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Impulsive Choice and Workplace Safety: A New Area of Inquiry for Research in Occupational Settings

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A conceptual argument is presented for the relevance of behavior-analytic research on impulsive choice to issues of occupational safety and health. Impulsive choice is defined in terms of discounting, which is the tendency for the value of a commodity to decrease as a function of various parameters (e.g., having to wait or expend energy to receive the commodity). A high degree of discounting is often considered an index of impulsivity. We argue that for workers, possible negative consequences (e.g., injury or disease) are often disregarded, or discounted, in choices about workplace safety because such consequences are typically delayed and uncertain. Furthermore, some evidence suggests that certain environmental conditions, such as those that lead to stress or sleep deprivation, may increase discounting. Increased discounting, by extension, leads to a further devaluation of safety practices and their benefits. A call is made for research aimed at more clearly delineating the relation between impulsive choice and workplace safety.

Key words: impulsivity, discounting, choice, health, occupational safety, workers

One of the more subtle dangers to occupational health and safety is not endemic to any particular facet of the workplace itself. Rather, it originates from human choice and can manifest with particularly disastrous consequences in many workplaces. The problem is that workers often behave in ways that are inconsistent with their long-term best interests. That is, workers sometimes choose far smaller but immediately rewarding options like convenience over larger, ultimately more beneficial options like increased safety and health. In such instances, workers fail to tolerate an immediate small cost required to avoid a larger more serious loss that is delayed or uncertain.

These types of worker choices may take the form of risk taking or they may involve the failure to take known preventive safety measures, but in both cases they can compromise the long-term health-related interests of the individual. The U.S. National Institute for Occupational Safety and Health (NIOSH) (1998) estimates that 17 workers died every day from injuries on the job in 1997, contributing to a total of 6,238 occupational fatalities that year. In addition, more than 5 million nonfatal work-related injuries were reported to have occurred in 1997 in the U.S. alone (NIOSH). It is reasonable to assume that a number of these occupational deaths and injuries were avoidable and occurred because some of those involved had unnecessarily placed themselves in situations that elevated their risk of death or injury. Examples of such unnecessary risks may include a construction worker deciding to ride on a tine of a coworker's forklift instead of walking; or, despite clearly posted warning labels, inappropriately using the top rungs of a folding ladder instead of taking the time to find and use a more appropriate taller ladder. Such choices appear to be based on avoiding immediate small costs involving effort or more time (i.e., walking or taking the time to find a ladder) and discounting delayed or uncertain health consequences.

This behavioral conflict between an

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individual's long-term and short-term interests, which we describe more precisely below in relation to impulsive choice, can render useless the best efforts of the biological sciences to improve worker health. Many of the threats posed by dangers ranging from pathogens to repetitive stress injury can indeed be mitigated by existing interventions. Yet none of these technologies can afford the worker a safe environment unless he or she actually uses them. Even the best respirator, for example, cannot improve a worker's safety if he or she consistently fails to put it on.

Researchers who seek to diminish the potential safety hazards of the workplace are therefore faced with a twofold challenge. First, researchers must control the fundamental causes of occupational hazards in the work environment, and second, they also must ensure that workers consistently practice safety precautions and use safety technologies. In this way, choices, and the methods of behavior analysis, become a necessary link between laboratory and worker to improve conditions of occupational health and safety.

The present article has two primary goals: (a) to introduce the broad concept of impulsive choice and (b) to illustrate conceptually how impulsive choice may be related to issues of occupational safety and health. To accomplish the first goal, attention has been devoted to defining impulsive choice. Towards the second goal, arguments are presented to support the position that impulsive choice is an important variable related to safe practices in occupational settings. Some suggestions will be given to illustrate how intervention efforts (and certain environmental conditions that may lead to increases in impulsive choice) might contribute to reducing occupationally related injury or death. Ultimately, through this article we hope to inspire new interest in impulsive-choice research for the occupational domain.

THE DISCOUNTING DEFINITION OF IMPULSIVE CHOICE

William James noted that, "Inner happiness and serviceability do not always agree. What immediately feels most 'good' is not always most 'true,' when measured by the verdict of the rest of experience" (1982, pp. 15–16). The quandary that James articulates here is precisely the concern of contemporary impulsive-choice research. Such research aims to study how (and understand why) we sometimes choose rewards that stand in opposition to "the verdict of the rest of experience."

This phenomenon may be best illustrated by the example of seat-belt use. Given that, of the 2,158 workers fatally injured on the job in traffic-related motor vehicle crashes in 1996, only 18% were reported wearing a safety restraint, the benefits of seat-belt use as an occupational safety measure seem clear. When measured against the possible benefit of a longer life, the benefits of not wearing a seat belt (e.g., comfort, convenience, one less thing to "keep up" with) are comparatively insignificant. Yet, in 1984, before laws mandating seat-belt use were enacted, the national usage rate among drivers (on and off the job) was only 14%. Seat-belt use increased in subsequent years only after legal punishments for nonuse were imposed (National Highway Traffic Safety Administration, 1998). Clearly, the possible benefits offered by a safety measure are sometimes insufficient to motivate its use. Why was it necessary for the government to rearrange contingencies to tip the choice-making scale towards compliance? If anyone were given the specific choice between the probability of losing one's life or health versus a bit of slightly increased comfort or convenience, he or she would surely choose remaining healthy or alive. Why, then, is a lifetime of safety, by itself, not sufficient to result in 100% seat-belt usage rates?

One viable answer to this question,

and to many more like it, lies in a process called *discounting,* which is central to our definition of impulsive choice (see Critchfield & Kollins, 2001). Discounting is a behavioral phenomenon in which a commodity of personal value (e.g., money, weight loss, health) loses some of its value as a function of various parameters, such as the commodity being delayed (e.g., Green, Myerson, & Ostaszewski, 1999), requiring effort to obtain (Mitchell, 2003), requiring a small immediate cost (e.g., Ostaszewski & Katarzyna, 2002), or being uncertain (e.g., Reynolds, Karraker, Horn, & Richards, 2003). Discounting can be considered impulsive when an individual's behavior is markedly more sensitive to immediate than to uncertain or temporally distal consequences, which then often results in undesirable outcomes (e.g., Daruna & Barnes, 1993; Oas, 1985; Richards, Zhang, Mitchell, & de Wit, 1999). For the current paper, discounting is defined in the broader context of impulsive choice, such that discounting describes an option losing value relative to other options because it is (a) delayed, (b) uncertain, (c) requires an initial cost, or (d) requires effort to obtain. In the seat-belt example, we would say that the health benefits associated with wearing a seat belt may be discounted impulsively as a function of the immediate small cost (e.g., inconvenience) of putting on the seat belt and the temporally distant and uncertain advantages associated with wearing the seat belt (i.e., that they only occur in some possible future traffic accident). Under these conditions, the delayed and uncertain health benefits associated with wearing a seat belt essentially become inert in affecting behavior relative to the smaller but immediate and certain costs of wearing the seat belt (e.g., inconvenience).

In attempting to conceptualize the behavioral processes involved in impulsive choice, it becomes important to consider these processes in the complex workplace environments in which they are to be applied. A realistic choice context for a worker will often include concurrent delay, effort, uncertainty, and initial cost contingencies. Evidence also suggests that some of the different types of discounting described above may reflect partially independent choice processes (e.g., Holt, Green, & Myerson, 2003). Given the likelihood of orthogonal choice processes, and the likelihood of a multicontingency choice context, it seems unlikely that any one of the types of discounting described to this point would account for all of the choice processes involved in determining even one choice in a workplace environment. Rather, it seems more likely that multiple modes of discounting (e.g., delay, probability, etc.) are involved in choices about work-safety precautions, with some modes fitted better to some types of situations than to others. Therefore, we describe multiple, simultaneous modes of discounting in our work-related situational examples in an effort to conceptualize more fully the processes involved in choices about safety and health. This "multiple-discounting-modes" approach (i.e., conceptualizing a single choice in terms of different but concurrent discounting processes) is novel, but we believe that such an approach will be necessary to understand the relation between impulsive choice and complex choice contexts. Ultimately, future attempts to predict safe or unsafe behaviors will be enhanced by the use of a multifactor choice model that includes multiple modes of discounting.

THE MEASUREMENT OF DISCOUNTING

Many of the laboratory procedures used to assess discounting in humans involve responding to a series of hypothetical questions about choice preference between a larger amount of money that is either delayed or uncertain or requires some degree of effort or an initial small loss to obtain, and a smaller amount of money that requires

nothing of the respondent but to make that choice. In addition to hypothetical procedures, a number of more experiential procedures have been developed in which respondents experience choice consequences (e.g., delays, monetary reinforcers) during choice sessions (e.g., Lane, Cherek, Pietras, & Tcheremissine, 2003; Reynolds & Schiffbauer, in press-b; Schweitzer & Sulzer-Azaroff, 1995). The degree of correspondence between results from experiential and hypothetical procedures is unknown, although one recent study did show a positive correlation between experiential- and hypothetical-procedure data (Lane et al.).

In using hypothetical questions to assess the influence of delay on monetary value, questions might be worded as follows: "Would you prefer $10 in 180 days, or would you prefer $3 now?" The smaller, nondelayed amount of money in this example would be increased or decreased across subsequent questions until the subjective value of $10 in 180 days is established. With this type of procedure, the smallest amount of money a person prefers immediately over $10 in 180 days is treated as the person's indifference value for $10 at the given delay (i.e., 180 days; see Green, Fry, & Myerson, 1994; Reynolds & Schiffbauer, in press-a; Richards et al., 1999). In the case of delay discounting, an individual's indifference values are the points at which smaller sooner and larger later reinforcers are of equivalent reinforcing effectiveness at various delays. This same type of procedure also may be applied to determining indifference values between certain and uncertain rewards, those that require different degrees of effort, or those that require some initial cost.

By analyzing indifference values over multiple delays, probabilities, effort requirements, or initial costs, the rate at which discounting occurs as a function of increases or decreases in these parameters can be quantified. Curves representing rate of discounting have been best represented by a hyperbolic function (Mazur, 1987), $V = A/(1 + kX)$, where V represents the value of the contingent reward, and A and X are the amount of reward and a numeric index indicating the conditions for receiving the reward (e.g., delay length, odds against receiving, effort, etc.), respectively. k is a free parameter that represents the steepness of an individual's discounting curve and serves as a parametric index of impulsivity, with higher values indicating greater discounting and impulsivity.

Although this is only a brief description of the assessment of impulsive choice, it illustrates how researchers have attempted to operationalize such choice processes. As detailed more extensively below, the actual choices assessed by these measurement tasks parallel in some ways many of the safety-related choices workers regularly confront on the job.

IMPULSIVE CHOICE AND THE WORKPLACE

To date, we know of no systematic effort to relate the discounting model of impulsive choice to issues of occupational safety and health. However, as we have already suggested, it is likely that impulsive choice plays a role in work practices that may potentially lead to occupational injuries or fatalities.

Consider the hypothetical case of a construction worker who is working on the partially completed roof of a three-story building. On the morning that he first starts to work on the roof, he recognizes that the particular job he will be doing is potentially dangerous and that he needs to take special care not to fall. Later in the morning, though, he realizes that he did not bring enough nails to his location. Unfortunately, the rest of the roofing nails are located on the roof at the opposite end of the building. When he does run out of nails, he can either try to get across the partially constructed roof and back with the nails from the other side without falling (Option A) or expend more

time and effort to go all the way down to the ground and back up on the other side to get the nails, then back down to the ground again, and back up to where he was originally working (Option B).

In this example, the benefits of convenience and less effort (Option A) are at odds with the reduced probability of injury in Option B. From our previous discussion of impulsive choice, it can be predicted that higher k values from Mazur's (1987) equation for probability and effort should be associated with more discounting of the safety benefits linked with Option B, because falling is uncertain and would require time and effort to avoid.

From this example, intervention efforts would likely target one or both circumstances (i.e., the perceived low probability of negative consequences for Option A and the effort and time requirements of Option B) that lead to a discounted value for the safety benefits of Option B. In analogous situations, it has been suggested that a key factor in the reduction of impulsive choice involves information and experiences related to the environment and choice consequences (e.g., Logue, 1998). For example, an imagery intervention might be useful in offsetting a perceived low probability of falling. Construction workers could be guided through imagery exercises in which they imagine themselves attempting to get across such a roof and falling. Highly detailed imagery exercises may serve to make the negative consequences (i.e., loss of health or life) of high-risk behaviors more salient and therefore more compelling as behavioral determinants (see Gregory, Cialdini, & Carpenter, 1982).

Alternatively, effort discounting might be mitigated by a reduction in overall energy expenditure. Requiring workers to take regular rest breaks, especially during jobs involving a good deal of energy, may reduce effort discounting. Breaks might serve as an abolishing operation by decreasing effectiveness of escape from effortful safety precautions as a reinforcer (Laraway, Snycerski, Michael, & Poling, 2003). In our example, if the construction worker were to run out of nails early in the day (before becoming tired from the day's work), his perception of the effort required for Option B would likely be different than if the same situation were to occur towards the end of the work day when he is fatigued. Regularly scheduled rest breaks might reduce fatigue, and affect discounting, in a similar manner.

Another type of example from an occupational setting involves the effective use of known safety precautions. DeVries, Burnette, and Redmon (1991) used a performance feedback intervention with hospital nurses to improve compliance of glove wearing during medical procedures that were likely to increase risk of disease transmission from patient to nurse. Although DeVries et al. found that performance feedback did increase glove wearing, nurses still often failed to wear gloves and reported that wearing gloves was difficult (i.e., required effort or some initial cost). Also, some nurses reported that they did not believe elderly patients were capable of transmitting diseases like HIV, and the nurses therefore did not wear gloves during what they considered low-risk situations. From an impulsive-choice perspective, it appears that the delayed and probabilistic negative consequences (loss of health) associated with not wearing protective gloves and the initial inconveniences of putting them on resulted in discounting.

Interventions from an impulsive-choice perspective would target factors that influence the immediate antecedents associated with a decision to wear gloves (e.g., making gloves more readily available and more convenient to put on) and that emphasize the possibility of long-range negative consequences associated with continued failure to use them. Another intervention for this type of situation might involve the use of precommitment strategies (Ainslie, 1975, 1992; Rachlin, 1995),

which require an individual to add an additional consequence (an incentive or punisher) to a choice option while the choice consequences are still temporally distant, thereby ultimately altering choice-option values. For example, with the nurses and glove use, a precommitment intervention might begin with a training session in which enough information is presented about the hazards of not wearing gloves that the nurses are more likely to act to improve their own glove-wearing behavior. At the training session, interested nurses might agree to participate in a precommitment program in which incentives and punishers are added to wearing or not wearing gloves, respectively. For example, nurses could agree to give up 10 min of break time when they are seen without gloves by a supervisor, but also to gain 10 min of break time when seen wearing gloves. Incentives under these types of conditions appear to be highly effective in improving workplace safety (MacAfee & Winn, 1989). There also appears to be a relation between the size of incentives and reductions in accidents (Wilde, 1991). In the context of impulsive choice, such incentives may serve to add immediate and certain value to choices associated with safety behavior.

In these and previous examples, impulsive choice and the discounting phenomenon fit conceptually with worker decisions either to employ safe work practices or to adopt less safe but more convenient options. Another important outcome of impulsive-choice research would be the discovery of different types of broad environmental work conditions (e.g., high-stress conditions or shift-work conditions that cause sleep disruptions) that lead to increases or decreases in impulsive choice. For example, a recent study found an increase in delay discounting during a period of sleep deprivation (Reynolds & Schiffbauer, in press-b). Other research suggests that distraction may also lead to increases in discounting during times when an individual is engaging in multiple tasks (Hinson, Jameson, & Whitney, 2003). Also, NIOSH has published recommendations that include a model of the different factors related to workplace stress (Sauter et al., 1999), which suggests a link between stress and worker safety as follows: "Although more study is needed, there is growing concern that stressful working conditions interfere with safe work practices and set the stage for injuries at work" (p. 11). We hypothesize that stress increases impulsive choice, which then contributes to increased injuries in the workplace.

Further research is needed to substantiate a relation between stress and impulsive choice; however, some research does exist to suggest a link between stress and increases in some of the behaviors associated with impulsivity. For example, elevated stress has been associated with increased cigarette smoking (Parrott, 1995) and alcohol abuse (Gorman, 1994), both of which have been related to higher k values in hypothetical delay-discounting procedures (Bickel, Odum, & Madden, 1999; Vuchinich & Simpson, 1998). Also, a recent study reported an increase in impulsive choice using an experiential delay-discounting procedure during a pain manipulation often operationalized as stressful (Flora, Wilkerson, & Flora, 2003). Participants made choices between a larger delayed amount of money and a smaller amount that was immediate while holding a hand in ice water or warm water. Participants in the ice-water condition made significantly more responses for the immediate but smaller amount option, and thus received less money. This finding occurred even though impulsive responding had no direct effect on reducing pain. The same impulsive choice pattern was observed with the introduction of aversive loud noises during the measurement procedure (Flora, Schieferecke, & Bremenkamp, 1992).

The identification of broad environmental conditions that lead to increases

or decreases in impulsive choice, such as stressful conditions, has obvious implications for workplace interventions. Despite recognition that stress seems to increase unsafe work practices (Sauter et al., 1999), the mechanisms of such a relation are not fully understood. If impulsive choice as defined by discounting were to accurately describe the relation between stress and unsafe work practices, then interventions intended to reduce unsafe practices could be developed to target either the source of the stress itself or the contingencies associated with impulsive choice, as described earlier.

CONCLUSION

In an article published by *The Synergist* (a journal from the field of industrial hygiene), it was asserted that "there is no doubt worker behavior plays a significant role in injury and illness prevention and that many injuries result from unsafe acts" (Umbrell, 2002, p. 35). Furthermore, "psychology has a place in occupational health and safety [research] because it's important to recognize how human behavior influences workers to take (or ignore) safety precautions" (p. 32). Clearly reflected in these statements are concerns about, and an appreciation for, what the individual worker might bring to the process of improving safety conditions in the workplace.

Related future research on impulsive choice might emphasize several critical issues. The first of these is the empirical examination of the relation between certain safety behaviors (i.e., high-risk behaviors or use of preventive technologies) and impulsive choice. Such foundational work is necessary to ensure that such choice tendencies predict unsafe work practices, and to delineate the specific relations between different forms of discounting (i.e., delay, probability, cost, or effort discounting) and different work situations that lead to unsafe work practices.

Another critical area of research is the study of environmental conditions that may lead to intraindividual state-like variability in impulsive choice. As suggested earlier, environmental conditions that lead to elevated stress may be a good place to start. Such research can easily be conducted with either nonhuman animals or humans using already-established stress procedures. Other conditions of interest might be long work hours without adequate time off, not eating enough (which may lead to low blood sugar), or the influence of certain drugs (prescribed or otherwise). The implications of this research may be that such conditions lead to increases in impulsive choice and therefore, by extension, to increases in unsafe work behaviors. These findings would illuminate problematic work conditions as well as the behavioral mechanisms that cause such conditions to be problematic. Ultimately, this research would directly inform intervention efforts to reduce unsafe work practices.

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