RacLab

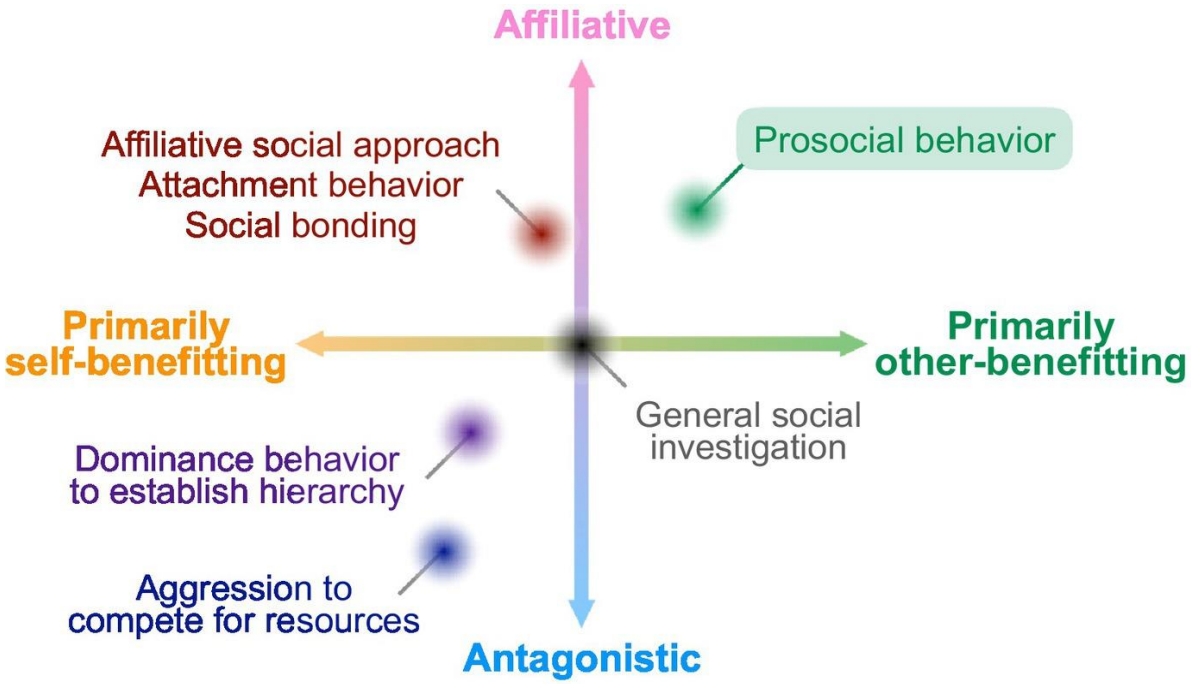
Selfish behavior requires top-down control of prosocial motivation

bioRxiv; 2024

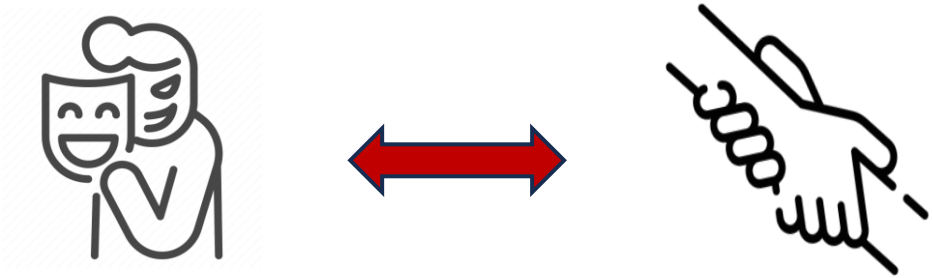
Yang Ziyang

2025.4.10

Introduction



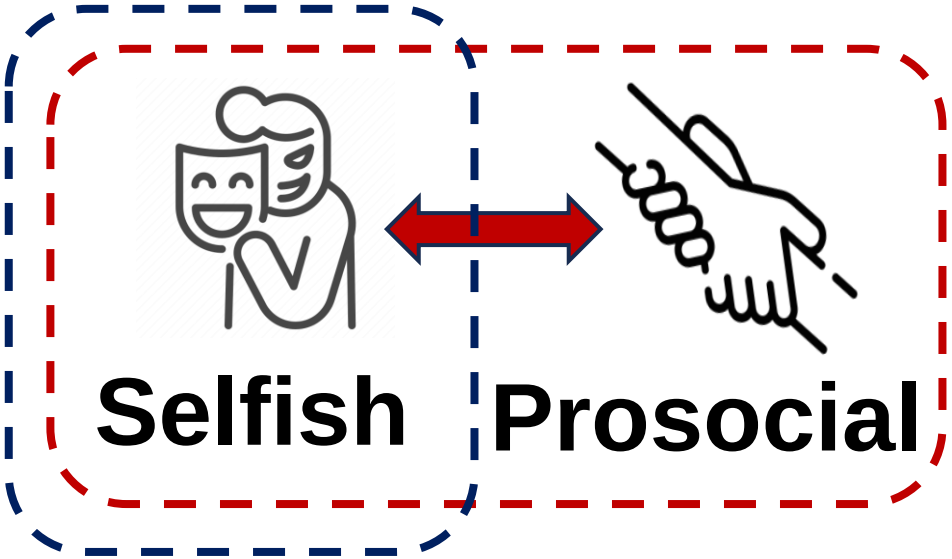
(Wu et al, 2022; TiNC)

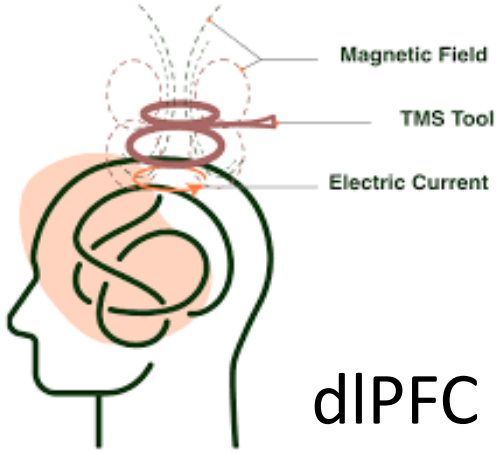


Selfish **Prosocial**

Introduction

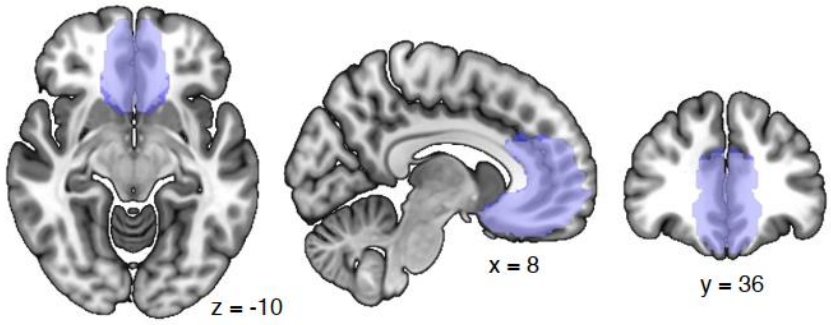
exerting cognitive control





dlPFC

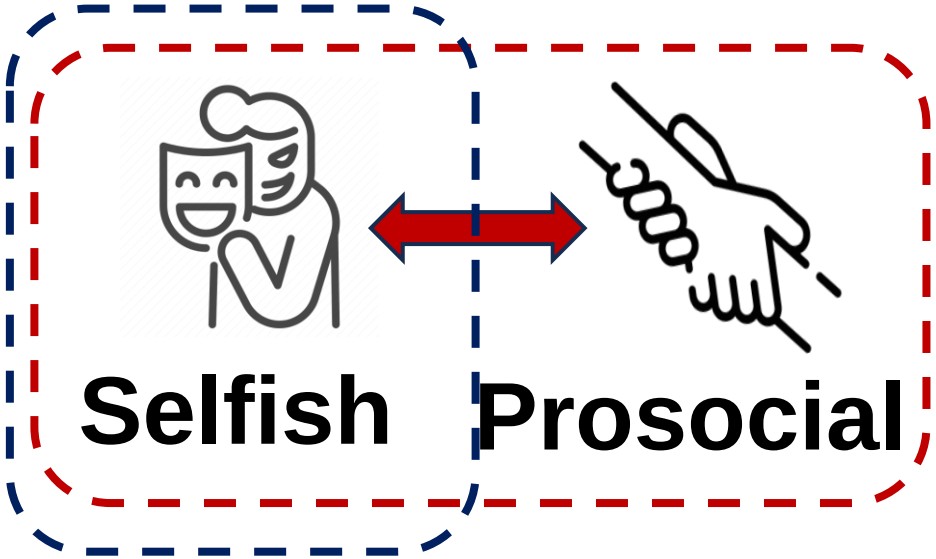
Low frequency TMS



vmPFC

Introduction

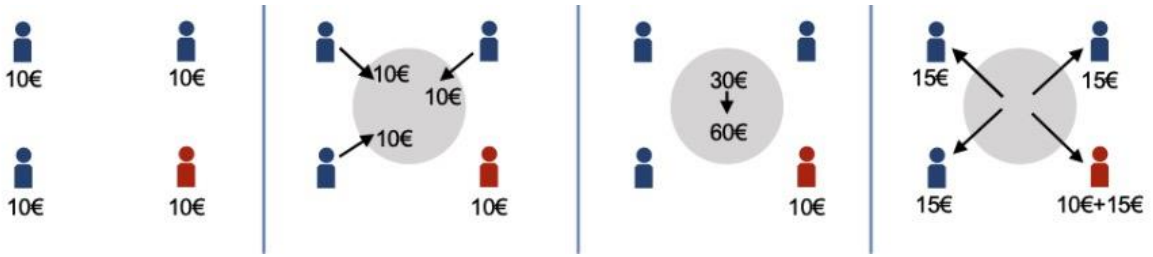
exerting cognitive control

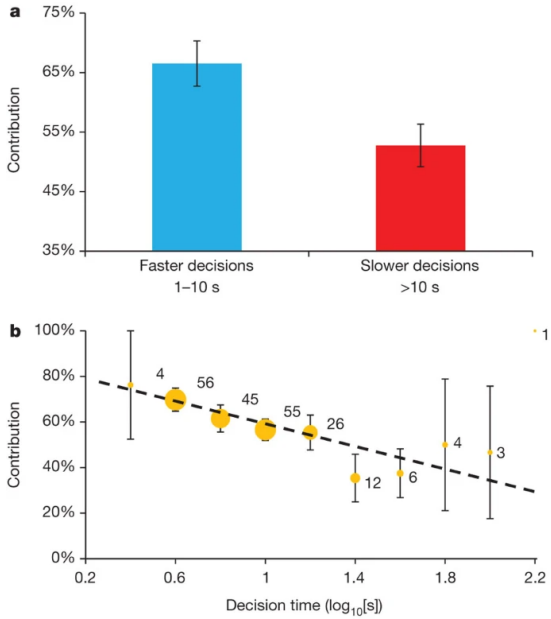


nature

Spontaneous giving and calculated greed

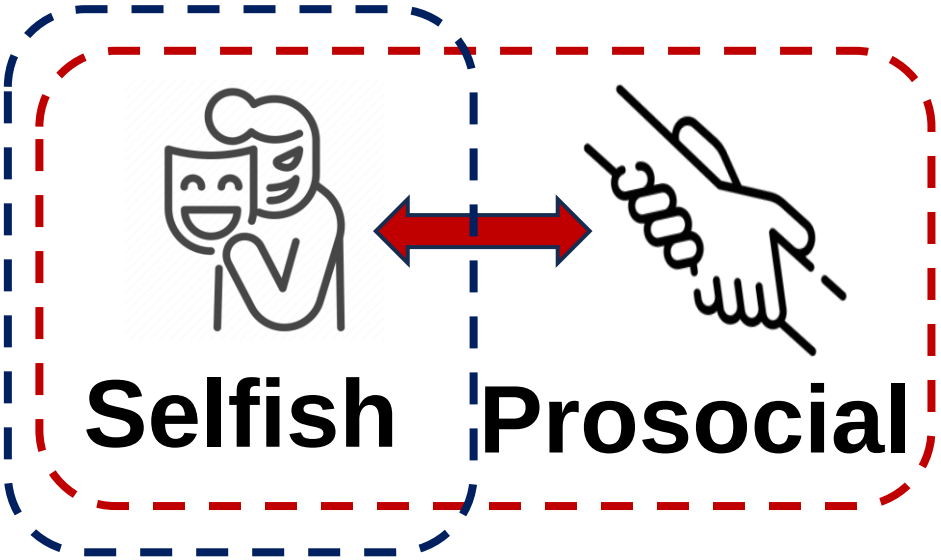
David G. Rand, Joshua D. Greene & Martin A. Nowak





Introduction

Prosocial behaviors are often faster than *Proself behaviors*



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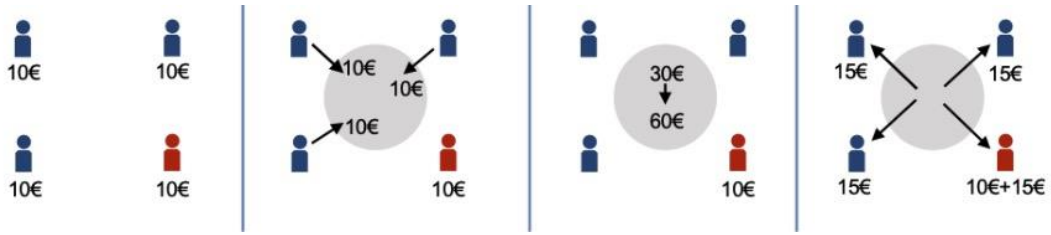
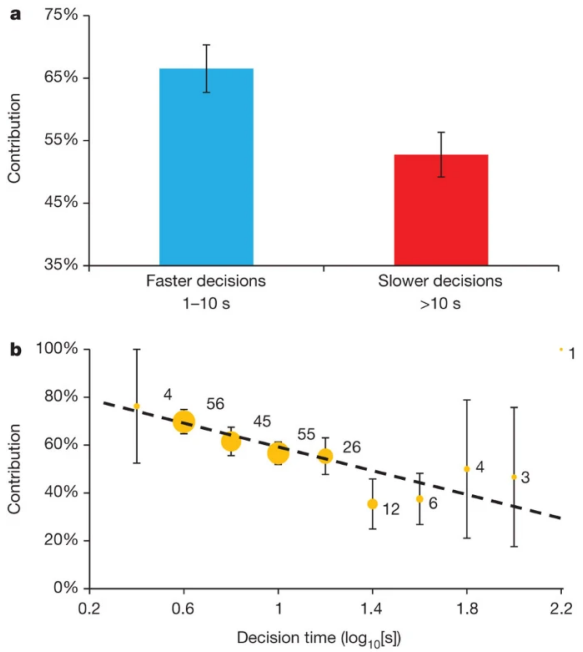
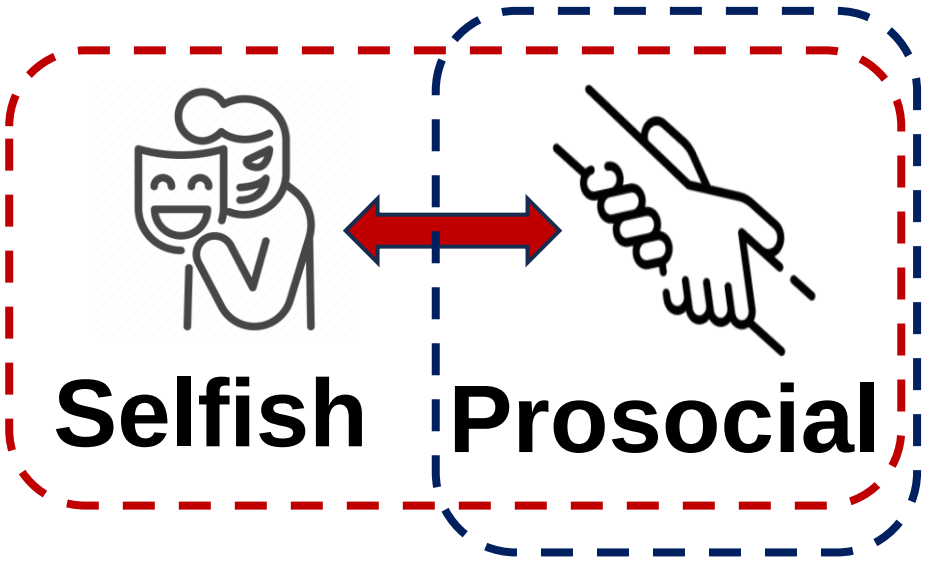


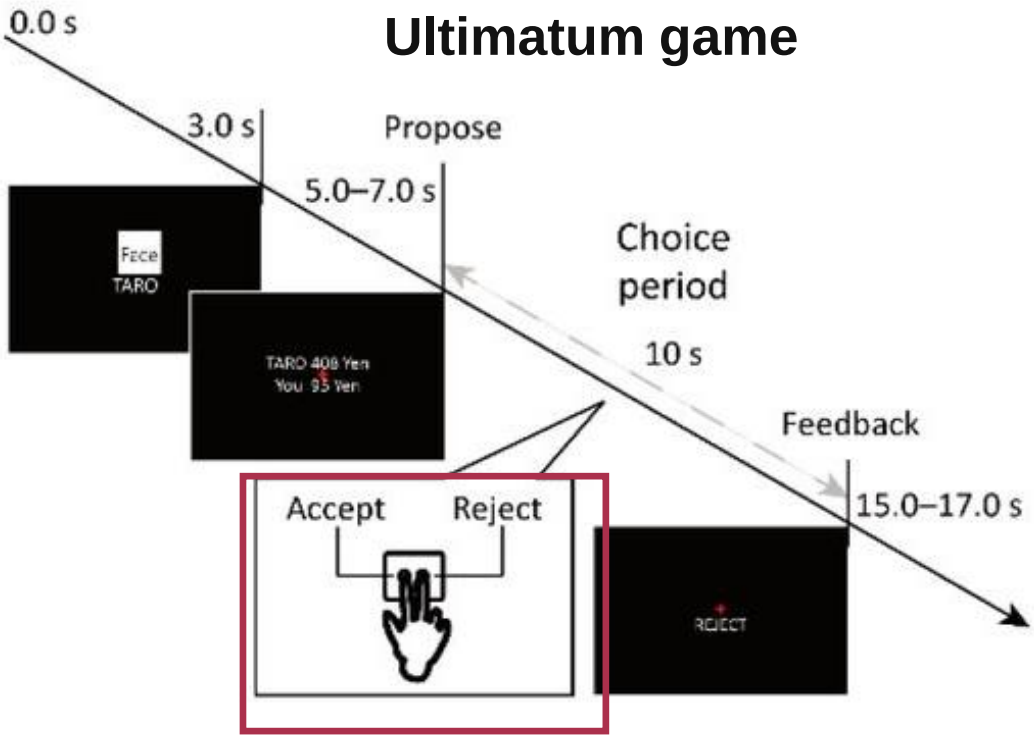


Introduction



top-down control of intuitive prosocial motives underlies the selection of proself behaviors

Design



- 58 participants
  (36 males and 22 females)

(self-reward; SR) - (other-reward; OR)

7-3; 3-2;
1-1;
2-3; 3-7; 1-4; 1-9

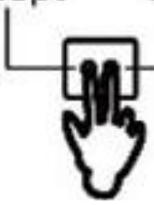
advantageous inequity (AI)

disadvantageous inequity (DI)

**adding a uniform random number ranging from ¥-25 to ¥25 in each trial*

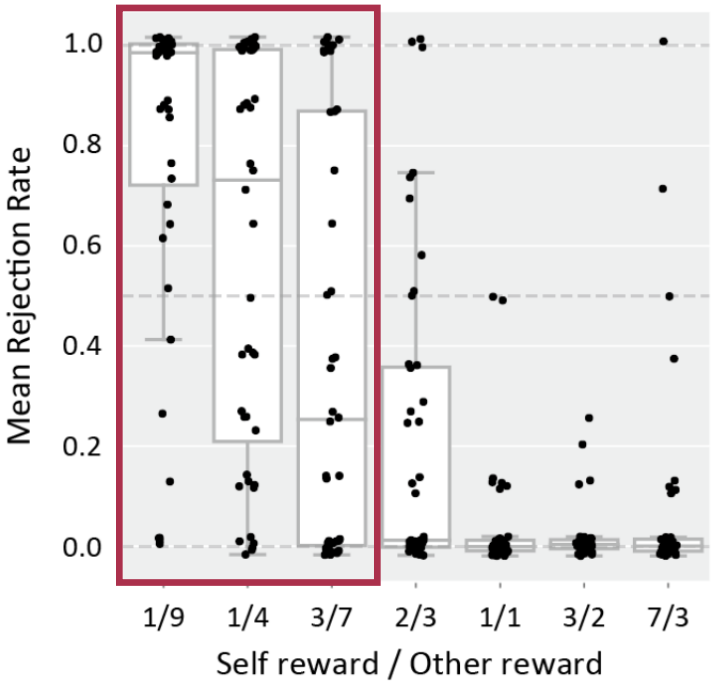
acceptance of unfair offers — be seen as a form of proself behavior

rejection of unfair offers — be seen as a form of altruistic punishment

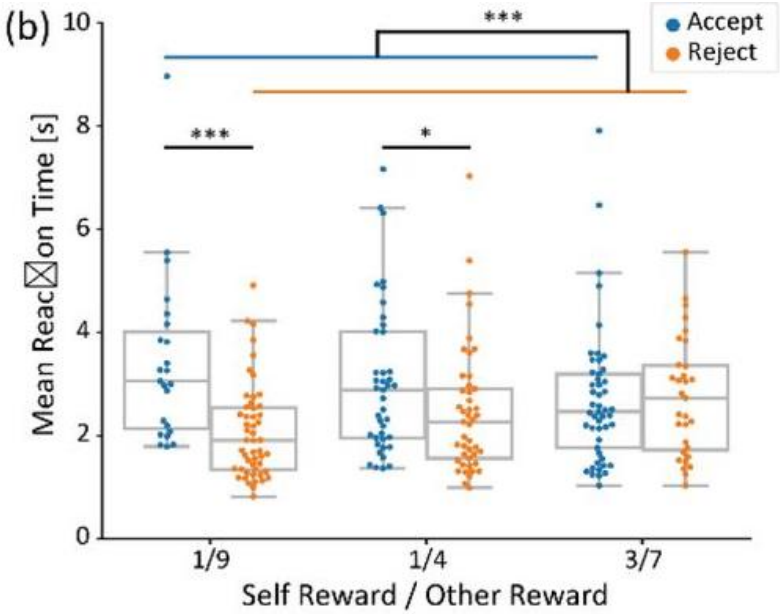


- eight trials for each based offer, 56 trials in total

Result



Participants rejected more as the degree of DI increased

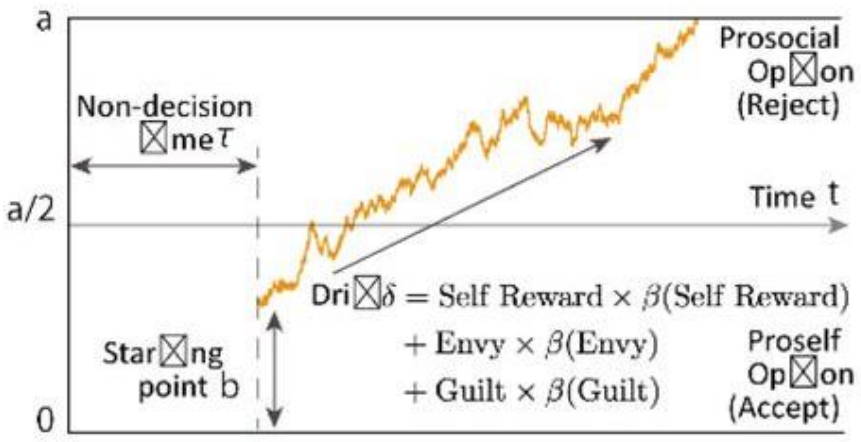


Proself longer

Only for disadvantageous offers were acceptances (proself choices) slower than rejections (prosocial choices)

Result

上限和下限之间的距离a
相对起点b;
漂移率δ
非决策时间τ



evidence height (a) and non-decision time (τ) to be constant across all part

$$\mathrm{DI}_t = \max(\text{other-reward}_t - \text{self-reward}_t, 0)$$

$$\mathrm{AI}_t = \max(\text{self-reward}_t - \text{other-reward}_t, 0),$$

$(SR)_t$ = Self Reward is the reward for the participant

Nelder-Mead Method

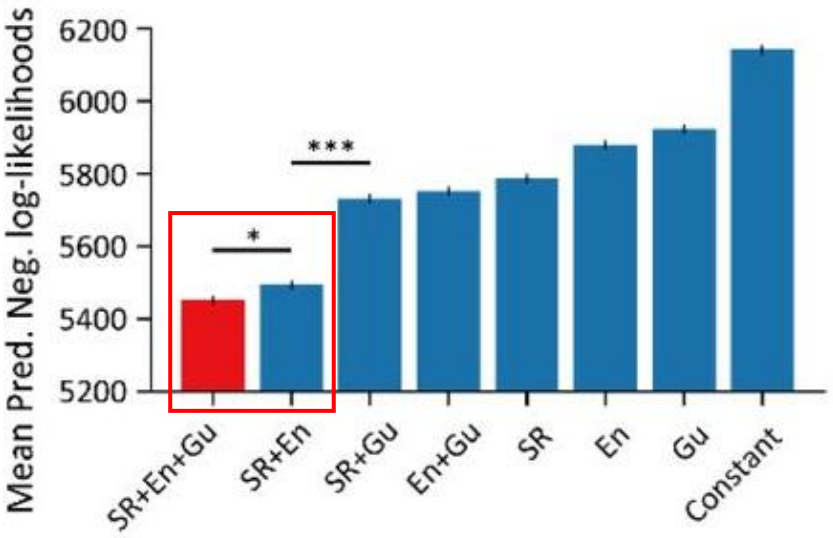
$$\delta_t = \sum_{X \in 2^{\Omega}} \beta(X) \times X_t,$$

Ω = {SR, AI, DI}

$$\delta_t = \begin{cases} \beta(\mathrm{SR}) \times \mathrm{SR}_t \\ \beta(\mathrm{AI}) \times \mathrm{AI}_t \\ \beta(\mathrm{DI}) \times \mathrm{DI}_t \\ \beta(\mathrm{SR}) \times \mathrm{SR}_t + \beta(\mathrm{AI}) \times \mathrm{AI}_t \\ \beta(\mathrm{SR}) \times \mathrm{SR}_t + \beta(\mathrm{DI}) \times \mathrm{DI}_t \\ \beta(\mathrm{AI}) \times \mathrm{AI}_t + \beta(\mathrm{DI}) \times \mathrm{DI}_t \\ \beta(\mathrm{SR}) \times \mathrm{SR}_t + \beta(\mathrm{AI}) \times \mathrm{AI}_t + \beta(\mathrm{DI}) \times \mathrm{DI}_t \\ \text{Constant only.} \end{cases}$$

Result

上限和下限之间的距离a
相对起点b;
漂移率δ
非决策时间τ

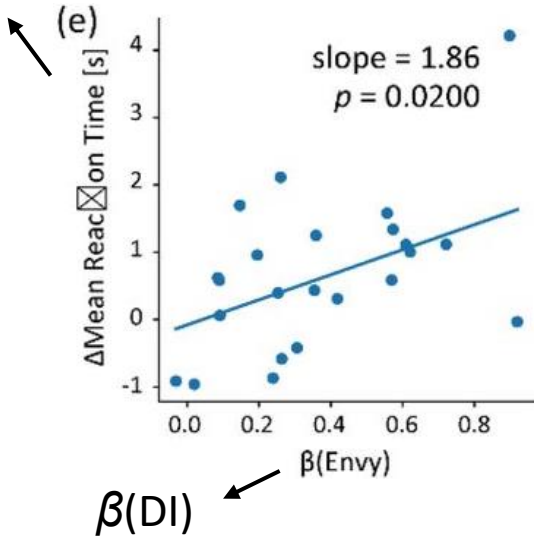


$$\beta(\mathrm{SR}) \times \mathrm{SR}_t + \beta(\mathrm{DI}) \times \mathrm{DI}_t$$

$$\beta(\mathrm{SR}) \times \mathrm{SR}_t + \beta(\mathrm{AI}) \times \mathrm{AI}_t + \beta(\mathrm{DI}) \times \mathrm{DI}_t$$

DI and SR
in the drift term are important

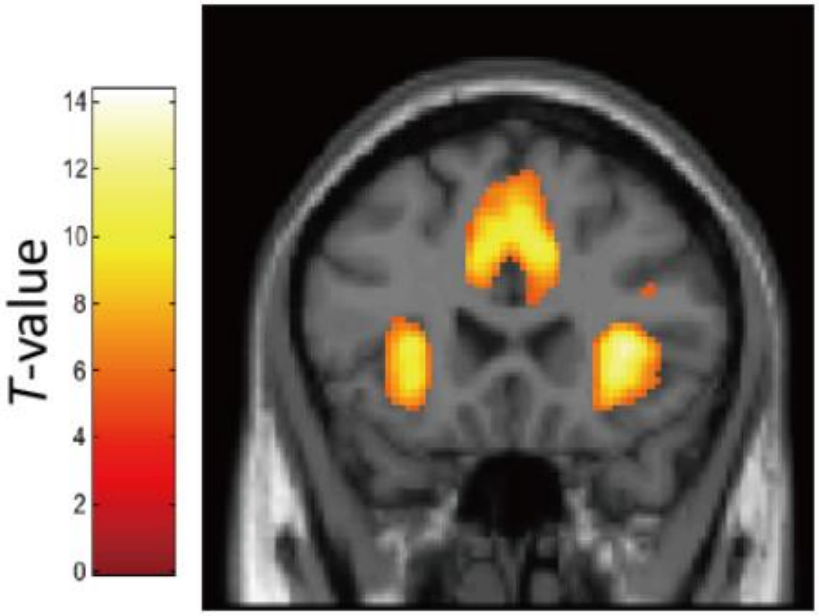
individual differences between the mean reaction times for acceptance and rejection



β(DI)

β(DI) showed the strongest correlation with both the mean rejection rate(r = 0.689 and $p = 3.22 \times 10^{-16}$) and the mean reaction time(r = -0.409 and $p = 1.40 \times 10^{-3}$)

Result



successfully captured brain activity patterns reported in previous studies

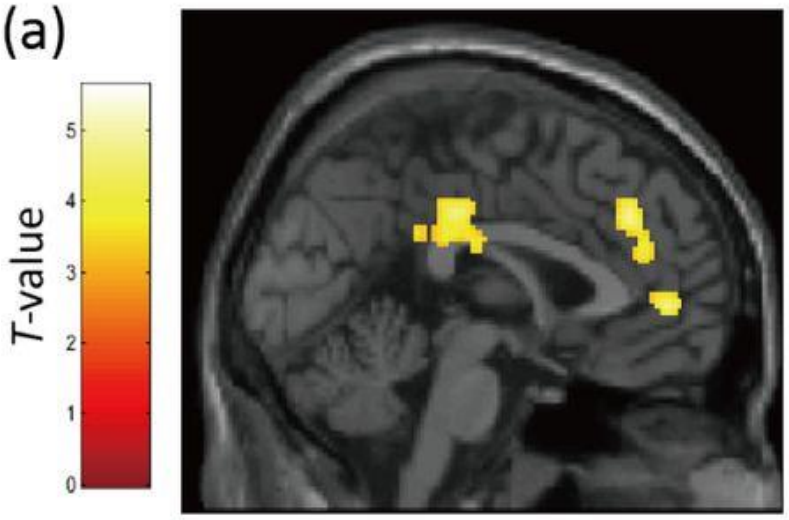
strong activations in the *bilateral anterior insula(AI)* and *dACC*

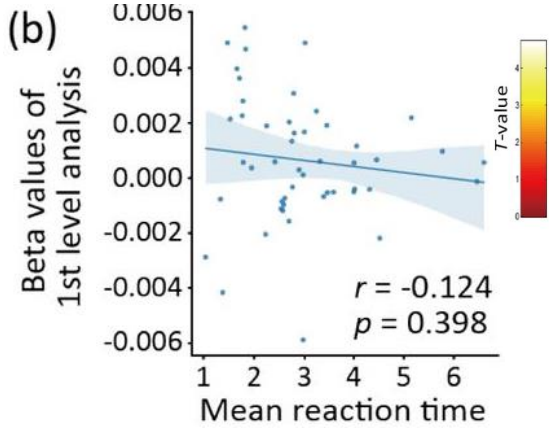
Result

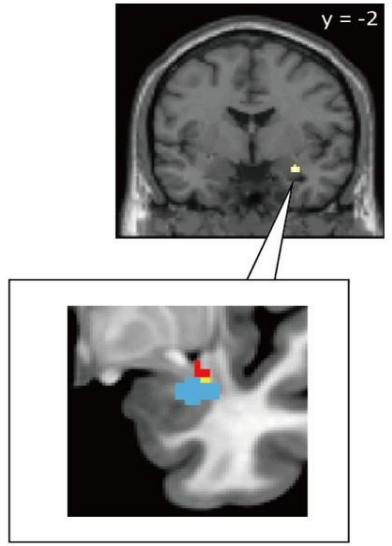
1. conducted a within-participant (first level) general linear model (GLM) analysis for the disadvantageous-offer onsets
2. performed a group-level (second level) one-sample t-test to replicate the previous studies for DI

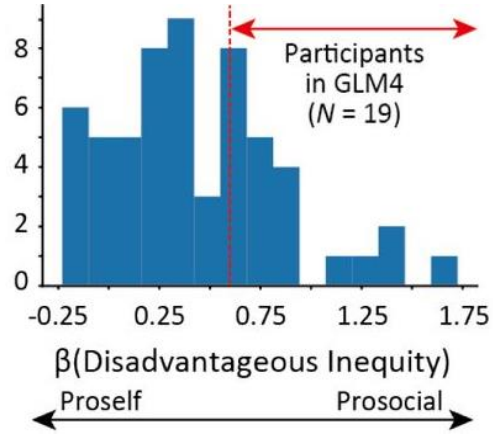
For disadvantageous offers, accepting behavior is realized by top-down control (or suppression) of the aversion to DI.

寻找在个体层面活动与 DI 相关且群体 beta 值与 $-\beta$(DI)相关的大脑结构





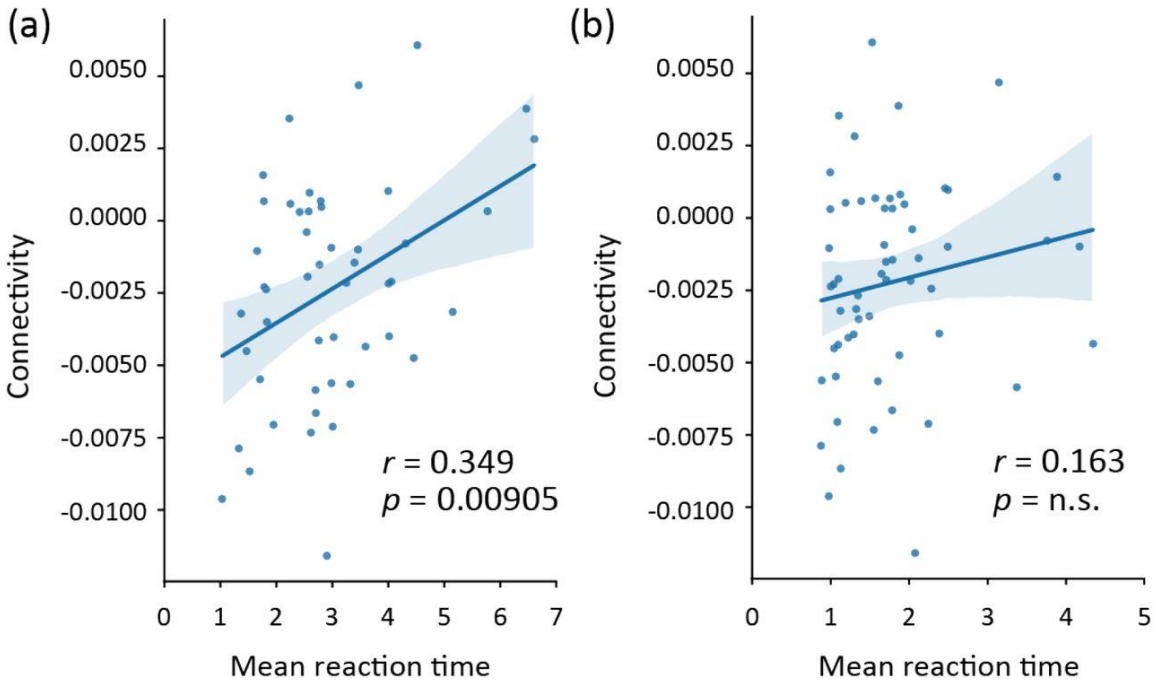




dACC and *posterior cingulate cortex (PCC)*

Result

this negative interaction between the dACC and amygdala encodes the response times for accepting disadvantageous offers?



dACC 通过对杏仁核中编码的 DI 厌恶进行认知控制，从而为接受 DI 奠定了基础

disadvantageous inequity (DI)

advantageous inequity (AI)

Result

$$v(t) = V_{\{t,\text{prosocial}\}} - V_{\{t,\text{proself}\}}. \quad \Rightarrow \quad p_{\text{prosocial}}(t) = 1/\left[1 + \exp\left(-v(t)\right)\right].$$

assumed that the best predictive logistic model has the same components as the drift term in the best predictive DDM

0

$$V_{\{t,\text{prosocial}\}} = \gamma_0 \times g_{\{t,\text{prosocial}\}}$$

$$V_{\{t,\text{proself}\}} = \gamma_0 \times g_{\{t,\text{proself}\}} - \gamma(\text{AI}) \times \text{AI}_t - \gamma(\text{DI}) \times \text{DI}_t,$$

$SR_{(t)}$

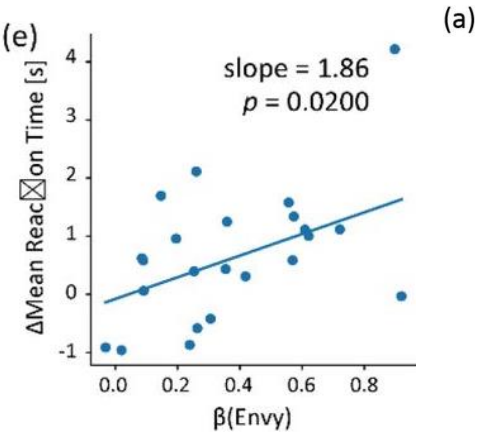
Result

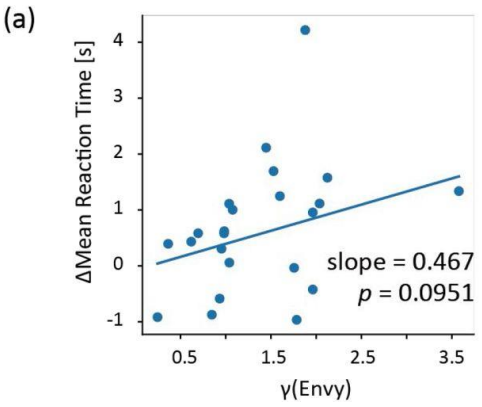
compared the DDM and a standard value-based model (i.e., a logistic model)

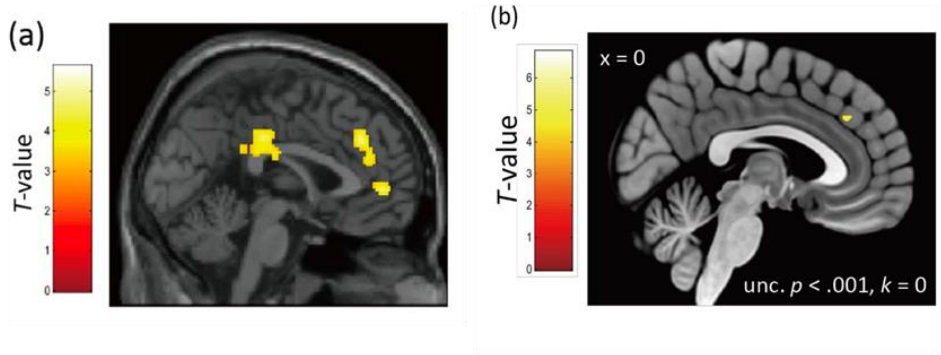
	Drift diffusion model	Logistic model
choices	✓	✓
reaction times	✓	✗

V.S.

所有二级回归量都被逻辑模型的系数取代







identified much weaker activity in the dACC

confirmed that only the DDM can capture behaviors in the time domain

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Selfish behavior requires top-down control of prosocial motivation

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