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Discounting the value of safety: Effects of perceived risk and effort

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ABSTRACT

Introduction: Although falls from heights remain the most prevalent cause of fatalities in the construction industry, factors impacting safety-related choices associated with work at heights are not completely understood. Better tools are needed to identify and study the factors influencing safety-related choices and decision making. *Method:* Using a computer-based task within a behavioral economics paradigm, college students were presented a choice between two hypothetical scenarios that differed in working height and effort associated with retrieving and donning a safety harness. Participants were instructed to choose the scenario in which they were more likely to wear the safety harness. Based on choice patterns, switch points were identified, indicating when the perceived risk in both scenarios was equivalent. *Results:* Switch points were a systematic function of working height and effort, and the quantified relation between perceived risk and effort was described well by a hyperbolic equation. *Conclusion:* Choice patterns revealed that the perceived risk of working at heights decreased as the effort to retrieve and don a safety harness increased. *Impact on industry:* Results contribute to the development of computer-based procedure for assessing risk discounting within a behavioral economics framework. Such a procedure can be used as a research tool to study factors that influence safety-related decision making with a goal of informing more effective prevention and intervention strategies.

1. Introduction

Occupational safety professionals and researchers have long sought a greater understanding of the factors that influence safety-related behavior in the workplace. It has been particularly challenging to accurately predict or influence behavior at the moment workers face hazards or risks (Carrillo, 2011; McLain & Jarrell, 2007; Olson, Grossheusch, Schmidt, Gray, & Wipfli, 2009; Reynolds & Shiffbauer, 2004). For example, consider a construction worker faced with the task of working on a two-story elevated platform. The elevation clearly possesses a risk of falling, and yet it is uncertain that a worker in that situation will always take necessary and adequate precautions to prevent a fall. Despite widespread attention to the problem and advances in fall protection technology, falls from heights remain a leading cause of fatalities in the construction industry (Bureau of Labor Statistics, 2011).

According to BLS (2011), the construction industry had the highest number of yearly fatal work injuries in 2010; approximately one out of every six workers fatally injured in that year was a construction worker. Falls from heights accounted for 34% of all construction fatalities in 2010 making falls the number one fatality category that year. The magnitude and persistence of the problem suggest that our understanding of root causes is not sufficiently complete, but a consistent finding is that many falls can be attributed to a lack or improper use of adequate fall protection (Cattledge, Hendricks, & Stanevich, 1996; Kines, 2002). Studies show that risky choices leading to these injuries and deaths cannot be attributed simply to a lack of awareness or training (Kines, 2002; Lipscomb, Dale, Kaskutas, Sherman-Voellinger, & Evanoff, 2008). Many different factors have been shown to influence construction workers' decisions and behavior, including the presence of workplace barriers to safety performance (Gershon et al., 2000), and production pressures (Lipscomb et al., 2008).

A greater understanding of these factors and the various conditions under which these factors exert influence over safety-related decision making in construction and other high risk industries would lead to more effective prevention strategies. Toward that end, the development of a simple and reliable method for quantifying the *relative* influence of various safety-related factors in human decision making would be useful for basic and applied research. Fortunately, such a method may already exist in a common experimental approach used in behavioral economics to study human choice and decision-making.

1.1. Delay discounting

Delay discounting occurs when an individual prefers an immediate smaller reward to a delayed larger reward (Rachlin & Green, 1972). A

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common research method for assessing an individual's preference for immediate, smaller rewards involves presenting the individual with a series of trials in which they are asked to choose one of two different outcomes with the greater subjective value. The value of the outcome is influenced by the two reward parameters—magnitude and delay. In the typical procedure, an individual's pattern of choices is assessed across many trials in which reward magnitude and delay are parametrically and systematically varied between the outcomes. An indifference point (e.g., $1000 delivered in 2 months is equivalent to $750 delivered immediately) is then determined for each magnitude of the delayed reward. The resulting pattern of indifference points across delay values can be fit with mathematical utility functions that describe the relative influence of reward magnitude and delay on the individuals' choices. Using this basic approach, Mazur (1987) proposed that the rate of delay discounting can be expressed with a hyperbolic function

$$V = A/(1 + kD), \quad (1)$$

where V is the subjective value of the reward, A is the amount of a reward, k is the parameter that describes the rate of discounting, and D is the delay to the reward. The resulting function is a negatively decelerating curve, illustrating the robust finding that change in discounting is most rapid when delay values are small. Some key findings in the delay discounting literature are that rates of discounting can differ across individuals (e.g., Odum & Baumann, 2010), and high rates of discounting are presumed to reflect impulsive behavior (Bickel & Marsch, 2001; Reynolds, Ortengren, Richards, & de Wit, 2006). Rates of discounting can also vary for the same individual across situations (Odum & Baumann, 2010) and across different kinds of rewards (Odum & Rainaud, 2003).

In addition to reward delay, researchers have studied other factors affecting the value of a reward including its probability of occurrence (Rachlin, Raineri, & Cross, 1991) and the effort associated with obtaining it (Mitchell, 1999, 2004). Indeed, a large body of empirical research in behavioral economics shows that discounting of delay, probability, or effort provides explanatory accounts of risky choices across wide-ranging topics such as drug abuse and dependency (de Wit, 2009), personal finance (Hamilton & Potenza, 2012), diet (Appelhans et al., 2011), and gambling (Dixon, Marley, & Jacobs, 2003) to name a few.

1.2. Effort and risk discounting in safety

The general behavioral economics approach may be used effectively to study safety-related risk and the factors associated with safety-related decisions. Indeed, a conceptual link between delay-discounting and risk taking in occupational settings has been proposed previously (Normand, 2005; Reynolds & Shiffbauer, 2004), but to date this link has not been investigated empirically.

For the purpose of exploring the applicability and utility of conceptualizing safety-related decision making within a behavioral economics paradigm, a computer-based procedure was developed as a research tool to present individuals a series of hypothetical scenarios involving safety-related choices. The scenarios describe a common construction-related task in which a demand for *productivity* is pitted against the required *effort* to perform the work safely. In our novel application, an individual is asked to imagine working on a roof at a specific height, and that a specific amount of effort is required to retrieve and don a safety harness prior to initiating the work. In each trial, the individual is presented with a choice between two types of scenarios. In the *standard* (STD) scenario, height and effort remain constant across trials. In the *adjusting* (ADJ) scenario, height varies parametrically across trials and effort varies parametrically across blocks of trials. In each of several trials, the individual is asked to choose the scenario in which they would be *more likely* to retrieve and don the safety harness. On the basis of the resultant choice patterns between STD and ADJ scenarios across the trials, a *switch point* can be calculated to quantify the relative influence of height and effort on individuals' choices, and can be conceptualized as when the participants' perception of risk in the STD and ADJ scenarios are equivalent. Furthermore, a mathematical function can be fitted to the switch points across different height and effort conditions to describe the magnitude and rate of *risk discounting*. If this approach is found to be reliable and valid, then the general procedure can be used as a research tool to better understand the choices and decision-making processes of workers in other safety-related scenarios.

1.3. Study objectives

Thus the main objective of this study was to evaluate a novel risk discounting procedure as a potential research tool to quantify individual's pattern of choices in a safety-related scenario as a function of perceived risk and response effort. To demonstrate the utility of the approach, choice patterns were obtained from individuals across multiple trial blocks in which the working height in the STD scenario was set at either 20 ft or 40 ft and the effort to retrieve and don the safety harness in the ADJ scenario was either 5 min, 10 min, 15 min, or 25 min. These values represent common conditions encountered at construction sites. It was hypothesized that switch points are a function of the STD height (i.e., perceived risk) and time required to retrieve and don the safety harness. It was further hypothesized that the mathematical functions that describe the rate of risk discounting in the present scenarios are hyperbolic and consistent with hyperbolic patterns of discounting seen with other frequently studied behavioral phenomena.

2. Method

2.1. Participants

Twenty-one students were recruited from an undergraduate learning course at a university in the Mid-Atlantic area. All participants received extra class credit in exchange for their participation. Data from 11 participants (3 males and 8 females) were included in the final analyses. Participants were excluded from the statistical analyses because their choice patterns indicated that they might have misunderstood the procedure. This was evidenced in one of two ways: (1) participants chose the same scenario exclusively and throughout an entire block of trials, or (2) participants chose the scenarios without any consistency. Ten participants showed one of these types of responding in at least one block of trials and, as a result, all data from these participants were excluded. All procedures were approved by the Institutional Review Boards of both affiliated institutions.

2.2. Setting and materials

Instructions and all experimental trials were presented on a laptop computer running E-Prime 2.0 (Psychology Software Tools, 2008). Each participant completed one approximately 45-min session alone in a quiet room.

2.3. Instructions and orientation

The session began with the participant seated in front of the computer. The following instructions were presented on the monitor:

> "Welcome to our occupational risk-taking study! Before you start the study, we will take you through detailed instructions on how to respond. You will be asked a number of questions. Each question will involve a choice between two options. One option will be on the right, and one option on the left. Please press the '1'