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Physical, emotional, and cognitive effort discounting in gain and loss situations

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ABSTRACT

Evidence suggests that factors associated with obtaining a reward, such as the probability of receiving it, or temporal delays, could influence the reward's subjective value. Several studies have suggested that increasing the effort required decreases the subjective value of a reward. Nevertheless, the nature of effort that results in discounting, discounting in a loss situation, and individual consistency in effort aversion across different types of effort have all remained unclear. Therefore, the present study examined whether physical, emotional, and cognitive efforts induce discounting of subjective reward value under two hypothetical situations. In the gain situation, participants made a choice about engaging in effortful work to obtain a reward, whereas in the loss situation they paid a reward to another person to do the work. The results demonstrated that increasing physical, emotional, and cognitive effort caused discounting of the subjective reward value in both situations. Additionally, the results suggested a relatively high degree of individual consistency in effort aversion in each situation, and a moderate degree of consistency across the two situations.

1. Introduction

When deciding to do a task, people make their judgments based on the balance between the benefits and costs associated with it. Most individuals are averse to increasing costs and risks associated with obtaining a reward. Studies on a variety of choice situations have reported discounting of the subjective value of rewards, due to a variety of types of costs, such as temporal delay before the receipt of the reward (Green and Myerson, 2004; delay discounting: e.g., Rachlin and Green, 1972) and lower probability of obtaining the reward (probability discounting: e.g., Green and Myerson, 2004). It is known that exponential $V = Ae^{-kD}$, and hyperbolic $V = A/(1 + kD)$ functions fit such discounting curves (e.g., Green and Myerson, 2004), where V is the subjective discounted value of a reward, A is the actual undiscounted value of the reward, D is the delay, and k is a free parameter that describes the rate of delay discounting.

Response effort is one of the most direct costs associated with obtaining a reward. However, it has been less well investigated. Sugiwaka and Okouchi (2004) demonstrated that increasing the repetitions of a hypothetical physical activity, such as cleaning a bathtub and the wash room, made participants willing to forgo larger rewards. These manipulations however, were confounded with delay discounting, because increasing the number of repetitions may have increased the delay in obtaining the reward. Nishiyama (2014) overcame this problem by using a paradigm similar to that of social discounting (Jones and Rachlin, 2006). In that study, participants generated a list of 100 effortful tasks they had performed in the past. Participants were then asked whether they would prefer to engage in the listed tasks for a fixed number of hours to earn an extra salary, or to receive a fixed basic salary without engaging in those tasks. The results demonstrated that participants were willing to forgo larger amounts of money as the response effort increased. The exponential as well as hyperbolic functions fitted to the effort discounting.

However, there are several remaining concerns. The paradigm used by Nishiyama could not determine the types of efforts that participants imagined. In addition, Nishiyama's study did not examine whether participants were willing to pay additional money to someone else to avoid response effort, i.e., a loss situation. Soman (2004) demonstrated that participants were willing to pay additional money to avoid consumer tasks such as assembling a desk in a hypothetical buying choice between do-it-yourself and effort-saving products.

The present study, therefore, was designed to investigate whether physical, emotional, or cognitive effort would induce effort discounting in a situation where people could avoid effortful tasks by forgoing reward money (gain situation) and a situation where people could avoid effortful tasks by paying money (loss situation).

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Furthermore, this study also investigated whether there was individual consistency in effort discounting for physically, emotionally and cognitively effortful work in the two situations.

2. Methods

2.1. Participants and procedure

Thirty-six undergraduate students (21 female; age: $M = 20.56$ years, SD = 3.89) in a psychology class completed a seven-page (14.8 × 21 cm) pencil–paper questionnaire based on the fill-in- the-blank method (Chapman, 1996). Additional data from two participants who did not change their answer at all were excluded from analysis. The first page of the questionnaire inquired about participants' age and gender. The following instructions were printed on the first page:

> You will be asked to make choices about money. This is a hypothetical situation and hence you cannot actually earn any money. However, please try to answer each question as if you really would be able to earn money. We only want to know your preferences, and therefore, there are neither correct nor incorrect responses to the questions.

In the next six pages, one of the following instructions, depending on the combination of the types of efforts and the gain/loss situations, was printed in the upper half of each page:

2.1.1. Physical effort

Imagine 100 physically effortful tasks (leading to physical fatigue) that you have ever engaged in, in order of effort from the most demanding to the least demanding.

2.1.2. Emotional effort

Imagine 100 emotionally effortful tasks (leading to a depressed mood) that you have ever engaged in, in order of effort from the most demanding to the least demanding.

2.1.3. Cognitive effort

Imagine 100 cognitively effortful tasks (leading to mental fatigue) that you have ever engaged in, in order of effort from the most demanding to the least demanding.

2.1.4. Common across all conditions:

Task #1 would be the most effortful and task #100 would be relatively easy and effortless to complete. Only imagine that you have to engage in these tasks; you do not have to create an actual list.

2.1.5. Gain condition

Imagine that you would obtain a certain amount of money for engaging in the effortful tasks that you ranked for six hours. You would obtain a fixed ¥ 6000 base payment regardless of whether you did or not do any work. If the payment is only ¥ 6000 even when doing a demanding task, most people would choose not to work. Please, tell me the smallest amount of money (from ¥ 6000 to ¥ 20000) that would lead you decide to do the following demanding tasks.

2.1.6. Loss condition

Imagine that you would pay a certain amount of money to someone to do the effortful tasks that you ranked for six hours. You should pay a fixed ¥ 6000 base payment regardless of whether you did or not ask someone to do the work. If the payment is only ¥ 6000 even when asking someone to do a demanding task, most people would choose to ask someone to do the work. Please, tell me the smallest amount of money (from ¥ 6000 to ¥ 20000) that would lead you to decide to do the following task by your self (the largest payment that you would decide to offer someone else to do them).

In the lower half of each page, an effortful work ranking (1, 5, 10, 20, 50, or 100), and blank response columns were printed. After the experimenter read the instructions aloud, each participant silently completed each page of the questionnaire at his or her own pace. The participants' responses were limited to ¥ 20000 (about $ 160), which seems very high compared to ¥ 6500, the average payment for real part-time work in Japan (Japanese Ministry of Health, Labour and Welfare, 2014). The orders of the gain/loss situations and the type of effortful work were counterbalanced across participants. In half the participants, the effortful work ranking was presented in ascending order, whereas in the other half of participants, it was in descending order.

2.2. Data analysis

The individual and group median data fitted to exponential $V = Ae^{-kD}$ and hyperbolic $V = A/(1 + kD)$ functions; then the parameter V was estimated, which indicates the discounted subjective value reward, as well as the parameter k, which indicates the discounting rate. In addition, the area under the curve (AUC) of the responses (Myerson et al., 2001), which is a model-free measure, was calculated by the trapezoidal integration method.

Repeated analysis of variance (ANOVA) within each situation (gain, loss) and effort type (physical, emotional, cognitive) was conducted for k and AUC values. In addition, to investigate individual consistency in the discounting rate, a correlation analysis and a factor analysis, which is a multivariate correlation method for describing underlying structures among variables, were conducted for k and AUC values. The factor scores were estimated by the factor analysis by minimizing residuals with oblimin rotation.

3. Results

Fig. 1 shows that participants abandoned (forwent or paid) over ¥10,000 to avoid the most physically, emotionally, and cognitively effortful work in both gain and loss situations. The amount of abandoned money decreased as work effort decreased. The best-fitting results of exponential as well as hyperbolic functions appear to adequately describe the effort discounting curves. The R-squared and AIC values indicate a better fit of the hyperbolic function; hence k values from the hyperbolic function were used in the later analysis.

An ANOVA revealed that the k values were not significantly different among the types of effort, $F(2, 70) = 0.17$, $p = .85$, $\eta_p^2 = .004$, or between the gain/loss situations, $F(1, 35) = 1.60$, $p = .21$, $\eta_p^2 = .04$, and there was no interaction between the types of effort and the gain/loss situations, $F(2, 70) = 0.12$, $p = .89$, $\eta_p^2 = .003$.

The AUC were also not significantly different among the types of effort, $F(2, 70) = 0.18$, $p = .83$, $\eta_p^2 = .004$, or between the gain/loss situations, $F(1, 35) = 0.14$, $p = .72$, $\eta_p^2 = .005$, but the interaction was significant, $F(2, 70) = 5.32$, $p = .007$, $\eta_p^2 = .13$, although simple main effects did not reach statistical significance, $Fs < 2.80$. The analyses based on the k values as well as the AUC suggest that the discounting rates do not significantly differ among the types of effort and between the gain and loss situations.

Table 1 indicates relatively high correlations of k parameters as well as the AUC values among physically, emotionally, and cognitively effortful work in each gain and loss situation. However, the correlation of each effortful task between the gain and loss situations was moderate. The factor analysis using k parameters as well as the AUC indicated a two-factor structure comprising values in gain (factor 1) and loss (factor 2) situations. These results support the consistency of the discounting rates across the effort types in each situation.