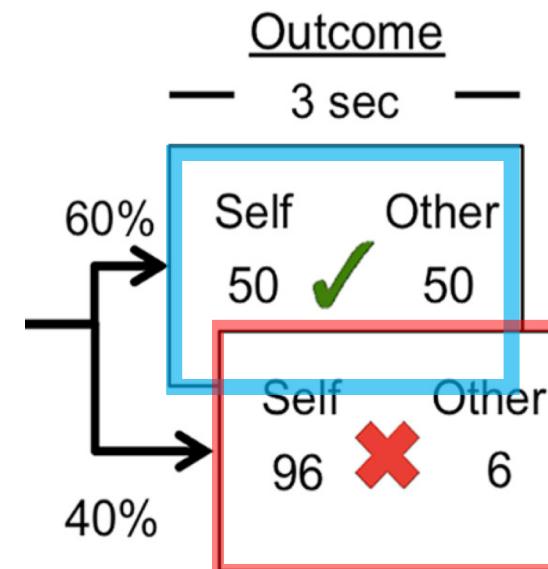
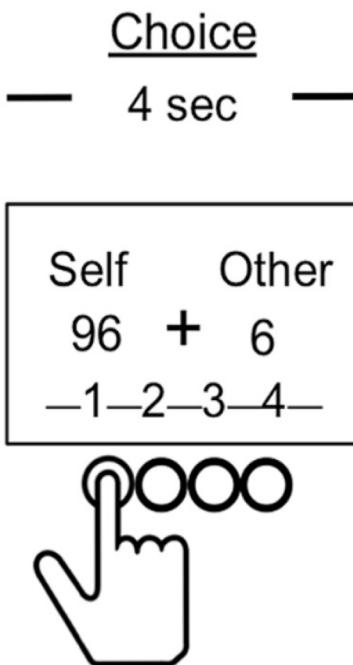


# Results

## Model Implications



Errors are more likely  
to involve generous choices



Positive affect  
Utility-coding

# Results

## Model Implications

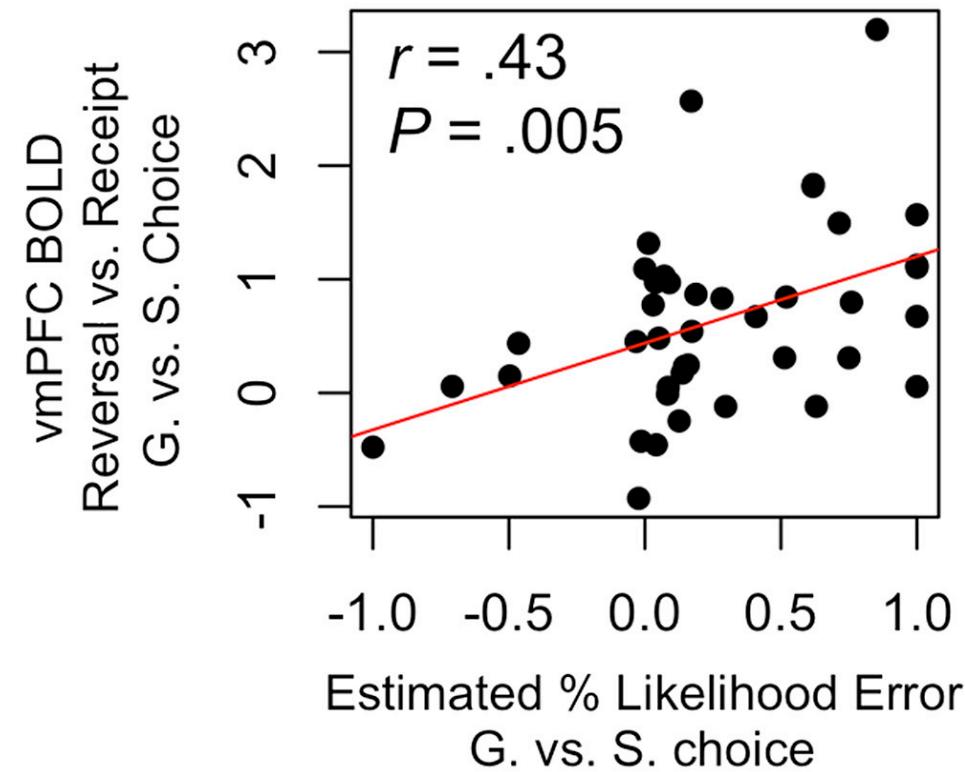


Errors are more likely  
to involve generous choices

A



B



# Conclusion

- Alternative interpretation of altruistic behavior and its neural response
- Exploration of the precise mechanism of manipulations which influence generosity



altruism  
altruism



**Thank you 😊**

# Any Questions ?

