BEHAVIOR ECONOMIC AND SOCIAL VARIABLES INFLUENCING CELL-PHONE DISTRACTED DRIVING

A Thesis

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Despite media campaigns aimed at reducing cell phone use while driving, prevalence remains alarmingly high. One reason why individuals may use a cell phone while driving is because they are unable to delay gratification when faced with an immediate reward, an interpretation consistent with delay discounting, or the tendency for rewards to decline in value as a function of time until their receipt.

The present study applied a discounting framework to examine the effects of behavioral economic and social variables on college students' decisions about using a cell phone while driving. In a novel Distracted Driving Delay Discounting Task (DDDDT), participants were asked to imagine they were driving on the highway when they received either a phone call or a text message. Across trials, social variables and the time to one's destination were manipulated. Participants indicated their likelihood of waiting to return the phone call or reply to the text message. Participants also completed a Cell Phone Dependence Scale, Distracted Driving Behavior Norms Questionnaire, Driving Habits Questionnaire, and Drug Use Questionnaire. Results showed that the likelihood of cell phone use decreased hyperbolically as a function of time until one's destination is reached. Results also demonstrated that likelihood of cell phone use while driving decreases when contacted by a less important social relation through a text message and while traveling with passengers in the car. Our translational findings are likely to inform interventions aimed at reducing cell phone distracted driving by mitigating excessive delay discounting in vulnerable driver populations.

CHAPTER I

INTRODUCTION

Mobile cell phones have gained popularity rapidly in recent years. In 2015, the Pew Research Center report, *Technology Device Ownership: 2015*, found that 92% of American adults own a cell phone, with 68% owning a smartphone device (Anderson, 2015). Within the past decade, cell phone ownership among American adults has increased by 27% with most individuals using cell phones as their main source of communication (Anderson, 2015). Technology has further expanded the newer generation of cell phones beyond the ability to send and receive phone calls and text messages. More recent cell phone models, also known as "smartphones," have multimedia functions and direct internet access, thereby expanding the accessibility of these features (Aoki & Downes, 2003; Pew Research Center, 2015). Undeniably, cell phones and "smartphones" in particular have impacted our present way of life.

Cell phones have made it possible to facilitate communication among individuals at any time and in any place (Aoki & Downes, 2003). The constant opportunity for connectedness among family, friends, and business employees has been reported to be beneficial to life rather than a burden (Aoki & Downes, 2003). A 2015 Pew Research Center report titled *U.S. Smartphone Use in 2015* asked "smartphone" users to report their feelings regarding cellular devices (e.g., "freedom vs. leash," "connecting vs. distracting," "helpful vs. annoying," "worth the cost vs. financial burden"). A substantial majority of users felt that cellular devices represented freedom, feelings of connectedness, were helpful rather than annoying, and were worth the cost rather than being a financial burden. Moreover, 71% of individuals reported that their cell phone was worth the cost, even when the monthly bill was reported to exceed $200+ for the device and services (Pew Research Center, 2015).

Despite the clear benefits and positive impact cell phones have on our lives, they can also be detrimental and harmful when operated too often or at inappropriate times (e.g., using a cell phone while concurrently operating a vehicle; Lepp, Li, Barkley, & Salehi-Esfahani, 2015). Cell phone use can become problematic and even addictive (Bianchi & Phillips, 2005), with 46% of individuals reporting that their cell phone is something they "couldn't live without" (Pew Research Center, 2015). Struckman-Johnson, Gaster, Struckman-Johnson, Johnson, and May-Shinagle (2015) developed a Cell Phone Dependence Scale (CPD) to examine gender differences in cell phone dependence levels. They found that females self- reported higher levels of cell phone dependence compared to males; however, both groups reported overall high levels of dependency on their cell phones. Results also demonstrated a positive relation for both genders between cell phone dependency scores and how often respondents reported texting while driving. These results demonstrate that higher cell phone dependency is related to cell- phone use while driving. Cell phone use while driving is extremely dangerous, as it diminishes the driver's awareness of the road and negatively impairs their driving (Sanbonmatsu, Strayer, Biondi, Behrends, & Moore, 2016; Stavrinos et al., 2013).

Cell Phone Distracted Driving

The use of a cell phone while driving is an example of distracted driving, and has recently been acknowledged as a global safety issue (National Highway Traffic Safety Administration [NHTSA], 2014). Every individual can be affected by distracted driving, whether it is the individual behind the wheel, a passenger in the car, or a pedestrian walking on the sidewalk. Distracted driving can be defined as *any* activity that diverts the driver's attention away from the primary task of driving (Regan, Hallett, & Gordon, 2011).

Distracted driving, and cell phone distracted driving in particular, is so dangerous because it encompasses three distinct types of distraction: manual, visual, and cognitive (Centers for Disease Control and Prevention, 2016; NHTSA, 2014). Manual distraction is any type of distraction that causes one to take their hands off the steering wheel (e.g. reaching for a cell phone). Visual distraction occurs when one takes their eyes off the road. This could occur when one looks over to see where their phone is located to grab it, when one looks at the phone to read an incoming text message, and/or when one looks at the phone to respond to the text message. Whereas manual and visual distractions require physical distraction, a cognitive distraction is anything that takes one's mind off the task of driving, such as thinking about the text message one just received and read. According to leading traffic safety and public health organizations, all three of these distractions take place when an individual uses a cell phone while driving (Centers for Disease Control and Prevention, 2016; NHTSA, 2014).

Cellphone distracted driving has been examined in controlled laboratory settings where participants were observed using a cell phone to engage in various tasks (e.g. talking on the phone or responding to a text message) while concurrently operating a driving simulator. Sanbonmatsu et al. (2016) examined participants' driving in a stimulator while either talking or not taking on a cell phone. The results showed that drivers who did not talk on the cell phone while driving made fewer errors and also self-reported that they made fewer errors. In contrast, the participants who used the cell phone while driving made more errors during the simulation. Surprisingly, this group's self-reported assessment of their driving ability did not correlate with actual errors made. This led the researchers to conclude that talking on a cell phone while driving not only leads to diminished attention on the road and surroundings, but also to diminished awareness of perception of driving ability. A similar study included texting on a cell phone while driving and reported similar results (i.e., cell phone use while driving compromises the driver's ability to safely maneuver the vehicle due to the diminished attention allocated to the road; Stayrinos et al., 2013).

In an effort to reduce cell phone distracted driving, legislation has been enacted prohibit this act. To date, 14 states including California prohibit the use of hand-held cell phones while driving. Thirty-eight states ban all cell phone use by novice drivers—each state has their own law of what constitutes a novice driver—and an impressive 46 states ban text messaging while driving for all drivers (Governors Highway Safety Association, 2016a). Unfortunately, despite these efforts to reduce cell phone distracted driving, rates of cell phone use while driving remain alarmingly high.

The present research proposes a psychological explanation for the problem of cell phone distracted driving, namely that drivers who use cell phones are unable to delay gratification. That is, when an individual is driving and receives an incoming phone call or text message, rather than wait until they reach their destination, they may be inclined to respond immediately. In light of the public health concerns surrounding cell phone distracted driving, the current study sought to examine the relation between delay to reinforcement (i.e., time until one reaches one's destination) and likelihood of cell phone use while driving in hypothetical driving scenarios with college students.

CHAPTER II

LITERATURE REVIEW

Cell Phone Research and Perceived Risk

Of the populations affected by cell phone distracted driving, young adults (16-20 years old) are among the most vulnerable (Governors Highway Safety Association, 2016b). In a recent study, 94% of college students reported that they sent or read a text message while driving, while 98% talked on a cell phone while behind the wheel (Struckman-Johnson et al., 2015). Likewise, Harrison (2011) found that 91% of participants reported having sent or read a text message while driving while more than half the participants (55%) reported that they had drifted into another lane due to texting distractibility. Additionally, Atchley, Atwood, and Boulton (2011) examined young adult drivers and found that 70% had initiated a text message conversation while driving, 81% had replied to a text message initiated by someone else, and 92% had read, but not replied to a text message while driving. Perhaps most surprising was Atchley et al.'s finding that only 2% of young adults stated that they would never text and drive under any circumstance.

Among the same population of participants who reported using a cell phone while driving, researchers also examined the perceived risk associated with this behavior. In general, individuals described cell phone use while driving to be a risky behavior (Atchley et al., 2011; Atchley & Warden, 2012; Hayashi, Russo, & Wirth, 2015). Terry and Terry (2016) examined participant estimates of perceived accident risk across various distracted driving behaviors including driving with a blood alcohol concentration (BAC) at the legal limit, sending text messages, reading text messages, talking on a hand-held phone, and talking on a hands-free phone. Driving with a BAC at the legal limit and sending or reading text messages while driving were perceived as higher risk for an accident than talking on a cell phone with or without hands-free technology. However, sending a text message as opposed to just reading a text message while driving was seen as more of a risk. In fact, sending a text message while driving was viewed as similar risk factor for an accident as driving with a BAC at the legal limit (Terry & Terry, 2016). Atchley et al. (2011) also assessed perceived risk of cell phone use while driving, both reading and initiating a text message, on a Likert scale ranging from 1 (“not dangerous at all”) to 7 (“extremely dangerous”). The mean rating ranged from 4.63 (reading) to 5.28 (initiating a text message), confirming the consensus of public health experts that cell phone use while driving is a high-risk behavior. Finally, Struckman-Johnson et al. (2015) sampled 526 college students and found that a majority agreed that texting while driving should be illegal due to the risk involved (Struckman-Johnson et al., 2015). These findings suggest that young adults are aware of the risks associated with cell phone distracted driving, yet continue to engage in this dangerous behavior.

Delay of Gratification

A growing body of research has been aimed at the question of why cell phone use while driving persists, despite the well-known risks of the illegal behavior. From a psychological perspective, one reason why individuals may choose to use a cell phone while driving is because they are unable to delay gratification; that is, they simply cannot wait until they reach their destination to respond to an incoming phone call or text message.

Research examining individual's choices and ability to delay gratification is not a new phenomenon. Walter Mischel and colleagues examined delayed gratification in the late 1960s and early 1970s with children aged 3-5 years old (Mischel & Ebbensen, 1970; Mischel, Ebbensen, & Zeiss, 1972). In one version of the experiment, children were asked to choose their more desired treat among cookies and pretzels. Once a decision was made, the researcher told the child they had to leave the room for a few minutes. The children were informed that if they could wait for the researcher to return, then they would be given their chosen most desired treat. However, if the child could not wait any longer for the researcher to return, then the child could signal for the adult and would be given the alternate less desired treat. The researchers were interested in examining whether preschool aged children were able to wait for their more desired reward rather than accepting the immediate, but less desired reward. This classic experiment is now typically referred to as the "Marshmallow Test," where the reward is marshmallows treats: one marshmallow immediately or two marshmallows after an unspecified delay (Mischel et al., 2011).

The ability to delay gratification as a preschooler and adolescent has been linked to a number of positive future outcomes including higher SAT scores (Mischel, Shoda, & Rodriguez, 1989), social competence (Mischel, Shoda, & Peake, 1988), as well as adolescent fluency and coping capability (Shoda, Mischel, & Peake, 1990). Likewise, Schlam, Wilson, Shoda, Mischel, and Ayduk (2013) observed a correlation between the ability to delay gratification as a 4 year old and body mass index at age 30. The inability to delay gratification at a young age has also been associated with negative outcomes, such as lower self-esteem and poor academic performance (Anokin, Golosheykin, Grant, & Heath, 2011; Mischel et al., 1988). Inability to delay gratification is also associated with greater risk taking and engagement in impulsive behaviors (e.g. substance abuse problems and distracted driving behaviors) in the adolescent and adult years (Hayashi et al., 2015; Heil, Johnson, Higgins, & Bickel, 2006; Johnson, Herrmann, & Johnson, 2014; Kollins, 2003). Based on the existing literature, it seems plausible that individuals may choose to use a cell phone while driving because they are unable to delay gratification when faced with the prospect of having to wait until they safely reach their destination to respond.

Impulsivity and Delay Discounting

The decision to choose a smaller, immediate reward over a larger reward available after some delay is often described as an impulsive choice (Madden & Johnson, 2010). One reason why this choice is described as being impulsive is because the individual disregards a more rational long-term choice to opt for a less rational short-term benefit. Importantly, the degree to which an individual prefers immediate rewards to delayed rewards can be characterized via the behavioral phenomenon known as delay discounting. Past literature has drawn connections between excessive delay discounting and impulsive behaviors such as substance abuse and dependence (e.g. MacKillop et al., 2011), gambling (e.g., Alessi & Petry, 2003), sexual risk behaviors (e.g., Johnson, Sweeney, Herrmann, & Johnson, 2016), and risk taking behaviors in general (e.g. risk adverse attitudes towards safety and health) (e.g., Mishra & Lalumière, 2016).

Delay discounting is a behavioral economic framework that is used to examine decision-making when the choice involves two rewards differing in their magnitude and immediacy (Madden & Johnson, 2010). When choice varies along one dimension (e.g., immediacy), the outcome is relatively predictable from an economic and evolutionary standpoint (Green & Myerson, 2004). For example, if given the choice between two varying monetary amounts, an individual generally chooses the larger amount over smaller amount. Likewise, if given the choice between two rewards of equal amount, except that one is available sooner than the other, the predictable economic and evolutionary advantageous option would be to select the sooner reward. However, this predictability decreases when options differ along more than one dimension (Green & Myerson, 2004). For example, the choice between a “smaller-sooner” reward, such as $10 now, and a “larger-later” reward, such as $100 in 1 month, varies along two dimensions. In these situations, individuals make trade-offs when choosing one option over the other (Keeney & Raiffa, 1993), such as accepting less money now to the exclusion of more money later. In many ways, this monetary example is analogous to the decision of choosing to use a cell phone while driving. Specifically, one must decide to respond to an incoming phone call or text message immediately or to wait to return the phone call or respond to the text message later once one has safely reached their destination.

Cell Phone Use and Delay Discounting

In order to understand the influence of delay discounting in decisions surrounding cell phone use, Atchley and Warden (2012) conducted an experiment to examine the informational value associated with phone calls and text messages. Participants were presented with four hypothetical reward scenarios, two of which involved monetary rewards only while the other two scenarios involved a monetary reward plus information from a phone call or text message. In the monetary reward only condition, participants chose between a smaller, immediate monetary amount (e.g., $100) or a larger amount after a given delay (e.g., $1000). In separate conditions, five different delays to the larger-later reward were examined: 1, 25, 50, 75, and 150 days.

In the monetary reward plus information conditions, the immediate reward consisted of a monetary amount and the ability to respond to an incoming phone call and/or text message right away. The delayed reward in these conditions was always $100, but the individual was not able to respond to the phone call or text message until a specified period of time had elapsed. Similar to the monetary reward only conditions, five different delays were examined: 1, 5, 30, 60, and 480 minutes. In these conditions, the phone message received was from the participant’s significant other and claimed to provide informational value upon response. If a participant did not have a significant other, they were asked to imagine that they did, and respond as if they were actually in that situation. The researchers hypothesized that if phone calls and text messages held high informational value, then they would expect to observe steeper discounting (i.e., participants would be less likely to wait) in the monetary and informational value reward condition compared to the monetary reward only condition.

Atchley and Warden (2012) showed that participants discounted more steeply in the monetary plus information reward condition when compared to the monetary only condition. In other words, the value of the larger-later outcome decreased more rapidly as a function of delay to its receipt in the monetary plus information reward conditions compared to the monetary only conditions. The study claimed that if the information held no additional value beyond the monetary reward then the loss of value over time (i.e., discounting) should be equivalent in all scenarios. Because this was not the case, the researchers attributed the differences in discounting to the added value of the information associated with the phone call or text message.

In the same study, Atchley and Warden (2012) conducted an additional experiment in which the social distance of the person who contacted the participant was manipulated. Interestingly, the results revealed steeper discounting (i.e., less likely to wait to call/text) when the informational reward involved a significant other compared to a friend or a casual acquaintance, suggesting that the relationship to the individual calling or texting is a critical variable.

In a related study, Reed, Becirevic, Atchley, Kaplan, and Lise (2016) used a hypothetical choice task to examine discounting rates of texting opportunity with an attached monetary value. Specifically, Reed et al. gave participants the choice between reading and responding to a text message immediately, but having to pay some amount of money ($0.50-$5.00) or waiting some period of time (ranging from 1 minute to 24 hours) to read and respond to the text message for free. Like Atchley and Warden (2012), the results indicated that as delay increased, the likelihood of waiting decreased. However, further investigation is needed to better understand individual’s decisions to read and respond to a text message in this scenario because these decisions do not involve monetary gains or losses outside of the laboratory (Hayashi, Miller, Foreman, and Wirth, 2016).

Cell Phone Distracted Driving and Delay Discounting

Due to the limitations of these studies, the relation between delay discounting and cell phone use while driving is still generally unexplained. Expanding on this research, Hayashi et al. (2015) examined the role of delay discounting in individuals who self-reported engaging in frequent texting while driving (TWD) to matched controls who reported infrequently texting while driving (Non-TWD). It was hypothesized that those in the TWD group would discount monetary values at a steeper rate compared to individuals in the Non-TWD group. All participants completed a hypothetical monetary choice task involving a smaller reward available immediately (ranging from $1 to $1,000) or a $1,000 monetary reward available after a given delay. Across repeated trials, the amount of the immediate reward was adjusted based on participants' choices to identify the point of subjective indifference (i.e. when the subjective value of the immediate reward was equivalent to the subjective value of the delayed reward). Across conditions, the delay to the larger-later reward ranged from 1 week to 10 years.

Hayashi et al. (2015) found that individuals who frequently send and receive text messages while driving (the TWD group) discounted delayed money more steeply than did individuals who infrequently texted while driving (the Non-TWD group). The data supports the researchers' hypothesis that TWD participants would discount monetary values at a greater rate than Non-TWD participants. Although the study by Hayashi et al.

contributes to the literature, a major limitation of the study is that there is not a direct connection to cell phone use (i.e., texting) while driving.

Hayashi et al. (2016) developed a novel discounting task that applied directly to texting while driving. Prior to completing the discounting task, participants were asked to self-report the number of days they engaged in texting while driving (e.g., initiating, reading, and replying to text messages) in the past 30 days. Based on reported texting frequency while driving in the past 30 days, participants were split into one of the following groups high (top-third percentiles), middle (middle-third percentiles), or low (bottom-third percentile).

The texting-while-driving discounting task presented participants with a hypothetical scenario that their significant other (or best friend) had texted them saying "Text me A.S.A.P." while they were driving at a speed of 40 mph and a specified time away from reaching their destination. The delay until one reached their destination was manipulated across six trials, ranging from 30 seconds to 6 hours (Hayashi et al., 2016). The participants used a slider scale (labeled 0 to 100) to indicate their likelihood of waiting until their destination was reached to reply to the text message. It was hypothesized that high frequency texting individuals would discount at a greater rate in the task.

In general, the likelihood of waiting to reply to the text message while driving decreased as a function of delay; that is, discounting was greater as the time until one's destination was reached increased. Statistically significant results in discounting rates were revealed among groups (e.g. high vs. moderate and moderate vs. low). In particular, participants who reported more frequent texting behaviors while driving over the past 30 days showed greater discounting rates as delay until destination increased in the task. These results demonstrate that a driver's decision to engage in texting while driving is influenced by delay.

The Present Study

Previous research has found that one reason why individuals may use a cell phone while driving is because they are unable to delay gratification when faced with an immediate reward, an interpretation consistent with delay discounting, or the tendency for rewards to decline in value as a function of time until their receipt. The purpose of the present study was to further explore and expand on previous research findings. A procedure similar to Hayashi et al. (2016) was applied to examine the relative contributions of behavioral economic and social variables influencing cell phone distracted driving. College students' (*n* = 100) hypothetical choices to either use a cell phone while driving or to wait until one safely reached their destination to use a cell phone was examined in a novel Distracted Driving Delay Discounting Task (DDDDT). In the task, participants were asked to imagine they were driving on the highway when they received either a phone call or a text message. Across repeated trials, the anticipated time until one's destination was reached was manipulated (range = 1 min. to 2 hrs.). In addition, to investigate the possibility that social variables influence one's likelihood of waiting in the discounting task, two additional factors were manipulated across conditions: the relationship of the person attempting to contact the driver (#1 vs. #20 contact) and the number of passengers in the vehicle at the time (alone vs. 3 friends). Thus, a unique combination of the three environmental variables was present in each hypothetical scenario, resulting in eight conditions. A question was also presented to examine participant's likelihood of answering a phone call or responding to a text message from their #1 social contact or #20 social contact when they were alone and with 3 friends when they were *not* driving. This question was designed to examine differences in likelihood depending on social contact and the presence of other people in the absence of risk (henceforth, referred to as "no delay" question).

Following the DDDDT, participants completed the Cell Phone Dependence Scale (CPD; Struckman-Johnson et al., 2015), a Distracted Driving Behavior Norms Questionnaire, and a Driving Habits Questionnaire. Within the latter questionnaire, we asked participants about their experiences with phone-based applications designed to discourage cell phone use while driving. In 2010, AT&T launched a nationwide *It Can Wait* campaign that is dedicated towards educating the public on the dangers of cell phone use while driving (National Safety Council, 2017). As part of their efforts to reduce the prevalence of texting while driving, AT&T released a mobile phone application called DriveMode®, which once activated, silences the notification of an incoming text message and automatically sends a response to the receipt attempting contact that user is driving and will respond when it is safe (National Safety Council, 2017). Activating DriveMode® (or a similar application) is an initial first step towards committing oneself to be a safer driver (National Safety Council, 2017), and thus, eliminates the temptation to have to actively choose to delay gratification when presented with the option to respond immediately. For the purposes of the present study, we were interested in whether participants: (1), already had an application like DriveMode® currently installed on their cell phone, and if so, how often they use this application while driving, and (2) if participants did not have such an application, if they would be interested in downloading one and how often they feel they would activate the application prior to driving. Finally, following the Driving Habits Questionnaire, we administered a Drug Use Questionnaire based on DSM-5 criteria for Substance Use Disorders (American Psychiatric Association, 2013).

CHAPTER III

METHODOLOGY

Participants

Ninety- nine individuals enrolled in undergraduate psychology courses at California State University, Chico served as participants in the study and were recruited via email, class announcements, flyers, and word of mouth. Participation was voluntary and contingent upon agreeing to an online informed consent form. Participants received extra credit toward their psychology coursework for participating in the study.

Design

The study consisted of two separate sessions: a 5-min online screening questionnaire to determine eligibility for participation and, if eligible, a 1-hour in-person, experimental session. Criteria for eligibility included being at least 18 years of age, being a current driver, owning a cell phone, and having used a cell phone while driving at least once in a participant’s lifetime.

The online screening questionnaire was hosted online (Qualtrics, Inc.; Provo, UT). The in-person, experimental session took place in the Psychology Department at California State University, Chico and lasted approximately one hour. Experimental tasks were completed by each participant in the following order: Demographic Questionnaire, Social Contact Ranking, DDDDT, CPD, Distracted Driving Behavior Questionnaire, Driving Habits Questionnaire, and the Drug Use Questionnaire.

Materials

Screening Questionnaire

Prior to participating in the experimental session, individuals completed a brief screening questionnaire consisting of demographic information (e.g., age of participants) and specific driving behavior questions (e.g., “Have you ever used your cell phone to answer an incoming phone call or reply to an incoming text message while driving in your lifetime?”).

Demographic Questionnaire

Participants who were eligible to participate in the experimental session were asked to indicate their age, sex, race(s), ethnicity, and level of education (years completed).

Social Contact Ranking

Prior to beginning the DDDDT (described below), participants were asked to rank and list 20 individuals in their life (friends, family, etc.). The directions indicated that the first person on this list (#1) should currently be the most important person in your life, whereas the last person on this list (#20) should currently be a less important person in your life. This list was used to populate hypothetical scenarios in the DDDDT in which the social relationship of the person attempting to contact the driver was manipulated. Specifically, the #1 and #20 names provided by each participant were inserted into the hypothetical scenarios. This manipulation provided each participant with a unique and personal scenario in regards to manipulating the social distance of the person attempting to contact the driver.

Distracted Driving Delay Discounting Task

The novel DDDDT presented participants with hypothetical driving scenarios in which they were asked to report their likelihood of waiting until one's destination was reached to return an incoming phone call or reply to an incoming text message. Across trials, the time until one's destination would be reached was varied (1 min, 2 min, 5 min, 10 min, 15 min, 30 min, 1 hour, and 2 hours.). In addition, three other environmental variables were manipulated to assess their influence on cell phone use while driving. These variables included the form of attempted contact (phone call or text message), the social relationship of the person that attempted to contact the driver (#1 or #20), and the number of passengers in the vehicle (0 or 3). Thus, a unique combination of three environmental variables was present in each hypothetical scenario, resulting in eight conditions. The "no delay" question (i.e., likelihood of responding when not driving) was also presented prior to the delay manipulation questions.

Before the participants were seated at the computer workstation, the researcher informed participants that, for the purposes of the task, they were to assume that "hands-free" devices (e.g., Bluetooth®) were not permitted. That is, all cell phone use behavior while driving in the task meant physically holding a cell phone while answering a phone call or responding to a text message. Prior to beginning the experiment, participants were presented with a series of practice trials to acquaint them with the slider scale to be used in the DDDDT. An example of a practice trial question was, "Imagine that the question is, 'How likely are you to eat dinner tonight?' " with a predetermined answer of, "Imagine you had a big lunch, and felt that you would almost definitely would not eat dinner tonight (a 5% likelihood that you would eat dinner.)

Please respond to this question with a 5% likelihood that you would eat dinner." The participant was prompted to answer "5%" on the slider scale, which ranged from 0% ("I am definitely not eating diner tonight") to 100% ("I am definitely eating dinner tonight"). The series of practice trials was in place to ensure that participants read the prompt thoroughly and responded appropriately. The practice trials also provided participants with an opportunity to respond using the slider scale used in the DDDDT. After the practice trials were completed, participants were informed that the experiment would now begin.

Participants were provided with instructions that read, "Please pretend that you will NOT face legal consequences for using your cell phone while driving. In other words, please pretend that you will not be pulled over by a police officer and have to pay a fine if you indicate you would use your cell phone in this task. Also, please consider each question on an individual basis. In other words, pretend each question is the only one you will face that day."

In each trial, a hypothetical scenario asked the participant to imagine they were driving on the highway and that they were some period of time from their destination. The scenario specified the delay, whether the participant was receiving an incoming phone call or text message, which social contact was attempting to contact them, and whether they were traveling alone or with 3 passengers. To ensure that participants were aware of the relevant environmental manipulation variables taking place in the given driving scenario, participants responded to 3 quiz questions verifying that they understood what was being presented in the upcoming condition. If any question was answered incorrectly, the participant was shown the description for that condition and the corresponding questions until all responses were correct.

A “no delay” question was presented prior to the beginning of the delay questions in each condition. In the “no delay” scenarios, the participant was not in a driving situation. The participant used the slider scale to indicate how likely they would be to answer a phone call or respond to a text message immediately from the person attempting to contact them. The anchors on the slider scale correspond to 0% (“I definitely will not answer X’s phone call”) and 100% (“I definitely will answer X’s phone call”), with X corresponding to the name of either their #1 social contact or their #20 social contact. An example of a “no delay” scenario is shown in Figure 1.

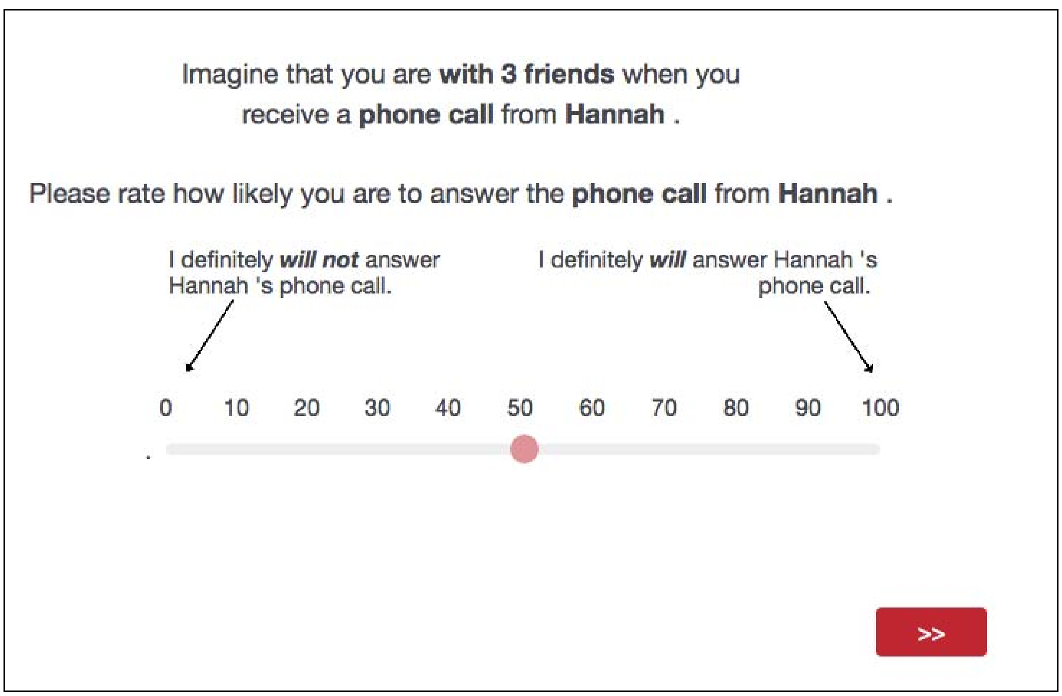

Figure 1. Example of hypothetical scenario from a “no delay” condition in the Distracted Driving Delay Discounting Task (DDDDT).

In each delay trial, similar to the “no delay” question, the participant used the slider scale to indicate how likely they would be to answer the phone call or respond to the text message from the person attempting to contact them given the delay (in minutes). The anchors on the slider scale corresponded to 0% (“I definitely will not answer X’s phone call” or “I definitely will not reply to X’s text message”) and 100% (“I definitely will answer X’s phone call” or “I definitely will reply to X’s text message”), with X corresponding to the name of either their #1 social contact or their #20 social contact. Across trials, the time until one’s destination would be reached was varied (1 min, 2 min, 5 min, 10 min, 15 min, 30 min, 1 hour, 2 hours.). An example of a given driving scenario is shown in Figure 2. For all trials, the default position of the slider was at 50 so as not to bias participants toward either alternative.

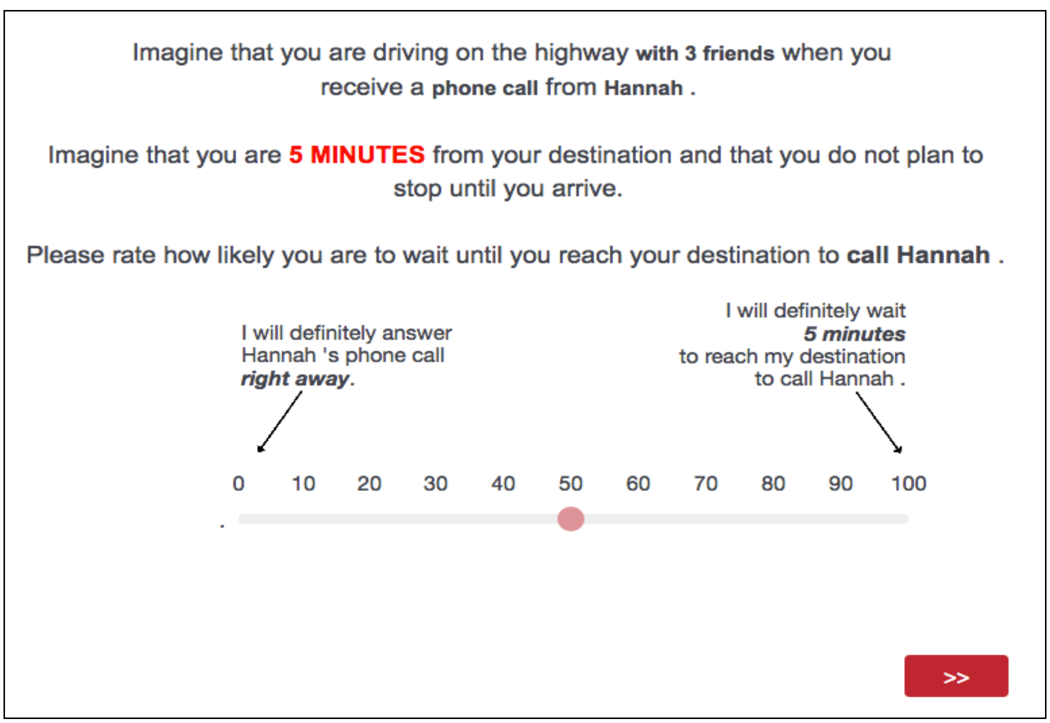

Figure 2. Example of hypothetical scenario from the Distracted Driving Delay Discounting Task (DDDDT).

Cell Phone Dependence Scale

The Cell Phone Dependence Scale (Struckman-Johnson et al., 2015) assessed the level of dependence participants have with their cell phone. The CPD features 12 items related to two factors: anxiousness without cell phone (seven items) and cell phone dependence (five items). All responses were rated on a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). The five items measuring cell phone dependence were reverse scored.

Distracted Driving Behavior Norms Questionnaire

The Distracted Driving Behavior Norms Questionnaire assessed other behaviors individuals may engage in while driving. Responses to this type of question were dichotomous (“Yes” or “No”). Regardless of whether a participant reported engaging in a particular behavior while driving, they were also asked to report their perception of how dangerous they felt that behavior is to engage in while driving. Participants used a slider scale ranging from 0% (“not dangerous at all”) to 100% (“extremely dangerous”) to indicate how dangerous they perceived a particular behavior to be.

Finally, participants estimated how prevalent they thought that behavior was among college-aged drivers. Participants used a slider scale ranging from 0% to 100% to indicate their perception of how prevalent they thought that behavior was among college-aged drivers.

Driving Habits Questionnaire

Additional questions were asked regarding driving habits (e.g., “Do you wear a seat belt when you drive?”). Possible responses included “Never,” “Rarely,” “Occasionally,” or “Always.”

Drug Use Questionnaire

A drug use questionnaire asked participants to report instances of drug use (e.g., alcohol, cannabis) in the past year, past month, and past week. Based on the past year use, the major drug classes (e.g., alcohol, tobacco, cannabis) were assessed using DSM-5 criteria to characterize substance use disorders (American Psychiatric Association, 2013).

Procedures

Individuals enrolled in undergraduate psychology courses at California State University, Chico were recruited to participate in the study. Recruitment took place online using a system the Psychology Department’s SONA website (www.csuchico.sona-systems.com). Individuals were provided with a unique SONA ID, which was how the researcher identified participants throughout the study. Prior to participating in a single, 1-hr in-person experimental session, participants provided informed consent and completed a 5-min online screening questionnaire to determine eligibility. Eligible participants then completed experimental tasks and assessments during the in-person experimental session. Experimental sessions were conducted in a laboratory room in the Psychology Department at CSU, Chico that contained a computer workstation for the participant and a separate table workstation for the researcher. A partition separated the computer workstation from the table workstation to ensure the researcher was blinded to participants' responses.

As participants entered the laboratory, the researcher greeted them. The SONA ID number the researcher had on file and the SONA ID number provided verbally by the participant were compared. This was to ensure that that participant was the individual who had signed up for the session and that they were eligible for participation in the experimental session. Prior to beginning the experimental session, participants were seated at the worktable station and presented with a paper version of the consent form. Participants were given an opportunity to look over the informed consent while the researcher entered the participant's SONA ID into the computer. The researcher then informed the participant that when responding to questions regarding cell phone use in the DDDDT, they were to assume that "hands-free" devices (e.g., Bluetooth®) were not permitted. Lastly, the researcher informed participants to please read all directions and scenarios thoroughly and to ask questions if needed. Participants were ensured that the researcher was blinded to their responses on the computer due to the partition. If there were no questions, the participant was seated at the computer workstation and instructed to begin the survey on the computer. At the conclusion of the survey, the participant was debriefed as to the purpose of the study and asked if they had any questions or concerns.

Data Analysis

Demographics

Means and standard deviations were calculated for continuous variable questions (e.g., age), whereas number of participants and percentages were calculated for categorical data (e.g., class standing).

Distracted Driving Delay Discounting Task

The DDDDT data was examined for missing data. If there was an instance of a missing data within a condition (i.e., the participant failed to respond to one or more delays of X minutes until one's destination is reached), then the value of the missing data was imputed. Missing data values were imputed by taking the average of the two adjacent values (i.e. values of 100 and 60 would yield an imputed mean score of 80), and in the event that the first or last value in each condition was missing, the immediate adjacent likelihood value was used.

Following data examination, GraphPad Prism V (GraphPad Software, La Jolla, CA) was used to fit the data and to calculate individual area-under-the-discounting-curve (AUC) values for each individual in all eight DDDDT conditions. AUC values range from 0 to 1, with smaller values indicating steeper discounting (i.e. less likely to wait; Myerson, Green, & Warusawitharana, 2001). A two parameter hyperbolic equation (Myerson & Green, 1995) was utilized to fit the data to illustrate if the data decreased hyperbolically as a function of delay.

AUC values were analyzed using a repeated-measures analysis of variance (ANOVA; SPSS, Armonk, NY). Correlations were conducted between AUC values from the DDDDT conditions and CPD scores, driving habit behavior responses (e.g., years driving), and number of DSM-5 substance use criteria endorsed (alcohol, marijuana, and tobacco).

Cell Phone Dependence Scale

Individual scores on the CPD were calculated as the group sum of individual items. Scores ranged from 12 to 60, with higher scores reflecting greater cell phone dependence.

Distracted Driving Behavior Norms Questionnaire

Means and standard deviations of these items were calculated to examine risk perception and participants estimated value of prevalence for each distracted driving behavior. In the event of missing data, values were imputed by using the group average. Individual participant engagement in the various asked about distracted driving behaviors was also examined and the percentage of individuals who reported engaging in each behavior was calculated. If a participant failed to respond, the value (e.g. yes or no) was left blank and the sample size per behavior was adjusted accordingly.

Driving Habits Questionnaire

Means and standrard deviations were calculated for continous measures (e.g., years driving) and number of participants (*n*) and percentages (%) were calculated for categorical data (e.g., “How often do you wear a seatbelt while driving?”). For certain measures, such as number of years driving, if participants endorsed categorical responses (e.g., “less than one year” or “more than 30 years”), they were excluded from further analyses.

A series of questions was also asked regarding cell phone applications (e.g., AT&T DriveMode®) that once activated, silences incoming text alerts while driving at 15 mph or faster (AT&T, 2013).

Drug Use Questionnaire

DSM-5 criteria were applied to characterize substance use disorders (American Psychiatric Association, 2013) based on participants self reported usage of major drug classes (e.g,. alcohol, tobacco, cannabis) within the past year. Severity of substance use disorder was categorized as mild, moderate, and severe based on the number of criteria endorsed. Diagnosis for mild substance use disorder is consistent with endorsement of 2-3 criteria, moderate substance use disorder is consistent with endorsement of 4-5 criteria, and severe substance use disorder is consistent with endorsement of six or more criteria (American Psychiatric Association, 2013).

CHAPTER IV

FINDINGS AND RESULTS

Sample Size and Demographics

A total of 364 individuals completed the online screening questionnaire via SONA and Qualtrics. Of these, 300 (82.4%) individuals met eligibility requirements (i.e., were 18 years or older, a current driver, owned a cell phone, and had used a cell phone will driving at least once in their lifetime), and of these eligible individuals, 110 participants signed up and completed the main survey (37%). The first 10 participants were excluded from analysis because the experimenters failed to explain to participants during instruction that “hands-free” devices (e.g. Bluetooth®) were not permitted during the DDDDT and one additional participant was excluded due to having provided incomplete data. Thus, the final study sample subjected to analysis was $n = 99$.

Of these 99 participants, 13 (13.1%) were male and 86 (86.9%) were female. Participants ranged in age from 18-62 years old ($M = 24.36$, $SD = 8.00$), with a range in class standing status: 6 (6.1%) freshman, 4 (4.0%) sophomores, 34 (34.3%) juniors, 52 (52.5%) seniors, and 3 (3.0%) graduate students taking undergraduate courses. A total of 70 (70.7%) participants identified their race as White/Caucasian, eight (8.1%) participants identified their race as Asian, three (3.0%) participants identified their race as Black/African- American, one (1%) participant identified their race as Native Hawaiian/Pacific Islander, four (4%) participants identified as more than one race, and 13

(4%) participants preferred not to answer. The majority of participants (61.6%, $n = 61$) reported their ethnicity as not Hispanic or Latino with the remainder reporting Hispanic or Latino (36.4%, $n = 36$) or preferring not to answer (2.0%, $n = 2$). Table 1 contains participant demographic information.

Table 1

Participant Demographic Information

Sample	Mean (SD)	n (%)
Age, years	24.36 (8.0)	
Sex		
Male		13 (13.1)
Female		86 (86.9)
Ethnicity		
Hispanic or Latino		36 (36.4)
Not Hispanic or Latino		61 (61.6)
Prefer not to answer		2 (2.0)
Race		
White/Caucasian		70 (70.7)
Asian		8 (8.1)
Black/African- American		3 (3.0)
Native Hawaiian/Pacific Islander		1 (1.0)
More than one race		4 (4.0)
Prefer not to answer		13 (13.1)
Class Standing		
Freshman		6 (6.1)
Sophomore		4 (4.0)
Junior		34 (34.3)
Senior		52 (52.5)
Graduate student taking undergraduate courses		3 (3.0)

Distracted Driving Delay Discounting

Figure 3 depicts the mean likelihood of responding immediately (“no delay”) to a phone call or text message given the social relationship of the person attempting contact and presence of other individuals while one is *not* driving. In general, individuals

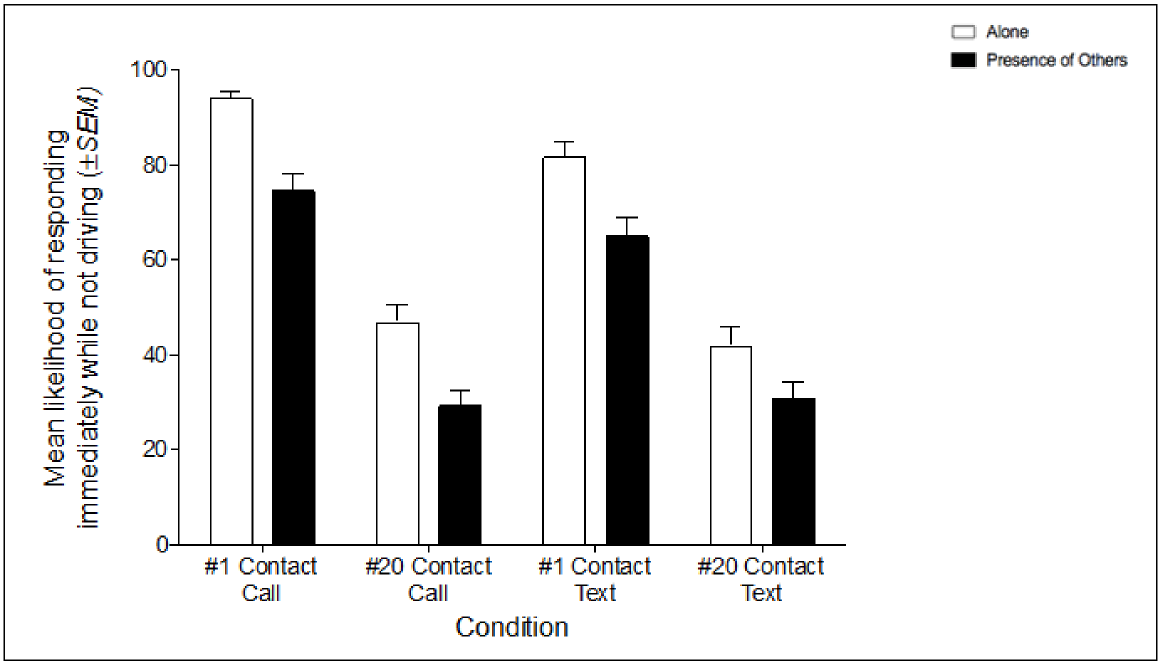

Figure 3. Mean likelihood of responding to an incoming phone call or text message immediately while not driving for each experimental condition from the Distracted Driving Delay Discounting Task (DDDDT). Error bars are standard errors of the mean.

were more likely to respond when contacted by their more important social relationship (#1) compared to their less important social relationship (#20). They were also more likely to respond when they were alone compared to when they were in the presence of others. Finally, participants were more likely to respond to a phone call compared to a text message.

These qualitative findings were confirmed statistically with a repeated-measures ANOVA. The "no delay" ANOVA revealed three significant main effects and one significant interaction. A significant main effect was observed for contact modality, F (1, 98) = 7.03, p = .009, η_p^2 = 0.07, social contact, F (1, 98) = 194.5, p < .001, η_p^2 = 0.67, and presence of other individuals, F (1, 98) =78.84, p < .001, η_p^2 = 0.45. A significant interaction was revealed between contact modality and the social relationship of person attempting contact, F (1,98) = 6.22, p = 0.01, η_p^2 = 0.06. Overall, participants were more likely to respond immediately to an incoming phone call (M = 61.37, SD = 39.43) compared to a text message (M = 55.07, SD = 39.90), when contacted by their #1 contact (M = 79.13, SD = 39.40) versus their #20 contact (M = 37.39, SD = 36.21), and when alone (M = 66.34, SD = 38.56) rather than in the presence of 3 other individuals (M = 50.10, SD = 39.54). The significant interaction revealed that the likelihood of responding to their #1 social contact or #20 social contact was dependent on whether an individual was contacted through a phone call or text message (e.g., more likely to respond to #20 when contacted through a text message than a phone call.)

Figure 4 illustrates the best-fit discounting curves from a two-parameter hyperbolic discounting equation (Myerson & Green, 1995) to the mean likelihood of waiting until one's destination is reached to return a phone call or text message. The equation fit the data well; R^2 values ranged from 0.83 to 0.97. In general, the discounting curves demonstrate that regardless of the condition, likelihood of waiting to use one's cell phone use decreases hyperbolically as a function of time until one's destination is reached. The discounting curves show that discounting is steepest (i.e., least indicative of waiting) when one receives a phone call from their #1 social contact (most important relationship) and is traveling alone in the vehicle. In contrast, regardless of contact modality, discounting is most shallow (i.e., more likely to wait) when one is contacted by their #20 (less important relationship) and is traveling with 3 friends in the vehicle. It is interesting to note the visually evident distinction between the two social manipulation variables: social relationship of the person attempting to contact the driver and number of

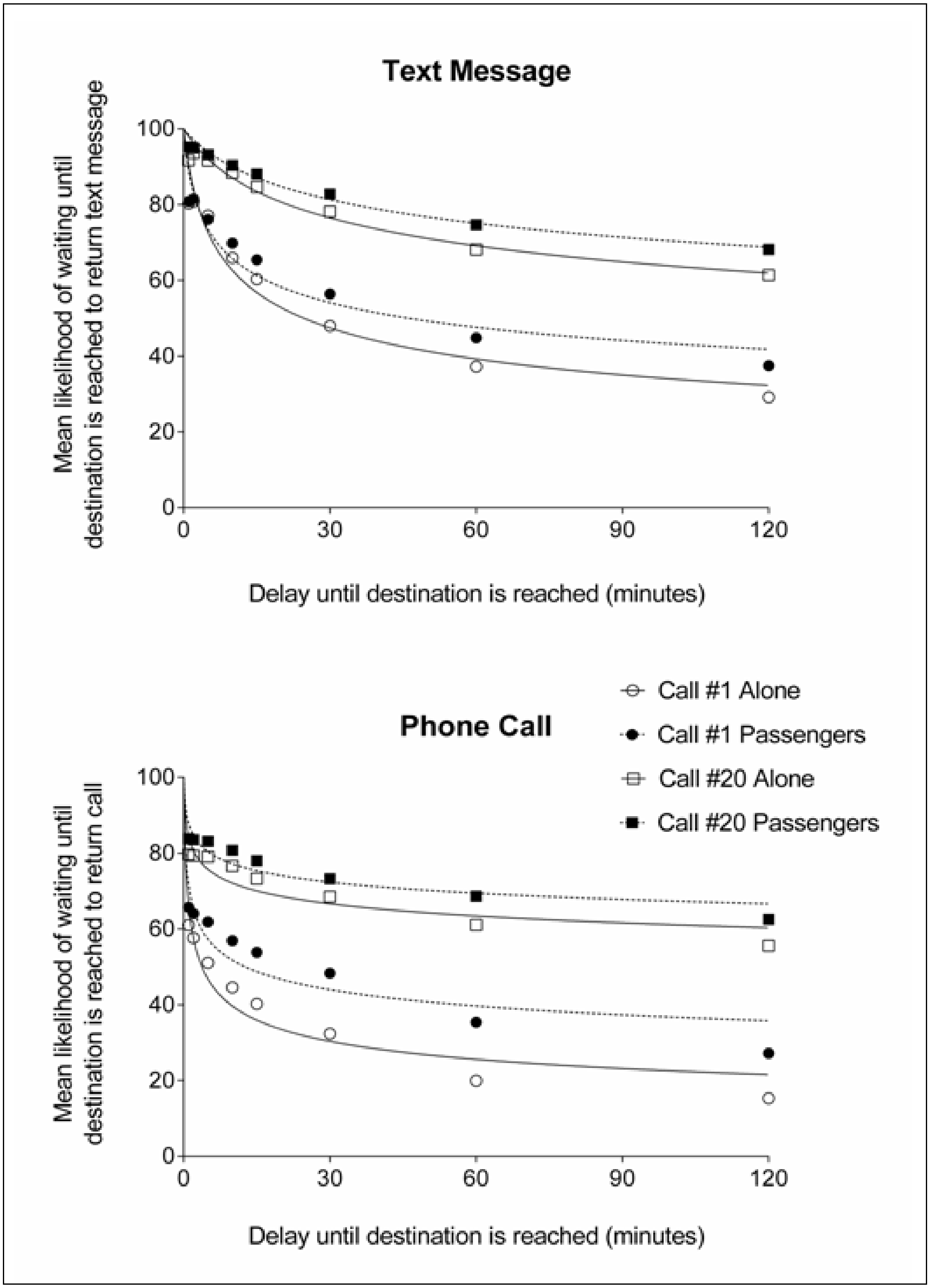

Figure 4. Mean likelihood of waiting until one's destination is reached to reply to an incoming text message or phone call as a function of delay until destination is reached.

passengers in the vehicle, demonstrated by the discounting curves. These data are also shown in Figure 5 as mean AUC values for each experimental condition.

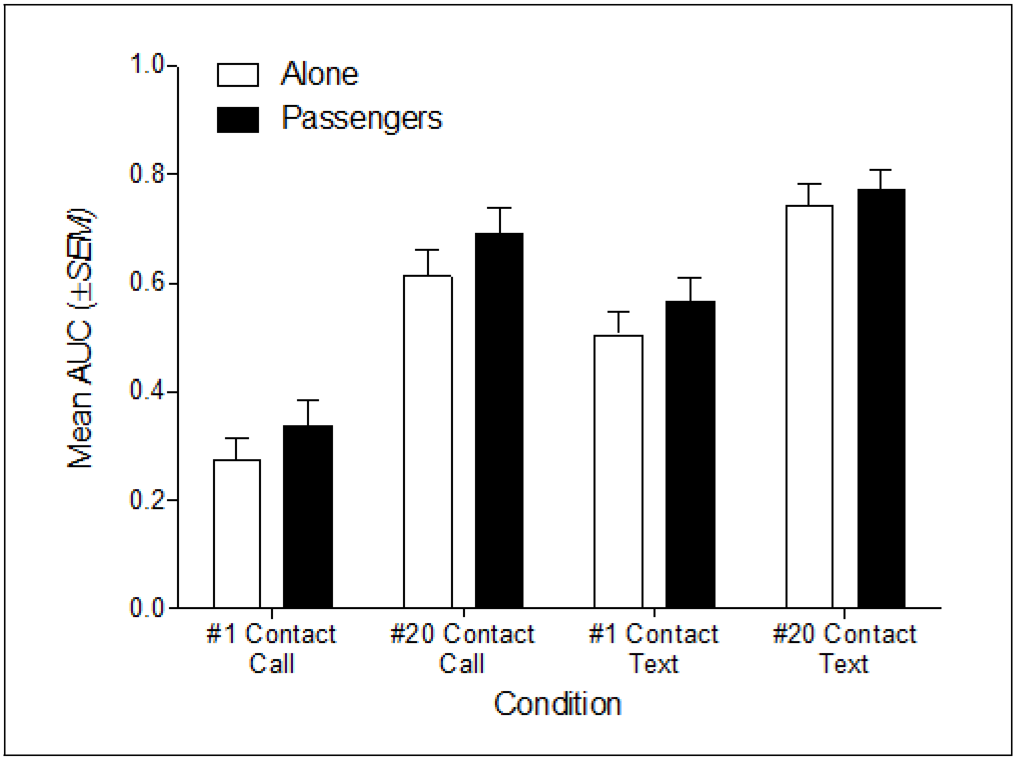

Figure 5. Mean area under the individual-subject discounting curve (AUC).

The qualitative discounting curve results were confirmed statistically with a repeated-measures ANOVA. The ANOVA revealed 3 significant main effects; no significant interactions were found. A significant main effect was observed for contact modality, F (1, 98) = 17.56, p < .001, η_p^2 = 0.15, social contact, F (1, 98) = 140.72, p < .001, η_p^2 = 0.59, and number of passengers in the vehicle, F (1, 98) =31.44, p < .001, η_p^2 = 0.24. These results confirm the findings shown from the discounting curves, that participants are less likely to wait until their destination is reached to return an incoming phone call (*M* = 0.50, *SD* = 0.38) versus a text message (*M* = 0.61, *SD* = 0.34), when contacted by their #1 contact (*M* = 0.40, *SD* = 0.33) versus their #20 contact (*M* = 0.71, *SD* = 0.33), and when traveling alone (*M* = 0.51, *SD* = 0.37) versus than with 3 friends in the vehicle (*M* = 0.60, *SD* = 0.36).

Cell Phone Dependence

Scores from the CPD scale revealed that college-aged students are highly dependent on their cellular devices (*M* = 40.30, *SD* = 8.43).

Distracted Driving Behavior Norms

Thirteen of 99 (0.04%) values were missing for questions regarding perceived risk and estimated prevalence, and 1 response was unanswered for whether or not a participant had ever engaged in a particular distracted driving behavior. The three riskiest distracted driving behaviors (as perceived by participants) were driving buzzed/drunk (*M* = 97.1, *SD* = 7.3), driving while consuming an alcoholic drink (*M* = 95.6, *SD = 10.8)*, and driving when one feels too drowsy to drive (*M*= 93.8, *SD* = 11.7). When participants were asked to estimate the prevalence of each behavior among college-aged drivers, sending a text message (*M* = 92.9, *SD* = 8.4), changing music on a cell phone (*M* = 92.8, *SD* = 11.5), and talking on the phone (*M* = 92.5, *SD* = 8.7) were estimated to be the most prevalent distracted driving behaviors. Contrary to these estimates, however, talking on a phone (*n* = 99; 100%), eating (*n* = 96; 97%), and sending a text message (*n* = 94; 94.9%) were reported by participants as the three most prevalent distracted driving behaviors. These results are shown in detail in Table 2.

Table 2

Distracted Driving Behavior Norms Questionnaire

Item	Risk Perception *Mean (SD)*	Percentage Estimate *Mean (SD)*	Engagement in Item (Yes) *n (%)*
Driven buzzed/drunk	97.1 (7.3)	66.8 (24.7)	48 (48.5)
Driven while consuming an alcoholic drink	95.6 (10.8)	54.6 (26.4)	8 (8.1)
Driven when you felt too drowsy to drive	93.8 (11.7)	78.9 (17.1)	81 (81.8)
Used illicit (i.e. illegal) drugs	93.0 (15.5)	53.3 (27.1)	18 (18.2)
Browsed the Internet	92.7 (10.2)	76.0 (19.6)	46 (46.5)
Read/studied	92.1 (10.3)	50.6 (25.8)	21 (21.2)
Checked/used a social media application	91.7 (10.5)	88.7 (14.9)	76 (76.8)
Driven immediately after having an alcoholic beverage	91.2 (16.6)	70.5 (21.9)	34 (34.3)
Sent a text message	91.0 (10.6)	92.9 (8.4)	94 (94.9)
Driven immediately after using illicit drugs	90.0 (17.5)	61.7 (26.0)	31 (31.3)
Changed clothes	89.3 (12.9)	54.2 (22.9)	35 (35.4)
Applied makeup	88.8 (15.4)	57.8 (21.1)	23 (23.2)
Checked your e-mail	85.6 (15.6)	70.0 (22.2)	50 (50.5)*
Taken pictures	85.4 (15.9)	78.7 (19.2)	78 (78.8)
Talked on the phone	68.9 (24.0)	92.5 (8.7)	99 (1.0)
Changed music on a cell phone	66.8 (25.7)	92.82 (11.5)	92 (92.9)
Eaten	53.7 (23.0)	92.0 (10.8)	96 (97.0)

Note: *$n=98$

Driving Habits

Table 3 shows the results of the Driving Habits Questionnaire. Of note, a series of cell phone application questions began by initally presenting participants with the question, “Does your cell phone currently have an application installed that, once activated, prevents you from receiving phone calls or text messages while driving?” (data not shown in Table 3). Eight (8%) participants reponded “Yes,” 77 (77.8%) participants repsonded “No,” and 14 (14.1%) participants did not respond to the question.

The eight participants that responded “Yes” were directed to the question, “How frequently do you use this application to prevent yourself from receiving phone calls or text messages while driving?” One participant responded “Always,” three participants responded “Occasionally,” and four participants responded “Never.” The 77 participants that responded “No” to the initial qeustionwere directed to the question, “Would you be interested in downloading a cell phone application that, once activated, prevents you from receiving phone calls or text messages while driving?” A total of 28 (36.4%) participants responded “Yes,” while 49 (63.6%) participants responded “No.”

Finally, the 28 participants that reponded “Yes” were directed to the question, “How frequently do you think you would use this application to prevent yourself from receiving incoming phone calls or text messages while driving?”A total of six (21.4%) participants responded “Always,” 19 (67.9%) participants responded “Occasionally,” two (7.1%) participants responded “Rarely,” and one (3.6%) participant responded “Never.”

Table 3

Driving Habits Questionnaire and Cell Phone Dependence (n = 99)

	Mean (SD)	n (%)
Cell Phone Dependence Scale [1]	40.30 (8.43)	
Years Driving [2]	6.91 (5.07)	
Average number of passengers while driving	0.94 (0.99)	
Number of accidents been involved in while driving	1.06 (1.13)	
How many times have you been pulled over by the police, regardless of ticket?	1.80 (2.12)	
Do you always wear a seatbelt while driving?		
Always		91 (91.9)
Occasionally		8 (8.1)
Rarely		-
Never		-
Do you wear a seatbelt when you are a passenger in a vehicle?		
Always		89 (89.9)
Occasionally		8 (8.1)
Rarely		2 (2.0)
Never		-
How would you rate the quality of your driving?		
Excellent		15 (15.2)
Very Good		49 (49.5)
Good		28 (28.3)
Fair		7 (7.0)
Poor		-
Driving behaviors differ downtown vs. highway?		
Definitely		46 (46.5)
Somewhat		47 (47.5)
Not at all		6 (6.0)
Driving behavior differ when stopped at a red light vs. actively driving?		
Yes, more likely to use cell phone at a red light		87 (88.0)
No difference		6 (6.0)
Yes, more likely to use cell phone while driving		6 (6.0)

Note: [1] Scores ranged from 12-60 with higher scores indicating greater cell phone dependence. [2] 5 participants reported driving "Less than 1 year" and "More than 30 years."

Past-Year Drug Use

DSM-5 criteria were used to characterize substance use disorders (APA, 2013) based on participants' self-reported past-year use of the major drug classes (e.g., alcohol, tobacco, marijuana). Alcohol (n = 89; 89.9%), marijuana (n = 55; 55.6%), and tobacco (n = 20; 20.2%) were the three most commonly used drugs during the past year. Severity of substance use disorders was charazterized as mild, moderate, or severe according to DSM-5 guidelines. Alcohol was associated with the most criteria endorsed for mild (38%) and severe (8%) alcohol use disorder, while marijuana was associated with the most crieria endorsed for a moderate (15%) cannabis use disorder. Results for these and other drugs of abuse are presented in Table 4.

Correlates of Distracted Driving Delay Discounting Task and Other Measures

AUC values from five of eight DDDDT conditions were significantly correlated with one another (all p values $\leq$ 0.41; see Table 5). Receiving an incoming phone call from one's #1 social contact while driving alone (i.e., C1A) was not significantly correlated with three conditions: receiving a phone call from one's #20 social contact while driving with 3 friends (C20P; p = 0.18), receiving a text message from one's #20 social contact while driving alone (T20A; p = 0.89), and receiving a text message from one's #20 social contact while driving with 3 friends (T20P; p = 0.80).

Correlations were also conducted between AUC values from the DDDDT conditions and other non-discounting measures (see Table 5). A significant relation was observed between the number of times a participant reported being pulled over by the police (regardless of whether they received a ticket or not) and the CPD scale (r = -0.21,

Table 4

Drug Use Questionnaire

Drug Sample ($N = 99$)	Reported "Yes" in past year n (%)	Mild n (%)	Moderate n (%)	Severe n (%)
Alcohol	89 (89.9)	34 (38.2)	4 (4.5)	7 (7.9)
Amphetamines (e.g., Adderall)	10 (10.1)	3 (30.0)	0 (0)	0 (0)
Barbiturates (e.g., Phenobarbital)	0 (0)	0 (0)	0 (0)	0 (0)
"Bath salt" products	0 (0)	0 (0)	0 (0)	0 (0)
Benzodiazepines (e.g., Xanax)	7 (7.1)	1 (14.3)	0 (0)	1 (14.3)
Cocaine	10 (10.1)	5 (50.0)	0 (0)	0 (0)
Hallucinogens (e.g., LSD)	9 (9.1)	1 (11.1)	0 (0)	0 (0)
Heroin	1 (9.1)	0 (0)	0 (0)	1 (11.1)
Inhalants (e.g., gasoline)	0 (0)	0 (0)	0 (0)	0 (0)
Marijuana	55 (55.6)	15 (27.3)	8 (14.5)	6 (10.9)
MDMD (e.g., Ecstasy)	11 (11.1)	1 (9.1)	0 (0)	0 (0)
Methamphetamine	0 (0)	0 (0)	0 (0)	0 (0)
Methylphenidate (e.g., Ritalin)	0 (0)	0 (0)	0 (0)	0 (0)
Nitrous Oxide	0 (0)	0 (0)	0 (0)	0 (0)
PCP, Angel Dust, Ketamine, DXM	0 (0)	0 (0)	0 (0)	0 (0)
Prescription Pain Relievers (e.g., Vicodin)	14 (14.1)	1 (7.1)	0 (0)	0 (0)
Salvia Divinorum	0 (0)	0 (0)	0 (0)	0 (0)
Synthetic Cannabinoids (e.g., "Spice")	0 (0)	0 (0)	0 (0)	0 (0)
Tobacco (e.g., cigarettes)	20 (20.2)	4 (20.0)	3 (15.0)	2 (10.0)
Other	1 (1.0)	0 (0)	0 (0)	0 (0)

TABLE 5

Pearson Correlation Coefficents on DDDDT AUC Values and Other Measures

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
C1A	-														
1. C20A	.24*	-													
2. C1P	.50**	.34**	-												
3. C20P	.14	.79**	.29**	-											
4. T1A	.40**	.36**	.49**	.32**	-										
5. T20A	.01	.25*	.21*	.34**	.48**	-									
6. T1P	.23*	.26**	.43**	.25*	.69**	.47**	-								
7. T20P	-.03	.33**	.21*	.41**	.29**	.75**	.46**	-							
8. CPD Scale	.04	.16	-.07	.14	-.09	.01	-.14	-.01	-						
9. Years Driving	.04	.01	.12	-.02	.11	.04	.18	-.01	-.23	-					
10. # of Accidents	-.03	.06	.06	-.02	-.05	.00	-.00	.02	-.12	.39**	-				
11. # of Times Pulled Over	-.10	.01	.03	-.05	-.04	.03	.01	.08	-.21*	.66**	.23*	-			
12. Typical # of Passenger	.22*	.11	-.05	.02	.09	-.08	.01	-.06	.02	.03	.02	-.05	-		
13. Alcohol Criteria Endorsed	-.35	.64*	.74*	.81**	.17	.47	.16	.60	-.36	.05	.11	-.09	-.18	-	
14. Tobacco Criteria Endorsed	-.20	-.09	.06	.09	.14	.31	.37	.28	-.26	.31	-.23	.07	-.38	87	-
15. Marijuana Criteria Endorsed	-.23	.11	.08	.11	-.15	-.06	.12	-.07	-.05	-.01	.08	.09	-.13	-.31	.16

Note: AUC = Area Under Curve; CPD Scale = Cell Phone Dependence Scale; Items 1-8 correspond to the 8 DDDDT conditions, where C = Phone Call, T = Text Message, 1 = Most Important Social Contact (#1), 20 = Less Important Social Contact (#20), A = Traveling Alone, P = Traveling with 3 passengers.

* $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

$p = 0.04$), reported number of years driving ($r = 0.66$, $p < 0.01$) and number of accidents a participant had been involved in when they were the driver ($r = 0.23$, $p = 0.20$). The number of years driving was significantly and negatively correlated with scores on the CPD scale ($r = -0.23$, $p = 0.03$), and significantly and positively correlated with the number of accidents one had been involved in as a driver ($r = 0.39$, $p < 0.01$. Finally, a significant relation was observed between the number of passengers an individual typically had in their car while they were driving and the DDDDT condition of receiving a phone call from one's #1 social contact while driving alone (C1A; $r = 0.21$, $p = 0.03$).

Lastly, a positive correlation was observed between the number of past-year alcohol use disorder criteria endorsed and three DDDDT conditions: when one received a phone call from their #20 social contact while driving alone (C20A; $r = 0.64$, $p < 0.05$), a phone call from their #1 social contact while driving with 3 friends (C1P; $r = 0.74$, $p = 0.02$), and a phone call from their #20 social contact while driving with 3 friends (C20P; $r = 0.81$, $p < 0.01$).

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Discussion

The current study expands upon earlier research examining delay discounting and social variables that influence cell phone distracted driving (e.g., Hayashi et al., 2016). The present study investigated one's likelihood of waiting to respond to an incoming phone call or text message while driving, given a combination of delay until one's destination is reached and social variables that were presented as hypothetical driving scenarios. Results from the "no delay" questions provided baseline data that less important social relationships (i.e., one's #20 social contact) were still important enough that participants would respond to a phone call or text message immediately. Our major findings involved the remaining he DDDDT conditions which showed that individuals were significantly more likely to wait to respond to an incoming text message compared to a phone call, significantly more likely to wait when the person attempting contact with the driver was a less important social relationship (#20) compared to a more important social relationship (#1), and significantly more likely to wait when the driver was traveling with three friends in the vehicle rather than when traveling alone.

Importantly, the main result, that likelihood of waiting to respond to an incoming phone call or text message decreased hyperbolically as a function of delay, is consistent with previous findings (Atchley & Warden, 2012; Hayashi et al., 2016; Reed et al., 2016). In general, individuals were more likely to use their cell phone while driving if they were further from their destination.

The DDDDT also revealed that the modality of contact (phone call versus text message) had a significant impact on an individual’s decision to wait to respond until one’s destination is reached. Specifically, individuals were less likely to wait until their destination was reached to respond when contacted through a phone call compared to a text message; however, the results showed participants were still highly likely to respond to a text message while driving. The perceived risk for texting may be greater than that of talking on a cell phone, which is why participants may be more likely to wait to respond to a text message than a phone call while driving. In regards to type of distraction, perceived risk of texting may be enhanced due to the fact that it requires individuals to be more visually distracted by the cell phone. The Virginia Tech Transportation Institute reported in 2009 that the average length of time to read or type a text message is about 4.6 seconds. Therefore, engaging in texting while driving for about three seconds is equivalent to driving blindfolded for the length of an entire football field if traveling at 55 mph. Texting while driving also increases the risk of a crash by 8 to 23.2 times, while talking on a cell phone while driving increases the risk of a crash 4 times higher than a non-distracted driver (National Safety Council, 2015). To our knowledge, this is the first study to directly compare discounting rates of likelihood of waiting to respond until one’s destination is reached across differing contact modalities. These results uniquely contribute to the literature in furthering our understanding of potential variables that influence cell phone distracted driving behaviors.

The present study also extends the current literature on the importance of the social relationship of the person attempting to contact the driver. Consistent with previous research (e.g. Atchley & Warden, 2012; Jones & Rachlin, 2006), discounting is steepest (i.e. participants were less likely to wait) when a more important social contact (#1) was attempting to contact with the driver than when a less important social contact (#20) was attempting to contact the driver. Research outside the realm of delay discounting has found supporting evidence of the implications for varying social relationships on cell phone use while driving. The NHTSA conducted a National Phone Survey on Distracted Driving Attitudes and Behaviors and found that 23% to 30% of respondents reported that their decision to respond to an incoming message while driving was dependent on how important they felt the person attempting contact was (Tison, Chaudhary, & Cosgrove, 2011). Our experimental findings support the notion that social distance of the person attempting contact is a potential variable that influences an individual's decision to engage in cell phone distracted driving behaviors; however, this leads to the question of how this knowledge about the importance of social relationships benefits individual drivers. Since it would be nearly impossible to prevent important people in one's life from attempting contact with them every time they were behind the wheel, it is therefore the responsibility of the driver to take action, either through delaying gratification when faced with immediate temptation, or by taking the initiative to activate a driving application (e.g. DriveMode®) that probibits messaging while one is driving.

Another major finding of the present study was that the number of passengers in the vehicle had a significant effect on the likelihood of waiting until one's destination is reached to respond to a phone call or text message. The finding that discounting was significantly less steep when passengers were in the car demonstrates that having passengers in the car could serve as a safeguard against cell phone distracted driving. This finding also uniquely contributes to the literature on distracted driving within a delay-discounting framework, as these variables, to our knowledge, have not been studied in this fashion. A 2009 Pew Research Center report, *Teens and Distracted Driving,* revealed that 48% of individuals reported feeling unsafe and like their life was at risk when a driver was using a cell phone while they were passengers in the vehicle. An interesting body of experimental research has also compared the effects on driving of talking on a cell phone versus talking to individuals in the vehicle (e.g. Drews, Pasupathi, & Strayer, 2004; Chartlton, 2009). The results demonstrated that drivers who conversed on a cell phone while driving made significantly more driving errors (e.g., missed the desired exit due to lack of attention on surroundings) compared to drivers who conversed with passengers in the vehicle (Drews et al., 2004). An analysis of the driver and passenger conversation suggests that in the driver-passenger conversations the driving surroundings often become part of their conversation (Drews et al., 2004), which allows passengers to guide and adapt their conversation based on the current driving condition (Association of Psychological Science, 2014). For example, a passenger can stop conversing with the driver if they encounter an unsafe driving situation. In contrast, conversations through a cell phone do not have this same benefit. The individual on the phone cannot view the road conditions and is therefore unable to adapt their conversation accordingly (Association of Psychological Science, 2014.). Taken together, research suggests that traveling with passengers may serve as a safeguard against cell phone use while driving and that conversation with passengers in the vehicle may benefit, rather than hinder, driving performance.

Beyond the DDDDT, the CPD scale (Struckman-Johnson et al., 2015) revealed that our sample of participants was highly dependent on their cell phone, endorsing items such as, “I would consider my cell phone an extension of myself.” High cell phone dependence was also significantly associated with the number of times an individual had been pulled over by the police, suggesting that these individuals are more likely to use their cell phone while driving. The Distracted Driving Behavior Norms Questionnaire, created for the purposes of the present study, revealed that high perception of risk does not equate to refraining from engagement in the behavior. As an example, participants identified driving when one felt too drowsy to drive as an extremely risky behavior, yet more than 75% of participants reported engaging in this behavior. This disconnect between risk perception and engagement in behavior is also consistent with previous research findings (Atchley et al., 2011; Atchley & Warden, 2012; Hayashi et al., 2015; Stuckman-Johnson et al., 2015). Finally, the present study also found a significant relationship between alcohol substance abuse and discounting rates in three of the DDDDT conditions. In other words, individuals who met DSM-5 criteria for an alcohol use disorder tended to display steeper discounting rates. The relationship between substance abuse and discounting rates is a finding that has been supported by several delay discounting studies (e.g. MacKillop et al., 2011) and remains a topic worthy of further investigation within the area of cell phone distracted driving.

Some consideration should be given to the study’s limitations. One study limitation was that the driving scenarios presented in the DDDDT were hypothetical.

However, given the nature of this research, it would be unethical and illegal to conduct this exact experiment in a natural, non-contrived hypothetical situation as cell phone use while driving without Bluetooth® is illegal in the state of California (Governors Highway Safety Association, 2016a). Furthermore, the validity of using hypothetical scenarios to examine delay discounting has been validated by many researchers who have shown that individuals discount hypothetical and real rewards in a similar manner (e.g., Madden, Begotka, Raiff, & Kastern, 2003; Johnson & Bickel, 2002; Madden et al., 2004; Matusiewinc, Carter, Landes, & Yi, 2013).

A second study limitation was due to experimenter error. The researchers failed to include the instruction that "hands-free" devices such as Bluetooth® were not permitted for the purposes of this study in the DDDDT for the first 10 participants. Although the experimenter verbally informed the remaining participants of this instruction prior to beginning the experiment, it would have been beneficial to include this information in the on-screen instructions as well.

A third limitation of the study was the experiment's reliance on self-report data. Self- report data can potentially be problematic, as it requires and relies on participants to self-evaluate their own behaviors and respond accurately. Social desirability bias—the tendency for research participants to respond in a more socially desirable, rather than truthful manner—is of concern. Alternatively, self-report data can be uniquely beneficial, as it allows the participants to respond in a confidential manner, which may prompt participants to respond more accurately than they would in a different situation. Despite this reliance on self-report data and social desirability bias being a concern, the results of the present study demonstrated significant differences between conditions, suggesting that the results of this study are unlikely to have been affected by this limitation.

Although the present results support the notion that delay, contact modality, the social relationship of the individual attempting to contact the driver, and the number of passengers in the vehicle are all variables affecting the likelihood of cell phone use while driving, future research should further investigate these variables and others to expand the literature. In addition, instead of applying hypothetical driving scenarios presented via a computer screen, driving simulators could provide further insight and realism to the experiment. Also, further investigation is needed to determine how these results may differ if the study were to be replicated in a different environment; for example, in a participants home without an experimenter present.

The present study results can be applied to inform interventions aimed at reducing cell phone use while driving in college-aged individuals. For example, in the DDDDT, driving with passengers in the vehicle was shown to increase the likelihood that an individual would wait to respond to an incoming message until their destination is reached. Therefore, a potential way to reduce cell phone use while driving is to encourage individuals to carpool. The DDDDT could also be used as a potential diagnostic tool in driving education courses to identify individuals who may be at risk for engaging in cell phone distracted driving behaviors. For example, California state law requires all drivers under the age of 17 ½ to complete a driver’s education course prior to being eligible to apply for a driver’s permit or driver’s license (California Department of Motor Vehicles, 2017). This hypothetical task could easily be incorporated into the curriculum to examine how individuals would respond to these hypothetical driving scenarios. Individuals who discount steeply (i.e., are less likely to wait until one's destination is reached to respond to a phone call or text message) could then be required to complete additional education courses aimed at discouraging cell phone use while driving. This task may also exposed at-risk drivers to certain "what-if" situations that can occur while driving and allow them to think about how they would handle the situation as if it were real.

Additionally, regardless of contact modality, the relationship of the individual attempting contact with the driver, or the number of passengers in the vehicle, cell phone use while driving was still evident (i.e., discounting still occurred). Therefore, it may be useful to further develop technology capable of decreasing cell phone use while driving. Although phone-based applications such as DriveMode® exist, an unfortunate downside to these applications is that, in the case of an emergency, the individual would not receive the message until their destination was reached, thereby punishing use of the application. Rather, an application that provides positive reinforcement contingent on desirable behavior could be more effective. An incentive- based application could be developed that rewards individuals for not engaging in cell phone use while driving. For example, individuals could acquire points for not engaging in cell phone use while driving, which could be exchanged for goods or services (e.g., insurance discounts). Prior research has shown that incentive-based interventions, known as contingency management, are effective in reducing undesirable behaviors such as substance abuse and increasing the frequency of desirable behaviors such as abstinence (Bickel, Johnson, Koffarnus, MacKillop, & Murphy, 2014). Thus, an application based on positive reinforcement could prove useful in decreasing cell phone use while driving.

The present study applied a delay-discounting framework to examine the relative contributions of behavioral economic and social variables to college students' hypothetical choices to either use a cell phone while driving or to wait until one safely reached their destination to use a cell phone. The results showed that one's likelihood of waiting until one's destination is reached decreases hyperbolically as a function of delay. Individuals were also more likely to answer an incoming phone call compared to a text message. In addition, the two social variables were shown to influence one's likelihood of waiting to return a phone call or text message until one's destination is reached. As such, the present results further support and expand the growing literature aimed at examining potential variables that influence cell phone distracted driving.

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