DELIBERATIVE EVALUATION IN INTERTEMPORAL CHOICE IS SHAPED BY EXPERIMENT STRUCTURE

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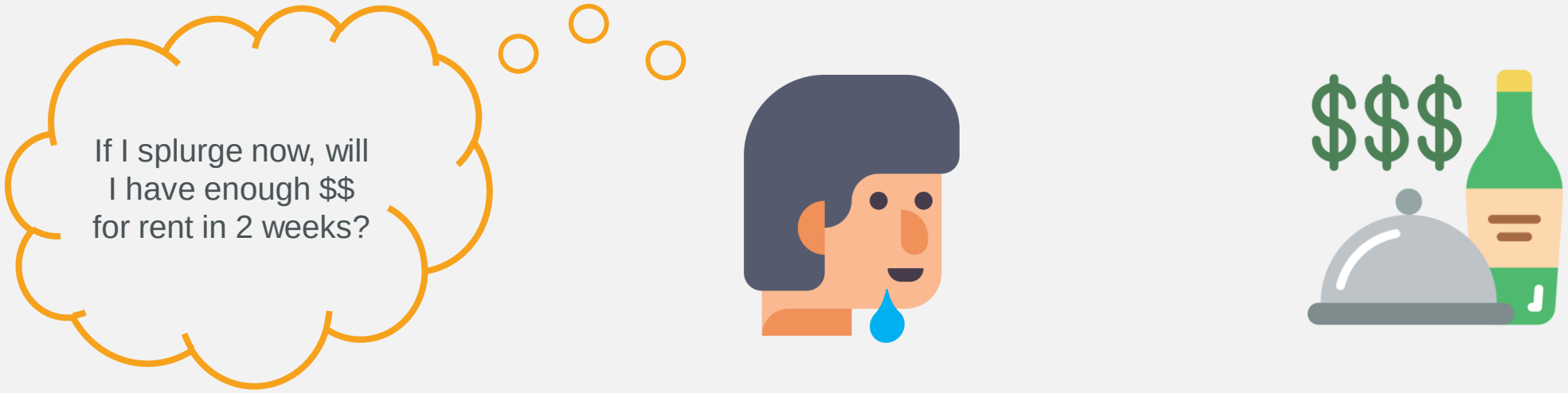
BACKGROUND

Popular **theories of intertemporal choice** involve **simulating the future** (Peters & Buchel, 2010).



Experiments typically consist of a **randomized sequence of** such **choices** (Hunter et al, 2018).

If individuals are indeed simulating their future, they may **cache the outcome** and **reuse** it **on the next trial** (Dasgupta et al, 2018).

BACKGROUND

This might result in **spillover**: the unintentional* influence of recent history on current choice and/or response time.

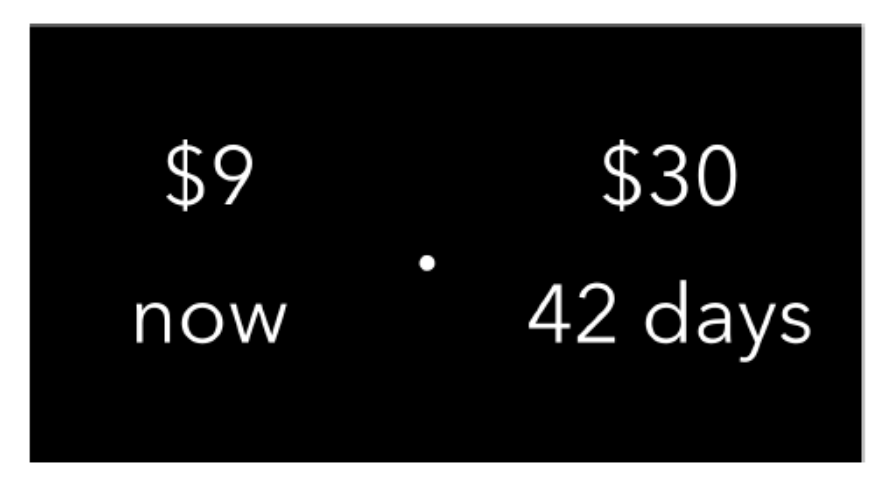
Thus, it could be an **important source of variability** in our statistical inference and can **affect psychological interpretation**.

As **reaction time measures deliberation in choice** (Hunter et al, 2018), our **goal** was to **quantify the presence/absence of stimulus-driven spillover effects in response time**. We did this by using hierarchical Bayesian methods to model trial-trial variability in reaction time.

QUESTION

Is deliberation sensitive to spillover effects?

INTERTEMPORAL CHOICE TASK



SS
"Smaller
Sooner"

LL
"Larger
Later"

n = 482

trials = 102

In person data collection

Randomized trials
No "feedback"
Incentive Compatible

DRIFT DIFFUSION APPROXIMATION

DDM: models deliberative process (through choice and RT) as the noisy accumulation of evidence

Key Parameters:

Bias: predisposition towards *SS* or *LL*
Drift Rate: rate of evidence accumulation
Threshold: amount of information needed to make choice

DRIFT DIFFUSION APPROXIMATION

$$Decision\ Time\ (DT) = \frac{threshold}{drift\ rate} \tanh(thresh \cdot drift)$$

Bogacz et al, 2006

$$RT \sim logNorm\ (\log(DT)\ , \sigma_{RT}^2)$$

As we want to **build stimulus properties** into the **DDM**:

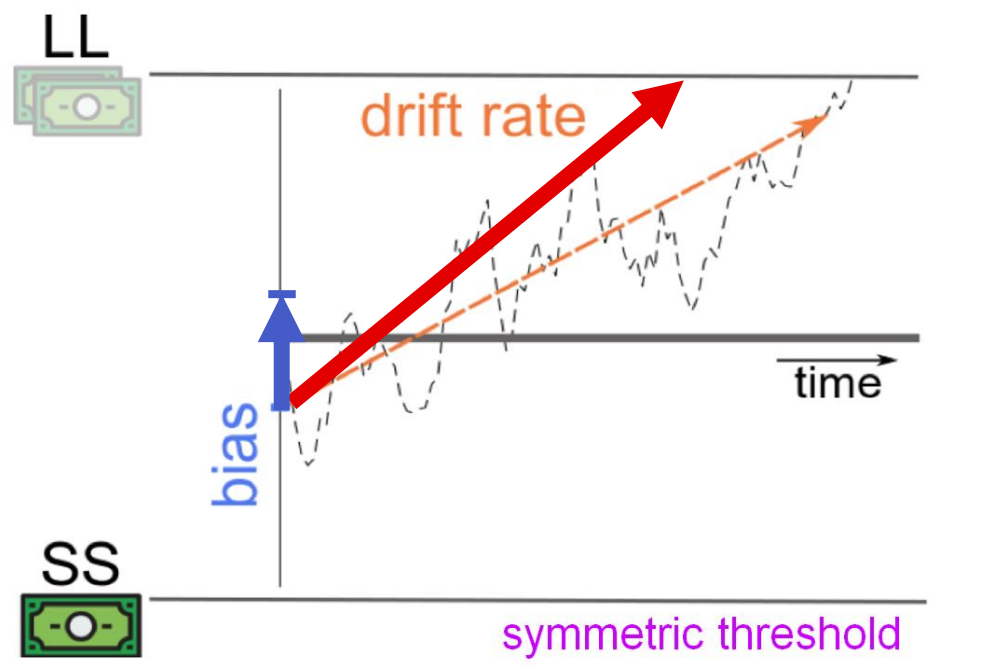
$$driftrate = \beta_0 + \beta_1 \cdot \boldsymbol{value\ difference} + \beta_2 \cdot \boldsymbol{delay}$$

Bias: predisposition towards *SS* or *LL*

Drift Rate: rate of evidence accumulation

Threshold: amount of information needed to make choice

QUANTIFYING SPILLOVER

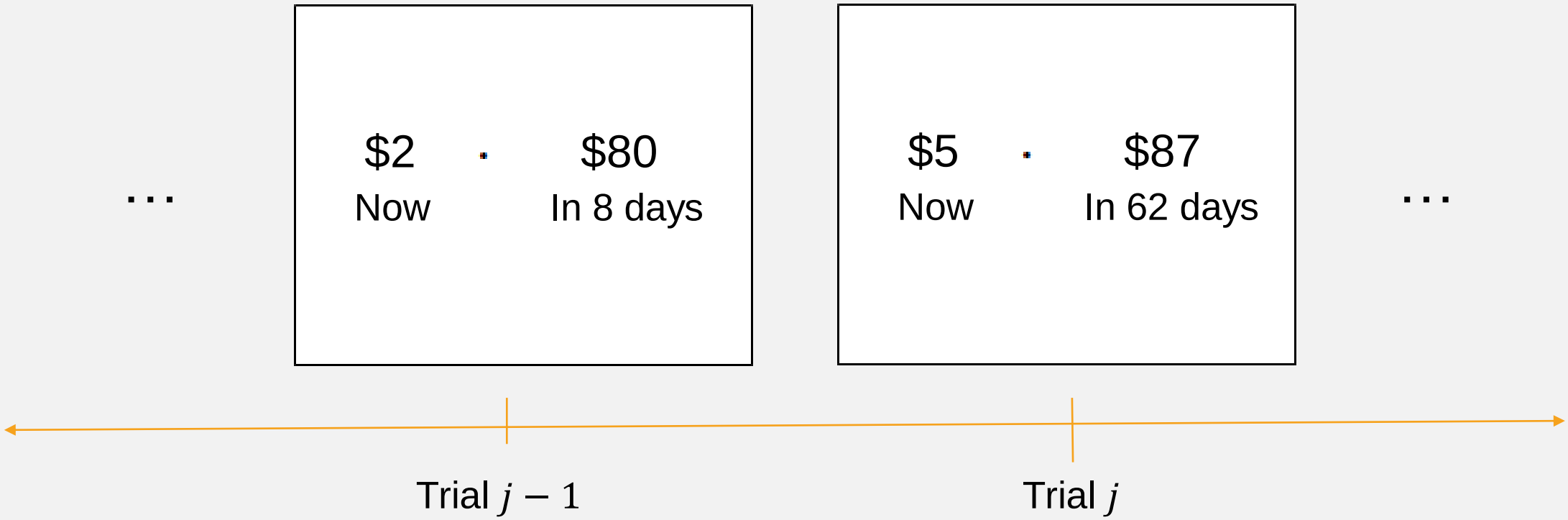


Darker color: with sequential effects

Allow **drift rate components**, $\beta_0, \beta_1, \beta_2$, *and* **bias** (4 parameters total) to change as a function of previous and current trial properties: **differences** in **reward value** and/or **delay**

QUANTIFYING SPILLOVER

$i = 1, \ldots, 482\ subjects; j = 1, \ldots, 102\ trials$



π_{ij} = *High delay* ***difference*** *x low value* ***difference***

$$\beta_2' = \beta_2 + \boldsymbol{\delta} \cdot \pi_{ij}$$

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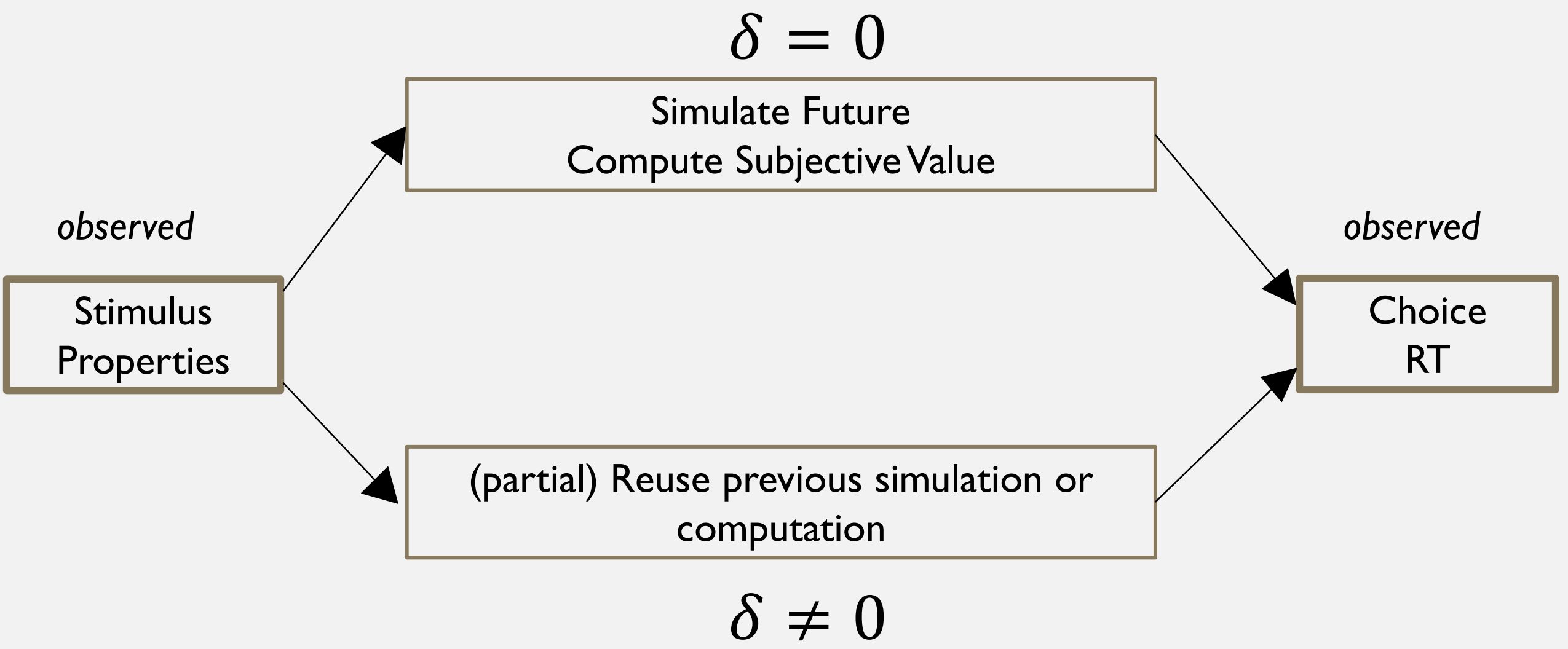
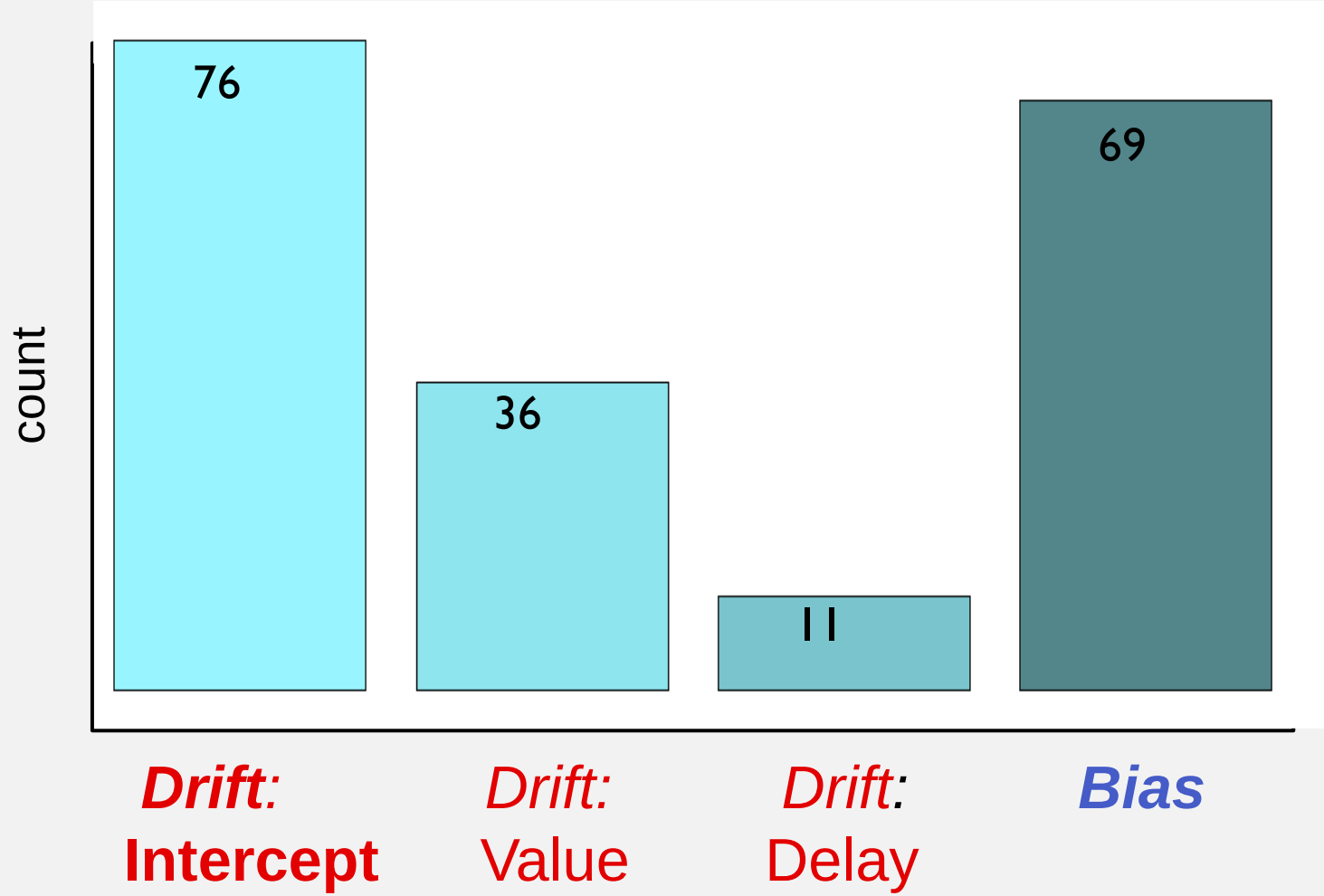
e.g. π_{ij} = *High delay* ***difference*** *x low value* ***difference***

QUANTIFYING SPILLOVER



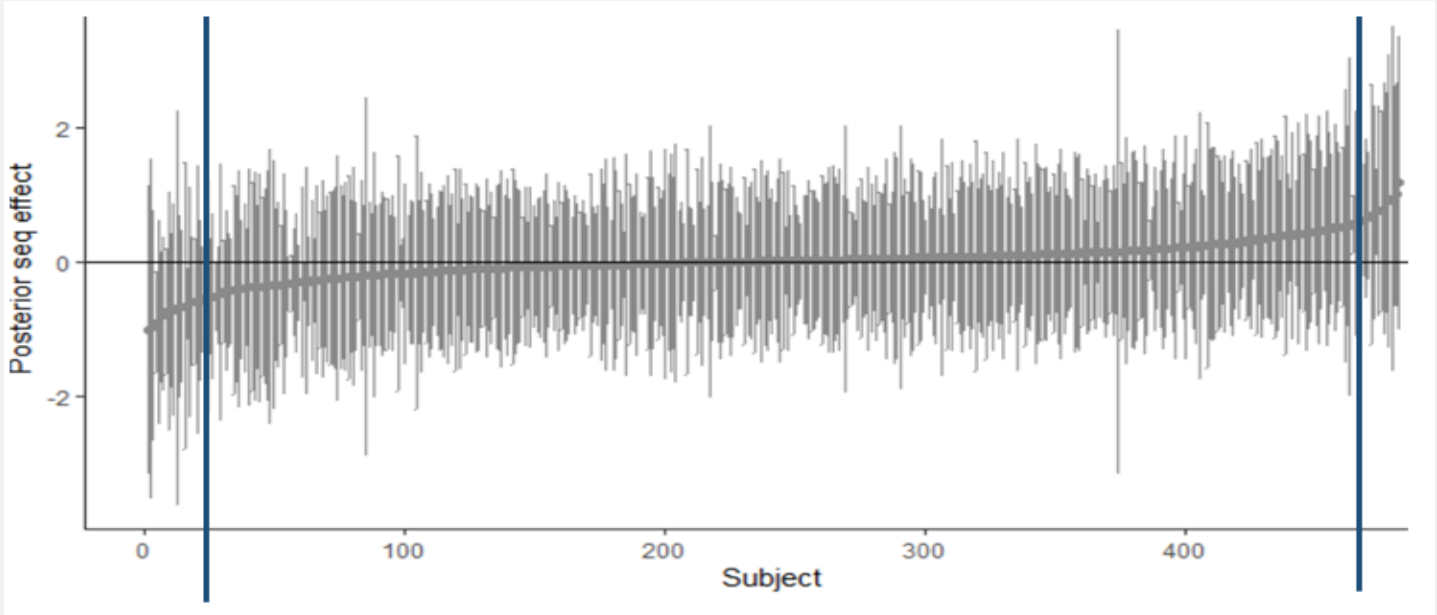
RESULTS

134 subjects out of 482 show evidence **in favor of spillover effects** across stimulus space (BF > 3)



RESULTS

We find evidence of considerable individual differences in the ***magnitude*** and ***direction*** of effects.



Posterior drift rate intercept parameter after adjusting for trial-trial influence of high delay x low value difference trials

RESULTS + TAKE HOME

Finally, for **58%** of these 134 **subjects**, **spillover adjusted parameters *change sign***, and therefore, **change psychological interpretation:** e.g. someone identified as patient is actually impulsive.

Take Home: It is critical to explicitly account for trial-trial dependencies even in higher order cognition tasks.

THANKS!

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