Deliberative evaluation in intertemporal choice is shaped by experiment structure

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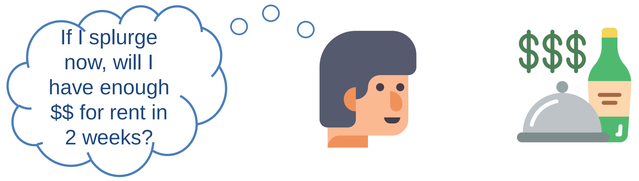
Background

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).

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

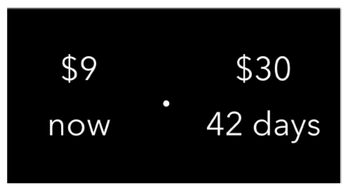
Thus, it could be an **important source of variability** in our statistical inference and can **affect psychological interpretation**.

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



n = 482 subjects

102 randomized trials
No feedback
Incentive compatible
Shorter Sooner (SS): $1 – $86
Larger Later (LL): $10 – $95
Delay: 4 – 180 days

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

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

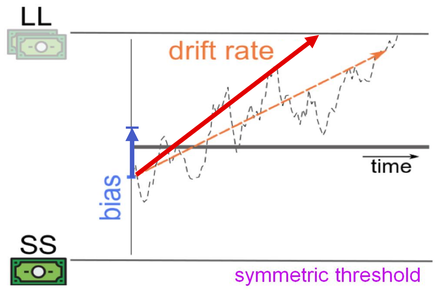
(Bogacz et al, 2006)

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

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

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

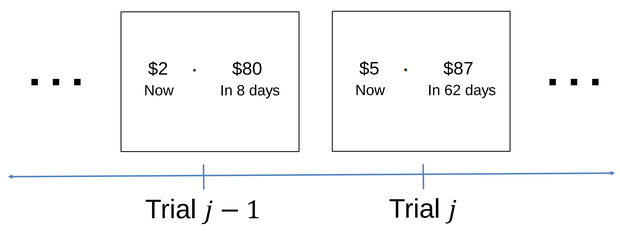
Quantifying Spillover



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**

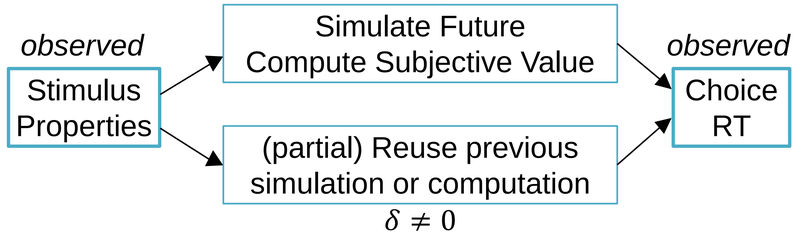
$$i = 1, \ldots, 482\ subjects; j = 1, \ldots, 102\ trials$$



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

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

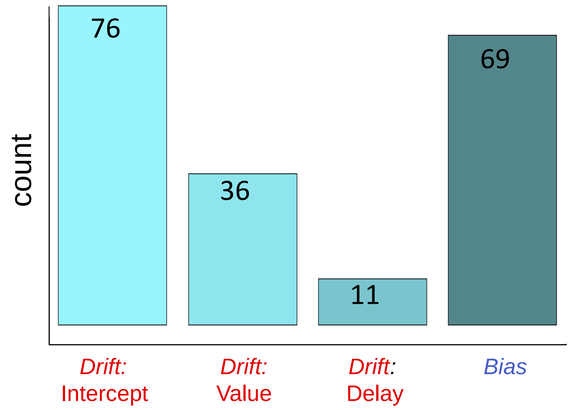
$\delta = 0$



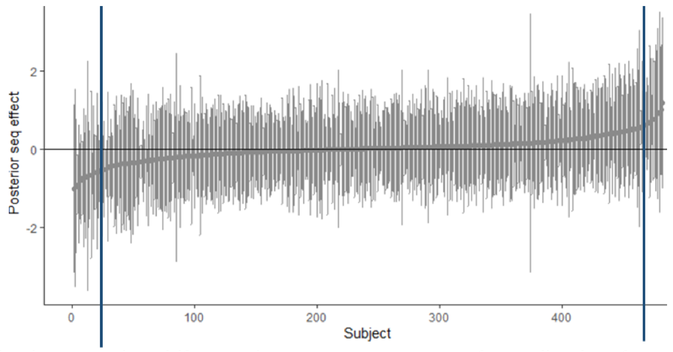
$\delta \neq 0$

Results

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



Most of the effects manifest on the **drift rate *intercept*** and **bias** terms, with some subjects showing spillover on multiple parameters.



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

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

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.

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

References and Acknowledgments

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