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A behavioral economic analysis of texting while driving: Delay discounting processes

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ABSTRACT

The purpose of the present study was to examine an impulsive decision-making process underlying texting while driving from a behavioral economic perspective. A sample of 108 college students completed a novel discounting task that presented participants with a hypothetical scenario in which, after receiving a text message while driving, they rated the likelihood of replying to a text message immediately versus waiting to reply for a specific period of time. Participants also completed a delay discounting task in which they made repeated hypothetical choices between obtaining a larger amount of money available after a delay and an equal or lesser amount of money available immediately. The results show that the duration of the delay is a critical variable that strongly determines whether participants choose to wait to reply to a text message, and that the decrease in the likelihood of waiting as a function of delay is best described by a hyperbolic delay discounting function. The results also show that participants who self-reported higher frequency of texting while driving discounted the opportunity to reply to a text message at greater rates, whereas there was no relation between the rates of discounting of hypothetical monetary rewards and the frequency of texting while driving. The results support the conclusion that texting while driving is fundamentally an impulsive choice.

1. Introduction

It is estimated that 6–16% of motor vehicle crashes in the United States in 2013 were due to text messaging (National Safety Council, 2015). Despite 46 states adopting legislation to ban text messaging (Governors Highway Safety Association, 2016) and various educational campaigns that increase awareness of the danger of texting while driving (e.g., Sherin et al., 2014), texting while driving remains a major problem in traffic safety. According to the Centers for Disease Control and Prevention (2013), 31.2% of drivers aged 18–64 years in the United States reported that they had engaged in texting while driving in the past 30 days. It is particularly pervasive among young drivers; more than 90% of college students reported having texted while driving (e.g., Atchley et al., 2011).

In an attempt to predict who is at risk of texting while driving, previous research has identified various psychological factors associated with this risky behavior. These factors include impulsivity (e.g., Quisenberry, 2015), habitual texting tendencies (e.g., Bayer and Campbell, 2012), cell-phone dependency (e.g., Struckman-Johnson et al., 2015), perceived need for a cell phone while driving (e.g., Musicant et al., 2015), perceived texting distractibility (only for males; Struckman-Johnson et al., 2015), risky behavior tendencies (only for females; Struckman-Johnson et al., 2015), and low levels of mindfulness (e.g., Feldman et al., 2011).

Although previous studies have made progress in identifying psychological predictors for texting while driving, the underlying behavioral and cognitive processes of texting while driving remain unknown. For example, one hallmark of texting while driving is that drivers engage in the behavior despite being aware of its dangers (Atchley et al., 2011). This tendency may explain why legislation to ban texting while driving and education on its dangers have not reduced texting while driving (Ehsani et al., 2014; Goodwin et al., 2012). The decision-making processes that influence drivers to continue engaging in such a risky behavior despite knowledge of its dangers warrant further investigation.

One framework that may be useful for understanding the persistent nature of texting while driving is a behavioral economic approach. Behavioral economics refers to the application of economic concepts and approaches to the study of individuals' choices and decisions controlled by reinforcement contingencies operating over extended periods of time (Bickel et al., 2014). When drivers

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engage in texting while driving, they make a choice between immediate text messaging (ultimately less valuable given the increased risk of a motor vehicle crash) and withholding text messaging and waiting some length of time until arriving at the destination (ultimately more valuable given safety). From a behavioral economic perspective, texting while driving can be viewed as an impulsive choice toward a smaller-sooner reward (i.e., immediate short text message) at the expense of safety. One potential explanation for this preference toward a smaller-sooner reward is delay discounting—the process by which the decision maker subjectively devalues future events (Madden and Bickel, 2010). An impulsive choice is made because the subjective value of a reward is discounted as the delay to its receipt increases (see Green and Myerson, 2004; for review). A large literature draws important connections between choice patterns using discounting tasks and a range of impulsivity-related problems, including substance dependence and abuse (MacKillop et al., 2011), obesity (e.g., Epstein et al., 2010), pathological gambling (e.g., Petry and Madden, 2010), internet addiction (e.g., Saville et al., 2010), HIV-risk behavior such as needle sharing (e.g., Odum et al., 2000), risky sexual behavior (e.g., Chesson et al., 2006), and criminal behavior (e.g., Arantes et al., 2013).

The extensive literature linking delay discounting and various impulsivity-related problems provides a compelling rationale to examine discounting as a potential mechanism that underlies texting while driving. Hayashi et al. (2015) recently reported patterns of delay discounting in relation to texting while driving. Using a delay discounting task with hypothetical monetary rewards, they compared the degree of delay discounting between college students who frequently text while driving and those who infrequently text while driving. They found that the rate of delay discounting of monetary rewards was greater for participants who frequently text while driving, suggesting that texting while driving is associated with impulsive decisions. Despite this evidence, it is not clear how the delay associated with texting per se (e.g., having an opportunity to reply to a text message after a delay) affects drivers' decision to engage in such a risky behavior. Further investigation is needed to better understand behavioral and cognitive processes underlying drivers' decision to text while driving.

To date, two studies have investigated the role of delay discounting in decision-making processes associated with general texting behavior (i.e., not specifically texting while driving). Using hypothetical scenarios, Atchley and Warden (2012) presented college students with a series of choices between one option to receive a smaller amount of money (e.g., $5) and reply to a text message immediately and another option to receive a larger amount of money ($100) and reply to a message after a delay (e.g., 60 min). Also using hypothetical scenarios, Reed et al. (2016) presented 18- to 64-year-old participants recruited via Amazon Mechanical Turk with a series of choices between one option to pay a small amount of money (e.g., $5) and read and reply to a text message immediately and another option to read and reply to a text message after a delay (e.g., 60 min) for free. In both studies, the likelihood of waiting to engage in texting decreased as the delay increased. In addition, the shape of the delay discounting function closely resembled that of hypothetical monetary rewards commonly reported in the literature.

Although these previous studies show that delay discounting occurs when individuals make decisions in some general texting scenarios, it is still unknown whether delay discounting is a major process that underlies drivers' decisions to engage in texting while driving. In addition, the delay discounting task in the previous studies involved both hypothetical money (gain or loss) and hypothetical opportunity to engage in texting (send or read/reply). Because drivers typically do not text while driving for monetary gains or losses, further investigation is needed to determine whether the *value* of texting behavior, like the value of monetary rewards, is directly affected by delays in opportunities to read or reply to them.

The first purpose of the present study was to determine whether decision making concerning texting while driving could be well characterized using the discounting paradigm. Based on the well-validated Sexual Delay Discounting Task developed by Johnson and his colleagues (e.g., Johnson and Bruner, 2012, 2013; Johnson et al., 2015), we developed a novel delay discounting task that presented drivers with a hypothetical scenario in which, after receiving a text message while driving, they were asked to rate the likelihood of replying to a text message immediately versus waiting to reply for a specific period of time. It was hypothesized that the subjective value of opportunities to respond to a text message received while driving will be discounted as a function of the delay (i.e., waiting time).

The second purpose of the present study was to test three mathematical models of delay discounting to determine which model best describes the discounting process in texting while driving. Eq. (1) is an exponential model (Samuelson, 1937):

$$V = Ae^{-kD}, \quad (1)$$

where V refers to the subjective or discounted value of a delayed reward, A refers to the reward amount, D refers to the delay to the reward, and k is a free parameter that reflects the rate of discounting. Higher k values indicate greater discounting and thus greater impulsivity (Bickel and Marsch, 2001). The exponential model is based on normative economic theory (Lancaster, 1963), and it predicts a constant rate of discounting across delays to receiving an outcome.

Eq. (2) is a hyperbolic model (Mazur, 1987):

$$V = \frac{A}{1+kD}, \quad (2)$$

where the parameters are the same as in Eq. (1). The hyperbolic model predicts a disproportional rate of discounting across different delays (i.e., the rate of discounting decreases as delay increases).

Eq. (3) is a hyperboloid model (Myerson and Green, 1995):

$$V = \frac{A}{1+kD^s}. \quad (3)$$

This equation is the same as Eq. (2) except for the inclusion of a free parameter s that reflects sensitivity to delay. Indeed, when the value of s is 1.0, Eq. (3) can be reduced to Eq. (2).

Determining the form of discounting functions is important because it has important behavioral implications (Green and Myerson, 1996). First, different mathematical functions lead to different predictions regarding behavior. For example, both hyperbolic and hyperboloid functions predict the occurrence of *preference reversals*, which refer to a shift in preference from a larger-delayed reward to a smaller-immediate reward as the receipt of the reward approaches (Green et al., 1981). As mentioned previously, one hallmark of texting while driving is that drivers often engage in texting while driving despite being aware of its danger. This phenomenon may be accounted for by preference reversals (details will be discussed later). Second, the form of mathematical functions provides clues as to the mechanism underlying a behavior of interest because different mathematical functions assume different ways in which the behavior changes. For example, exponential discounting assumes that individuals will make rational choices that maximize utility, and once a choice is made, it remains constant over the delay (Madden and Johnson, 2010). By contrast, the hyperbolic and hyperboloid functions do not assume rationality of choice; preferences may shift, or reverse, across different delays.