Delayed Discounting Experiment

PSY310: Lab in Psychology

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GitHub Link:
https://github.com/SaanchiBhatt13/Psy310/tree/Delay_Discounting_Experiment

Introduction

Understanding delay discounting—the tendency for people to devalue future rewards in favor of immediate ones—is essential to comprehending impulsivity. With unique neural, behavioral, and psychological correlates, delay discounting (DD)- the tendency to favor smaller immediate rewards over larger delayed ones- represents significant individual differences in decision-making. We now understand these factors better thanks to recent research showing how personality traits, cognitive processes, and brain connectivity interact.

Neuroimaging studies have linked Functional connectivity patterns to impulsivity (DD). They discovered that individual differences in DD are related to the connectivity of the left dorsal prefrontal cortex (dPFC), with higher DD being linked to increased functional connectivity between the default mode network (DMN)- a network involved in introspective thought- and the left dorsal prefrontal cortex (dPFC). In contrast, the dorsal and ventral attention networks (DAN and VAN), which are essential for goal-directed focus, showed reduced functional connectivity with the dPFC.

Yeh et al. (2020) found a weak correlation between DD and a subset of cognitive abilities and rather a distinct factor separate from broader cognitive functioning. DD was not linked to neuroticism or conscientiousness, contrary to expectations, and is often associated with impulsivity and self-control, suggesting that DD is an independent characteristic of individual decision-making rather than a reflection of poor cognitive ability or impulsiveness.

However, behavioral research indicates individuals discount delayed outcomes in different ways. Myerson et al. (2016) distinguished three subgroups in their treatment of delayed losses: Minimizers (consistently choose immediate losses regardless of delay length), Debt Averse (individuals prefer immediate losses for longer delays), and Loss Averse (individuals discount losses conventionally). debt-averse people were more likely to choose delayed gains over immediate ones. These results reflect subtle differences in how individuals assess trade-offs with respect to time.

These results demonstrate that DD is a complex concept impacted by personal characteristics, decision-making techniques, and neural connectivity. Knowing these elements helps one better understand human behavior and the processes underlying temporal preferences.

Method

The participants, all female, age 20, are third-year students at Ahmedabad University. They are undergraduate students majoring in Psychology. Before the experiment began, they were informed about the aim and methodology of the study and their consent was obtained. A 14.5" laptop screen and PsychoPy-2024.1.5 software were used to create the experimental setup.

Each trial began with a fixation in the shape of a cross [size: (0.05, 0.05); position (0,0)] flashing on the screen for a duration of 1 second. The slide then transitions to display a proposition [text element; font: Arial; letter height: 0.05; foreground color: white; position (0,0)] of the format:

$"GBP " + str(reward_today) + " today" + " or" + " GBP " + str(future_reward) + " after " + str(delay) + " days"

The sentence is a proposition, presenting a choice to the participant to choose between a reward (in GBP: Great Britain Pounds) that they may receive today or a higher reward that they may receive after a delay. The reward and delay values are pre-set and uploaded into the experiment via a conditions Excel file (figure 1). This slide is coded to be displayed till the participant's response is received.

A keyboard response requirement is added to the experiment, which is also set to an indefinite duration, as the experiment does not require any measure of the reaction time. The participant is to press the key "t" to choose the reception of the reward today and press an "l" if they choose to receive it after a delay.

105 trials per participant were conducted for 4 participants, and their responses were recorded in a CSV (Comma-delimited) file in a designated folder on the laptop. The data analysis was conducted using the parameters (reward_today, future_reward, delay, key_resp.keys), and the estimated discount value was calculated for each trial, and an average of k was calculated across all trials using a geometric mean.

The formula for calculating k:

$$\mathbf{k = [(A/V) - 1]/ D}$$

k: Delay Discounting value
A: Future Reward
V: Reward Today
D: Delay

Figure 1: Sample of the proposition slide

reward_today	future_reward	delay
11	30	7
15	35	13
27	50	21
40	55	62
49	60	89
67	75	119
78	80	162

Figure 2: Delay Conditions File

Results

k value for Participant 1	**0.015664**
k value for Participant 2	**0.038632**
k value for Participant 3	**0.00638**
k value for Participant 4	**0.00638**
Mean Estimated Discounting Value (k)	**0.016764**

The parameter k quantifies the point of indifference, i.e., it is the point at which a given reward will have an equal probability of getting chosen for today and later.

Discussion

Delay discounting, or the propensity to favor smaller immediate rewards over larger delayed ones, has become a key indicator for determining individual differences in impulsivity and decision-making, as was previously mentioned. Although there are a few subtleties to consider, Research supports the idea that discounting values can effectively capture these differences.

The stability of discounting values over time is one of their main advantages as markers. Individual differences in delay discounting are relatively consistent across studies, indicating that these rates represent enduring characteristics rather than volatile/transitory states. Moreover, several behavioral outcomes are linked to delay discounting. Steeper discount rates are associated with a higher likelihood of impulsive behaviors, such as substance abuse and bad financial choices. This association emphasizes the relevance of discounting values to comprehend maladaptive behaviors and psychological characteristics.

But it's important to recognize that delay discounting isn't a perfect indicator of individual differences. According to research, discounting rates can change based on the type of reward being assessed, indicating that discounting behavior is domain-specific. For instance, monetary rewards may result in a varied decision-making process and increased impulsivity compared to rewards with implicit motivation or reinforcement, like love or skill recognition. The various reward types are also a potential area for future research, as most current delay discounting studies are carried out for monetary rewards.

In conclusion, researchers should consider contextual factors and particular reward domains when interpreting delay discounting values, even though it is a sufficient and helpful marker for establishing individual differences in impulsivity. We will better comprehend the intricacies of delay discounting as an individual difference characteristic if measurement instruments and methodologies are continuously improved.

Citations

1. Pulcu, E Trotter, P. D., Thomas, E. J., McFarquhar, M., Juhasz, G., Sahakian, B. J., … Elliott, R. (2014). Temporal discounting in major depressive disorder. *Psychological Medicine*, *44*(9), 1825–1834. doi:10.1017/S0033291713002584.,

2. Myerson, J., Baumann, A. A., & Green, L. (2016). Individual Differences in Delay Discounting: Differences are Quantitative with Gains but Qualitative with Losses. *Journal of Behavioral Decision Making*, *30*(2), 359–372. https://doi.org/10.1002/bdm.1947

3. Mehta, K., Pines, A., Adebimpe, A., Larsen, B., Bassett, D. S., Calkins, M. E., Baller, E. B., Gell, M., Patrick, L. M., Shafiei, G., Gur, R. E., Gur, R. C., Roalf, D. R., Romer, D., Wolf, D. H., Kable, J. W., & Satterthwaite, T. D. (2023). Individual differences in delay discounting are associated with dorsal prefrontal cortex connectivity in children, adolescents, and adults. *Developmental Cognitive Neuroscience*, *62*, 101265. https://doi.org/10.1016/j.dcn.2023.101265

4. Yeh, Y., Myerson, J., & Green, L. (2020). Delay discounting, cognitive ability, and personality: What matters? *Psychonomic Bulletin & Review*, *28*(2), 686–694. https://doi.org/10.3758/s13423-020-01777-w