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Discounting delayed and probabilistic rewards: Processes and traits

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Abstract

Discounting of delayed and probabilistic rewards was examined in two relatively large samples (Ns > 100). For both types of rewards, a hyperbola-like discounting function provided good fits to individual data. Amount of reward had opposite effects on temporal and probability discounting: Smaller delayed rewards were discounted more steeply than larger delayed rewards, whereas larger probabilistic rewards were discounted more steeply than smaller probabilistic rewards. The nonlinear scaling parameter of the hyperbola-like function was larger for larger probabilistic rewards, but did not vary with the amount of delayed reward. Taken together, these findings suggest that despite the similar form of the temporal and probability discounting functions, separate processes may underlie the discounting of delayed and probabilistic rewards. Finally, weak to moderate positive correlations were observed between the discounting of delayed and probabilistic rewards. This finding is inconsistent with the notion of an "impulsiveness" trait that links an inability to delay gratification with a tendency to gamble and take risks.
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1. Introduction

Choices often involve outcomes that occur at different points in time and/or outcomes that are more or less likely to occur. Such choices have been studied under the rubrics *intertemporal choice* and *risky choice*, respectively. Intertemporal and risky choice represent traditional topics in microeconomics and are critical for understanding many aspects of decision-making, including consumer behavior (e.g., Becker, 1996; Kagel, Battalio, & Green, 1995; Loewenstein, 1988). In an analysis of purchases of home air conditioners, for example, Hausman (1979) addressed such issues as the tradeoffs between purchase price, durability, and energy efficiency. These tradeoffs pit the price paid now against the energy and replacement costs paid later, and exemplify questions frequently faced by consumers: "Should one spend more now on an item that will cost less to use and maintain in the future, or should one spend less now and risk having to pay more later?"

In recent years, behavioral economics has substantially influenced the way researchers understand decision-making in situations involving such tradeoffs. By highlighting decision-making tendencies that represent anomalies from the perspective of standard economic theory, behavioral economists have demonstrated the limitations of an approach that assumes that humans are purely rational decision-makers (e.g., Prelec & Loewenstein, 1991; Thaler, 1991). Instead, behavioral economists have highlighted the role played by psychological factors in choice behavior (e.g., Green & Kagel, 1987; Loewenstein & Elster, 1992).

Two areas in particular have received increasing attention in behavioral economics – temporal and probability discounting. Temporal discounting refers to the fact that the present, subjective value of a reward decreases as the delay until its receipt increases. Similarly, probability discounting refers to the fact that the subjective value of a reward decreases as the odds against receiving it increase (i.e., as the probability of its receipt decreases). These two types of discounting represent ways of thinking about the phenomena that fall under the larger rubrics of intertemporal and risky choice, respectively.

In addition to the obvious parallel in the definitions of the two types of discounting, there are interesting parallels in the way they are manifested in certain kinds of situations. For example, Prelec and Loewenstein (1991) have noted that there are corresponding behavioral anomalies in intertemporal and risky choice. Moreover, similar mathematical functions can describe both the decrease in subjective value as delay increases and the decrease in subjective value as the odds against an outcome occurring increase. For example, Green, Myerson, and Ostaszewski (1999) showed that a function of the form

$$V = A/(1 + bX)^s \tag{1}$$

describes both temporal and probability discounting. In Eq. (1), V represents subjective value, A represents the amount of reward, b is a parameter that (with s held constant) governs the rate of discounting, and s is a nonlinear scaling parameter. X represents the independent variable, either the time until or the odds against receiving a reward.

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