MASTER'S THESIS
Learning in Complex Systems
June 2018

Cellphone Use While Driving – a Behavioral Economic Perspective

Eskil Johnsrud Sæterlien

Faculty of Health Sciences
Department of Behavioral Science

OsloMet – Oslo Metropolitan University

Author's note

This master's thesis is the final part of my master's degree in Learning in Complex Systems at Oslo Metropolitan University (former Oslo and Akershus University College of Applied Sciences). The past two years have been an interesting and joyful journey. Especially with my semester exchange at the University of Nevada Reno, one of the worlds most professional programs within the field of behavioral science. There are several people that deserve praise for me being here I am today. I would first thank my supervisor, Per Holth. His availability and feedback led me through this work with a clear and systematic approach. Further, I want to thank my beloved cohabitant Helene, my family, and friends, for all the support during this period. Lastly, this thesis could never have been completed without all the participants taking the survey, the foundation of my empirical data. So thank you, and stop using the cellphone while driving.

"Education is what survives when what has been learned has been forgotten."

- B. F. Skinner

Table of Contents

List of tables, figures, and appendix

Article 1

Article 2

Summary

From a behavioral economic perspective, texting while driving involves a trade-off between immediate and delayed outcomes. It is showed behaviorally as a preference for smaller immediate rewards over larger delayed rewards. A literature review constitutes the first part of this paper. The purpose is to examine to what extent previous research has studied and explained cellphone use, or more specifically texting while driving, utilizing a delay discounting procedure. The literature reviewed suggests several potential areas for future research. There seems to be a need for investigating the effect of the information received on the cellphone and how this affects the probabilities of cellphone use while driving. Besides, while distracted driving seems to be pervasive with young drivers, less research has focused on the frequency of these behaviors in other age groups (Pope et al., 2017).

The second part of this paper is an empirical investigation of cellphone use while driving. With a framework especially inspired by Hayashi et al. (2016) and Ingersoll (2017), the decision-making process underlying both texting- and calling while driving within a behavioral economic perspective was examined. The results showed over 80% of the drivers had “initiated”, “read” or “replied to” a text message while driving during the past 30 days. Consistent with previous research, the likelihood of using the cellphone while driving increased as the time until destination increased. In addition, the participants tend to answer a call at a higher rate when driving alone rather than with passengers. A remarkable observation shows that drivers were over 50% more likely to answer a text message that said “Text me as soon as possible” rather than one with “Hi how are you”. Further investigation under more naturalistic conditions is needed to validate these results and to fully understand the variables underlying cellphone use while driving.

Article 1: Utilizing a Delay Discounting Procedure to Examine Factors Behind Texting While Driving – a Literature Review

Eskil Johnsrud Sæterlien

OsloMet - Oslo Metropolitan University

Abstract

Despite increased focus on cellphone use while driving through stricter regulations and sanctions, the frequency remains relatively high. People, especially teens and younger adults, engage in this dangerous behavior despite their awareness of the risks associated with it. The goal of this literature review is to emphasize previous studies of texting while driving with a behavioral economic approach utilizing the delay discounting procedure. With a highly specified phrase (topic) search and a number of criteria for inclusion, 7 articles were identified and reviewed. These articles utilized a delay discounting procedure in their study of the decision-making process underlying cellphone use, here texting and calling, while driving. To the author's knowledge, Hayashi et al. (2015) was the first to investigate texting while driving with the use of a delay discounting procedure. Previous research has left a solid basis for understanding different behavioral factors that helps explain the decision-making process underlying texting while driving or cellphone use while driving in general. While distracted driving seems to be pervasive with young drivers, less research has focused on the frequency of these behaviors in other age groups (Pope et al., 2017). The literature reviewed seems to study cellphone use while driving from different angles and thereby contribute to a broader understanding of this undesired behavior. The reviewed literature suggests several potential future research areas, where among others there seems to be a need for investigating the effect of the information received on the cellphone and how this affects the probabilities of cellphone use while driving (Salehinejad, 2015).

Keywords: texting while driving, distracted driving, delay discounting, behavioral economics, decision-making.

Introduction

Over the last decade, there have been several campaigns and a higher rate of controls in traffic to reduce distracting driving behaviors such as cellphone use. Despite more regulation and stricter sanctions by the government, the frequency remains relatively high (Hayashi, Miller, Foreman, & Wirth, 2016). The main goal of this study is not to give an account of the frequency of texting while driving, but rather to tap into the behavioral decision-making process underlying texting while driving. More specifically, the purpose of the present study is to examine and assess to what degree previous research has studied texting while driving from a behavioral economic perspective with the aim to explain this behavior with the use of a delay discounting procedure.

Delay discounting

Delay discounting can be defined as the tendency to devalue temporally distant rewards or punishments, even though they may greatly outbalance the immediate benefit of our choices (Madden & Bickel, 2010). It is a process that describes an individual's devaluation of an event as the delay to that event increases. In other words the decline in the value of a reinforcer as the delay to that reinforcer increases (Madden, Francisco, Brewer, & Stein, 2011). Furthermore, Madden et al. (2011) states that delay discounting describes a specific form of impulsive choice: preference for a smaller-sooner over a larger-later reward and the opposite preference involving aversive events. Impulsivity has many definitions and is said to be evident in many forms of problematic and addictive behavior such as substance use, gambling and self-injurious behavior (Morrison, Madden, Odum, Friedel, & Twohig, 2014).

Research has shown that the safety is strongly undermined for both the driver and others on the road when using a cellphone while driving. Moreover, teens engaging in this behavior are at higher risk to be involved in a car accident than adults (Klauer et al., 2014). In 2014, 27% of all car crashes in the United States were related to cellphone use (National Safety Council, 2015). More specifically, 6% of the crashes were caused by texting and 21% by talking on the phone. Even though the National Safety Council found that talking on the phone causes more car accidents, texting while driving remains a major behavioral problem in traffic as well. Most research on texting while driving has focused on identifying associated personality or demographic variables (Hayashi et al., 2016). Research has also demonstrated that drivers are well aware of the danger related to texting while driving, though one have seen numbers up to 90% of the drivers reporting usage of a cellphone while driving (Hayashi, Russo, & Wirth, 2015).

Distracted driving

Distracted driving is a common term for behaviors not related to actual driving, such as texting, eating and operating the radio. Klauer et al. (2014) states that this kind of performance of a secondary task while driving is a major cause of motor vehicle crashes among novice drivers such as teenagers but also adults who usually are experienced drivers. Klauer and her coworkers (2014) studied the relationship between the performance of secondary tasks and the risk of crashes. Their findings indicate the risk of a crash or a “near crash” among novice drivers increases with the performance of secondary tasks, such a texting and dialing cellphones.

The risk of an accident increases because secondary tasks are cognitively demanding, by the fact that for example texting prevents the driver from maintaining full attention to driving (Klauer et al., 2014). In other words, the secondary tasks are responses, which is incompatible with driving (i.e., tasks that requires the driver to look away from the road and thereby prevents the driver to respond to unexpected events while driving). Although there has been a lot of research conducted within the field of distracted driving, the focus in this paper will be narrowed down to cellphone use – especially texting while driving. Most of the research of texting while driving has focused on examining the frequency and risk associated with this undesirable behavior. Nevertheless, a relatively limited number of studies have focused on the behavioral decision-making process underlying texting while driving.

Behavioral economics

Behavioral economics refers to “the application of economic concepts and approaches to the molar study of individuals’ choices and decisions” (Bickel, Johnson, Koffarnus, MacKillop, & Murphy, 2014). From a behavioral economic perspective, texting while driving involves a trade-off between immediate and delayed outcomes, and it is showed behaviorally as a preference for smaller immediate rewards over larger delayed rewards. In other words, choosing a short text messages while driving over a longer conversation sometime later when not driving (Hayashi et al., 2015).

Cellphone Use While Driving

To understand the relationship between cellphone use and driving one first need to consider the relationship between the driver and the person with whom he or she is communicating with (LaVoie, Lee, & Parker, 2016). Lavoie et al. (2016) reports that previous research shows that the social distance is a strong predictor of cellphone use while driving and whether people engage in it or not. More specifically, they say that cellphone use while driving seems to be focused on communicating with only the people closest to the driver (LaVoie et al., 2016). They found that adults are more likely to talk with their spouses and teens are more likely to talk with parents. As a possible reason for this, LaVoie et al. (2016) say that the drivers choose to only answer the most important calls as an effort to compensate for the risk associated with the use of a cellphone while driving. They also say that the drivers are unwilling to ignore a call from a spouse or parent because of its perceived importance or because the parent or spouse will continue to call until they answer.

While distracted driving seems to be pervasive with young drivers, less research has focused on the frequency of these behaviors in other age groups (Pope, Bell, & Stavrinos, 2017). Still, Hayashi et al. (2015) say that a behavioral economic approach may be a useful research tool for investigating the decision-making processes underlying risky behaviors such as texting while driving. This study is, to the author’s knowledge, the first literature review with the purpose of examining to what degree previous research have studied cellphone use – or more specifically named texting while driving, utilizing a delay discounting procedure.

Method

Search strategy

The search strategy for this literature review focused on high specificity. The aim was to be as precise as possible to ensure that the literature captured had high relevance. As a result, "topic search" was used as a method for the literature search to find the most relevant literature as possible for this topic of interest. With the use of search engines and bibliographic databases such as Google Scholar, PsycINFO, PubMed, and Oria, a phrase search was done with active use of AND/OR to gather an encompassing number of relevant literatures to the topic.

To ensure high validity and reliability in the literature search, synonyms and related words to "texting while driving" and "delay discounting" were included in the search. Besides, the same search was done across all the databases to ensure a systematic and verifiable process. The search used in the databases was therefore: ("texting while driving" OR "distracted driving" OR "twd" OR "cellphone use while driving" OR "text driving") AND ("delay discounting" OR "temporal discounting" OR "delay of gratification"). There are possibly several other terms that could be related to both texting while driving and delay discounting. However, Table 1 displays the two topics (row 1) and the most relevant related terms.

Inclusion criteria

To be incorporated in this review, there were some criteria for inclusion that had to be met. In general, all published literature (journals, posters, theses, etc.) regarding the search topics were taken into account regardless of publication year and country. However, only literature written in English was captured since the search topics were English terms and not translated into other languages. The search was narrowed down to the mentioned words to remain a relatively high sensitivity and to keep the number of articles in a manageable number as well.

Furthermore, only empirical articles were included in this study. Articles where the search topics were mentioned only in the references or given as an example in the text were excluded from the study. There is possibly more literature examining variables that helps explain the mechanisms behind texting while driving, but because of the narrow and rigid criteria for inclusion the number of articles in this study is relatively low. Table 2 displays the result of each search in the databases examined.

Content analysis methodology: article coding

After the search strategy was defined, the criteria for inclusion were set and the literature search revealed a number of articles, the next step for analyzing the content was article coding. This coding process started with a review of the resulting compilation of articles from the literature search (see Table 2). Obviously, there were not 158 unique articles since this number is the sum of all articles across the databases. Rather, the number was 110 unique articles. After reading abstracts and method parts, it became clear which articles applied a delay discounting procedure in the study of texting while driving.

Results

Following the search process, the total number of unique articles was 110. Furthermore, after the coding process the number of articles that satisfied the criteria and thereby reviewed was 6. These articles not only mentioned all three words or concepts, but also utilized a delay discounting procedure in the study of distracted driving wherein texting was one of the factors examined. However, 7 articles will in fact be reviewed here. This is because of the relevance and importance of one article that studied texting with a delay discounting procedure but not directly in a driving situation. This article is, in the author's opinion, the corner stone for studying texting while driving within a behavioral economic perspective. It thereby laid the empirical basis for utilizing a delay discounting procedure within this field of research. The literature review will hence start with this mentioned study.

Systematic Literature Review

Atchley and Warden (2012)

Atchley and Warden (2012) were the first to link the tendency of texting to the performance on tasks that involved and measured delay discounting. In these tasks, choices were studied with the aim of establishing the degree of impulsiveness and to assess the rate at which the value of one choice (or a behavior) decreases relatively to other choices (Atchley & Warden, 2012). In other words, they examined the value of responding immediately to a text or call and the ability to wait. Also, people's willingness to delay texting or calling for a larger monetary reward was compared with the ability of delaying monetary rewards alone. One of the purposes of the study conducted by Atchley and Warden (2012) was to increase the understanding of the decision-making process and its underlying variables that lead to impulsive behavior such as the "need to text now". Atchley and Warden (2012) found that key data concerning the value of texting by younger adults relative to other behaviors was missing.

Method. Through a delay discounting procedure the authors examined the degree of impulsiveness among the participants. This method assesses the rate at which the value of a behavior decreases relative to other choices when participants are being presented with choices between sooner-smaller and later-larger rewards. Here, when participants were offered a choice to "text now" and receive a smaller monetary reward versus "text back later" and receive a larger monetary reward over a range of delays, Atchley and Warden (2012) attempted to establish a delay-discounting function of information (the ability to text or call) and money. They could thereby compare this to the discounting of money alone. Atchley and Warden (2012) make a couple of interesting remarks; first, as decisions become more impulsive, the value of delayed rewards declines more rapidly. Second, while money loses value on the time span of weeks, days or months, information loses value within minutes, which may, as they say, explain why behaviors like texting often occur in inappropriate situations and may also seem like addictions.

Findings. The results from Atchley and Warden (2012) imply that the discounting function that determines individuals' willingness to delay the response (text or call someone back) shows similarities with their willingness to delay the receipt of monetary rewards. They also found that the value of immediacy with regard to information is much greater than monetary rewards. This makes sense since some information may have no value when given too late. However, the results from this study cannot uncritically be transferred to texting while driving since they utilized a more universal approach to texting, not specifically while driving. In other words, the question here is whether this method truly provides a measure of the value of sending a text or making a call while driving.

The decision-making process related to cellphone use in an everyday setting does not usually imply monetary rewards, rather a form of social reinforcement. When the value of sending a text or making a call is paired with the value of money, the value of using the cellphone alone can hardly be accounted for. The study of Atchley and Warden (2012) is included in this review even though texting was investigated in environments other than driving. This is because the authors were the first to link texting to a delay discounting procedure. Their study therefore provided the basis for further investigation of texting while driving by others utilizing a similar procedure. Atchley and Warden (2012) is consequently a cornerstone in this field of study, although they ensure that the relation between delay discounting and texting while driving specifically remains uncertain in some sense.

Hayashi, Russo, and Wirth (2015)

The first to utilize a behavioral economic analysis to investigate texting while driving through the delay discounting procedure was, to the author's knowledge, conducted by Hayashi et al. (2015). Instead of calling texting while driving for some kind of unreasonable decision-making process, Hayashi et al. (2015) thought a more comprehensive explanation could be showed through the delay discounting procedure. Hayashi et al. (2015) states that although Atchley and Warden's study from 2012 provided knowledge about how a delay discounting procedure can explain individuals' decision-making in some texting scenarios, it still remains to be seen to what degree delay discounting differentiates drivers who frequently text while driving from drivers who do not engage in such activity. This is the purpose of the study conducted by Hayashi et al. (2015).

Method. In their study, Hayashi et al. (2015) attempted to capture the degree to which a decision-maker (driver) devalues future events. Here, participants were provided a choice between two hypothetical amounts of money: one smaller amount of money available immediately and another larger amount that could be obtained after a certain delay. Across several trials with different amounts and delays, a discounting rate that described how the drivers would choose an amount of money as a function of time until acquisition was examined. When analyzing the drivers' indifference points, the point at which preference for the larger reward was equivalent to the smaller immediate reward, Hayashi et al. (2015) compared this data with reported frequency of texting while driving and its perceived risk.

Findings. The result from Hayashi et al. (2015) shows that students who frequently text while driving discounts delayed rewards at a greater rate. The study supports the conclusions that texting while driving is fundamentally an impulsive choice made by drivers, and a behavioral economic approach may be a useful research tool for investigating the decision-making processes underlying risky behaviors. By linking the process of delay discounting to texting while driving, Hayashi et al. (2015) concludes that texting may be related to individual differences in impulsivity as measured by the discounting of delayed hypothetical monetary rewards. Also, their study provides a conceptual framework that may lead to a better understanding of the underlying behavioral processes leading to a driver's decision to text while driving.

There are however some limitations with Hayashi et al. (2015). A prompt of "text me as soon as possible (asap)" might be seen as an opportunity to share information which is only useful over the short term, but the behavior is far from mindless (Atchley & Warden, 2012). There is reason to believe the value of the information a text message carries will change as a function of the social distance, or history of reinforcement between sender and receiver. From a behavior-analytic perspective one would say that how one person responds to a message would differ from how another one would respond to the same message because people have different histories of reinforcement. The information in the text message "text me ASAP" may function as a command and implies for many that there is something urgent that needs to be done. This means that people who usually do not text while driving may be more likely to engage in such behavior than they otherwise would have been, because of their history of reinforcement with such commands.

Hayashi, Miller, Foreman, and Wirth (2016)

A year following their initial study, Hayashi et al. (2016) developed a new discounting task to examine an impulsive decision-making process underlying texting while driving from a behavior economy perspective.

Method. The task was to present participants with a hypothetical scenario where they, after receiving a text message while driving, rated the likelihood of replying to the text immediately versus waiting to reply for a specific period of time. The delays until destination were manipulated between six trials and varied from 30 seconds to 6 hours (30 sec., 3 min., 15 min., 1 hour, 2 hours, and 6 hours). Participants also completed a delay discounting task with monetary rewards. Here they made hypothetical choices between having a smaller amount of money available immediately versus an equal or larger amount of money available after seven different delays: 1 or 2 weeks, 1 or 6 months, and 1, 3, or 10 years. The smaller immediate reward ranged from $1 to $1,000 whereby the larger delayed reward always was $1,000 after a fixed delay.

Findings. The results from Hayashi et al. (2016) shows a variable of importance for determining whether people (while driving) wait to reply to a text message or not is the duration of the delay until destination. They also argue that the reduction in the likelihood of waiting as a function of increasing delays is best described by a hyperbolic delay discounting function. Their data show that participants who reported a higher frequency of texting while driving discounted the opportunity to reply to a text message at a greater rate. Anyway, there was no correlation between the rates of discounting of hypothetical monetary rewards and the frequency of texting while driving (Hayashi et al., 2016).

A limitation of the study of Hayashi et al. (2016) is the use of a 6-hour delay in the delay discounting task. People are not likely to drive continuously for 6 hours without any stops, providing an opportunity to reply to the text message. If the purpose was to uncover the point where people actually discount cellphone use while driving, one could for example rather exclude the 6-hour delay and substitute it with a more realistic amount of time people drive without stopping. However, Hayashi et al. (2016) makes an interesting remark; since drivers who frequently text while driving discount the value of a delayed opportunity to reply to a text message at a greater degree, they may devalue the benefits of safety to such a degree that these devalued benefits cannot adequately compete with the immediately rewarding consequences of texting while driving after a preference reversal. This, they claim, may explain why drivers engage in texting while driving despite being aware of its dangers.

From a behavioral analytic point of view, we may denote this relation between contingencies that favor texting and those that favor non-texting (safety) for a set of competing contingencies. With an everyday language one could explain this by saying that the usage of a cellphone while driving is incompatible with driving because we cannot give full attention on multiple things at the same time.

Salehinejad (2015)

Prior to Hayashi et al. (2016) there was a study conducted by Salehinejad (2015), which explored the decision-making process underlying responding to messages in driving situations with the use of a delay discounting methodology. In his study, Salehinejad (2015) investigated factors that could influence the probability of responding to a text message in driving situations, such as differences in weather condition. Also, the devices by which the drivers can respond to a message with (i.e., cellphone versus car in-dash system) were explored.

Method. Participants were provided a hypothetical delay discounting task seeming to build on the method from Atchley and Warden (2012). When given a scenario where the participants were told to be driving and in the same time receiving a text message from their significant other, the participants were asked to choose between getting a smaller ($5 to $95) amount of money and the chance to reply immediately versus getting a fixed ($100) amount of money and reply after a certain time (delay from 1 to 480 minutes). Over several trials, the difference in discounting rate was examined for both the device in which the text message was received and weather conditions.

Findings. The results indicate that first of all, weather conditions (normal versus severe) has an effect on the way people decide to respond to a text message while driving, and people often do not wait to respond to a message later while driving when the weather is normal. Similarly, Salehinejad (2015) found that drivers tend to respond to a message at a higher rate if the message is received through a car in-dash system than with a handheld cellphone. Texting while driving can be seen as an impulsive behavior, especially when it occurs at inappropriate times, such as a driving situation (Salehinejad, 2015).

Johnson, Ingersoll, and Freitas (2016)

A reason why drivers may choose to use a cellphone while driving is because responding to an incoming call or text message may be more valuable to an individual than waiting to respond under safer conditions (Johnson et al., 2016). Within a discounting framework Johnson et al. (2016)

studied college students' decisions to respond immediately versus later in several hypothetical driving scenarios.

Method. With the use of a novel Distracted Driving Discounting Task, the participants rated their likelihood of responding to an incoming phone call or text message while driving versus return the call or reply to the text message when the destination was reached. The time until destination therefore varied from 0 to 120 minutes. The "social closeness" of the person contacting the driver and the number of passengers (0 versus 3) in the car were also independent variables manipulated. What is meant with "social closeness" is that the authors made each participant rank their 20 "closest" persons (i.e., nr. 1 would probably be a parent or a significant other). Hence, Johnson et al. (2016) adjusted each question to the driver's prefilled list of people close to them. Likelihood of waiting until destination was measured for both text message and phone call, across several delays with and without passengers. The person contacting the driver also varied from the "closest" (nr. 1 ranked) to the number 20 "closest" the driver.

Findings. Consistent with Hayashi et al. (2016), Johnson et al. (2016) found that the college students were less likely to wait to respond to a text message or to an incoming phone call as the delay until arrival at one's destination increased. But as an expansion of the findings of Hayashi et al. (2016), they found that the likelihood of waiting to respond are influenced by the type of contact (call versus text), the social closeness of the person contacting the participant and the number of passengers. In general, the students had a higher probability of waiting to respond to a text message compared to a phone call. They were also more likely to wait when the people who attempted to contact them was in a "less important" social relationship, which derived from the social contact ranking completed in advance. Lastly, the students were more likely to wait when they were driving with friends rather than traveling alone (0 versus 3 passengers).

Ingersoll (2017)

Ingersoll (2017) expanded the study of Johnson et al. (2016) where they applied a procedure similar to Hayashi et al. (2016) to examine the role of delay discounting and social variables in cellphone distracted driving.

Method. A novel Distracted Driving Delay Discounting Task (4DT) examined hypothetical choices of either cellphone use while driving or waiting until arrival at destination. To investigate if social variables influenced the likelihood of waiting, Ingersoll (2017) utilized a method similar to Johnson et al. (2016) but with an expanded demography. In the discounting task, the relationship between the driver and the passenger (nr. 1 to nr. 20) and the number of passengers in the vehicle at the time were manipulated between both text message and phone call. Consistent with Johnson et al. (2016) the participants reported on likelihood of waiting until destination to return a phone call or reply to a text message, across 8 delays until destination (from 1 min. to 2 hours).

Findings. Similar to previous findings (Atchley & Warden, 2012; Hayashi et al., 2016; Johnson et al., 2016) Ingersoll (2017) found the participants were less likely to wait to respond to a text message, and here also an incoming phone call, as a function of the increasing delay until destination. Further, consistent with the findings of Johnson et al. (2016), individuals had a higher probability of waiting to respond to an incoming text message compared to a phone call. They were also more likely to wait when the person who attempted to contact the driver was in a "less important" social relationship, derived from a social contact ranking completed in advance of the 4DT. Additionally, the drivers were more likely to wait when driving with friends rather than driving alone (Ingersoll, 2017).

Hayashi, Rivera, Modico, Foreman, and Wirth (2017)

Hayashi et al. (2017) investigated the relation between frequency of texting while driving and so-called levels of executive function, which is defined as "cognitive abilities for adaptive functioning, allowing for behavior that is more goal-oriented, flexible, and autonomous" (Spinella, 2005). The purpose of the study conducted by Hayashi et al. (2017) was to see whether drivers who engage in texting while driving show different levels of executive function. Hayashi et al. (2017) claim that factors leading to distracted driving and thereby increasing the risk of an accident can be visual (i.e., looking away from the road), manual (i.e., taking a hand off the steering wheel and manipulating a device), or cognitive (e.g., thinking about something other than driving tasks). Texting while driving involves all these types of distractions (Hayashi et al., 2017).

A behavioral analytic approach to this investigation would be to focus on the behavior-environment relations and detect what kind of stimuli that exert control over these responses we call distracted driving. When talking about "cognitive processes" it is sometimes said that these processes occur on a scale so small that others cannot detect it. Much of this behavior (what goes on covertly) is verbal, because verbal behavior requires no environmental support (Skinner, 1974). However, cognitive processes may more typically constitute summary labels for overt behavior, which may often be correlated with other behavior (Hayes & Brownstein, 1986). Except from Pope et al. (2017) the relation between executive function and texting while driving has received little empirical priority (Hayashi et al., 2017).

Method. A survey completed by 120 college students assessed how frequently they read and sent a text message while driving. Based on the reported frequency, the students were divided into two groups. Hayashi et al. (2017) compared the two populations of drivers, on levels of self-reported measures of executive function and impulsivity. Based on the Executive Function Index (EFI) the students answered 27 questions categorized into five subscales: Motivational Drive, Organization, Strategic Planning, Impulse Control and Empathy. On each question, the participants were asked to rate the five items from 1 (not at all) to 5 (very much). The authors do not explain what constitutes the observational basis for the five subscales that the participants are expected to answer across the 27 questions. It is therefore unknown exactly what behavior the term executive function is meant to describe in this case.

The same can be said about the measures of impulsivity, where the authors utilized the Barratt Impulsiveness Scale (BIS) to measure what they call the dispositional trait of impulsivity. Based on 30 questions categorized into three subscales: Attentional Impulsivity, Motor Impulsivity and Non-Planning, the participants self-reported impulsivity from 1 (rarely/never) to 4 (almost always/always). Utilizing the BIS, the authors most likely aimed to capture some sort of discounting of everyday or probabilistic reward or punishment and thereby get an estimate of the impulsivity. Lastly, the two groups were compared on a behavioral measure of impulsivity (Hayashi et al., 2017). A delay discounting task which involved monetary choices was used. Here, they measured the extent to which the students discounted hypothetical monetary rewards ($25-$85) as a function of the delay (1 week to 6 months).

Findings. Hayashi et al. (2017) reports previous research in general has shown that executive function is inversely associated with addictive disorders such as substance abuse, obesity and gambling. Furthermore, the authors states if texting while driving shares some of the key features with these addictive, risky and impulsivity-related behaviors, executive function should be an important factor for understanding the cognitive mechanism that “underlies” texting while driving. The results showed that levels of executive function were lower in drivers who frequently text while driving. This group also showed a higher level of self-reported impulsivity, although the two groups did not differ significantly on the behavioral measure of impulsivity (the delay discounting task). Hence, Hayashi et al. (2017) concludes that drivers with lower levels of executive function and higher levels of impulsivity are more likely to text while driving.

Nevertheless, there seems to be a need for clarifying what the observational basis is for talking about executive function. If the aim is to give an account of the process or mechanism underlying texting while driving, executive function does not explain the environmental variables of which texting while driving is a function without further notice. However, to the extent traits of behavior summed up and labeled executive function or impulsivity can be measured and shown to correlate with texting while driving, they can be used to predict and possibly prevent the unwanted behavior to a greater extent.

Discussion

Despite a low number of studies, previous research has left us a solid basis for understanding different behavioral factors that helps explain the decision-making process underlying texting while driving or cellphone use while driving in general. LaVoie et al. (2016) reported the social distance between the driver and the person with whom he or she is talking or texting to is a strong predictor of cellphone use while driving. Surprisingly then, little research has been directed toward investigating to whom the drivers are talking or texting to (LaVoie et al., 2016). The findings of the studies seem to focus on cellphone use while driving from different perspectives or focus on different measures.

The study of Atchley and Warden (2012) is not directly conducted in driving conditions. The authors, though, seems to be the first to investigate texting with the use of a delay discounting procedure. Atchley and Warden (2012) argue that the discounting function that determines individuals' willingness to delay the response (text or call someone back) shows similarities with their willingness to delay the receipt of monetary rewards. They also found that the value of immediacy with regard to information is much greater than monetary rewards. This study provided an empirical basis for further investigation of texting, especially while driving.

To the author's knowledge, Hayashi et al. (2015) were the first to investigate texting while driving with the use of a delay discounting procedure. By linking the process of delay discounting to texting while driving, Hayashi et al. (2015) concluded that texting may be related to individual differences in impulsivity as measured by the discounting of delayed hypothetical monetary rewards. One year following this study, Hayashi et al. (2016) developed a new discounting task to examine an impulsive decision-making process underlying texting while driving from a behavioral economic perspective. The results from Hayashi et al. (2016) shows a variable of importance for determining whether people, when receiving a text message while driving, wait to reply or not is the duration of the delay until destination.

Salehinejad (2015) found that weather conditions (normal versus severe) have an effect on the way people decide to respond to a text message while driving. Individuals showed a higher probability of responding when a text message was received in normal weather conditions compared to severe weather conditions. Besides, the informational medium was found to affect the discounting rate. Here, Salehinejad (2015) found that drivers showed a higher probability of responding to a text message if the message was received through an in-dash car multimedia system rather than just the cellphone.

Both Johnson et al. (2016) and Ingersoll (2017) found that likelihood of waiting to respond to a text message are influenced by the type of contact (call versus text), the social closeness of the person contacting the participant and the number of passengers. With the use of a novel Distracted Driving Discounting Task, they found that individuals had a higher probability of waiting to respond to a text message compared to a phone call. Individuals were also more likely to wait when the person who contacted them was in a “less important” social relationship, which derived from a social contact ranking completed in advance. Additionally, individuals were more likely to wait when they were driving with friends rather than driving alone.

Hayashi et al. (2017) found that drivers with lower levels of executive function and higher levels of impulsivity are more likely to text while driving. Nevertheless, there seems to be a need to clarify what the observational basis is for talking about executive function. If the aim is to provide an account of the process or mechanism underlying texting while driving, one cannot pass by the behavior-environment relation that sets the occasion for a driver to text while driving. When we get a better description of the behaviors we sum up and label executive function or impulsivity, texting while driving can be measured, predicted and hence prevented to a greater extent.

Direction for future studies

The reviewed literature suggests several potential future research areas. While distracted driving seems to be pervasive with young drivers, less research has focused on the frequency of these behaviors in other age groups (Pope et al., 2017). With the purpose of investigating other possible factors that could have an effect on the contingencies of reinforcement related to text messages, Salehinejad (2015) suggests the content of a message as a possible approach for future studies. People may value responding to a text message differently depending on the content of the message. Consequently, there seems to be a need for investigating what effect the information in the text message received while driving has on the probability of responding.

As mentioned, the prompt “text me ASAP” used in Hayashi et al. (2016) seems to depend to a high degree on individuals’ history of reinforcement and might be seen as an opportunity to share information which is only useful over a short period of time. Previous literature in this field of research points also to a need for a more diverse sample for future studies (Hayashi et al., 2016). Moreover, conducting naturalistic driving studies (Hayashi et al., 2017) or driving simulators (Ingersoll, 2017) in future studies will provide a more objective recording of texting behavior and thereby further expanding and validating previous findings.

Concluding remarks

This is, to the author’s knowledge, the first literature review that explicitly examines to what degree previous research has studied and explained cellphone use, or more specifically texting while driving, with the use of a delay discounting procedure. The literature reviewed and it’s research questions have revealed solid insight about the relationship between texting while driving and delay discounting as an explanation of the decision-making process underlying this undesirable behavior. This is assumed to be crucial knowledge for how to arrange effective interventions to reduce such behavior as well as to prevent it. As mentioned by Hayashi et al. (2015), a behavioral economic approach may be a useful research tool for investigating the decision-making processes underlying risky behaviors such as texting while driving. Nevertheless, further investigation is needed to fully understand the variables underlying individuals' decisions to read and reply to a text message while driving.

References

Atchley, P. & Warden, A. C. (2012). The need of young adults to text now: Using delay discounting to assess informational choice. *Journal of Applied Research in Memory and Cognition*, *1*(4), 229-234. doi:10.1016/j.jarmac.2012.09.001

Bickel, W. K., Johnson, M. W., Koffarnus, M. N., MacKillop, J., & Murphy, J. G. (2014). The behavioral economics of substance use disorders: reinforcement pathologies and their repair. *Annual review of clinical psychology*, *10*, 641-677. Retrieved from http://dx.doi.org/10. 1146/annurev-clinpsy-032813-153724

Hayashi, Y., Miller, K., Foreman, A. M., & Wirth, O. (2016). A behavioral economic analysis of texting while driving: Delay discounting processes. *Accident Analysis and Prevention*, *97*, 132-140. doi:10.1016/j.aap.2016.08.028

Hayashi, Y., Rivera, E. A., Modico, J. G., Foreman, A. M., Wirth, O. (2017). Texting while driving, executive function, and impulsivity in college students. *Accident Analysis and Prevention*, *102*, 72-80. doi:10.1016/j.aap.2017.02.016

Hayashi, Y., Russo, C. T., & Wirth, O. (2015). Texting while driving as impulsive choice: A behavioral economic analysis. *Accident Analysis & Prevention*, *83*, 182-189. doi:10.1016/j.aap.2015.07.025

Hayes, C. S. & Brownstein, J. A. (1986). Mentalism, Behavior-Behavior Relations, and a Behavior-Analytic View of the Purposes of Science. *The Behavior Analyst, 2*, 175-190.

Ingersoll, B. L. (2017). Behavior economic and social variables influencing cell-phone distracted driving. (Master's thesis, California State University). Retrieved from http://hdl.handle.net/10211.3/196372

Johnson, P. S., Ingersoll, B. L., & Freitas, M. C. (2016). Can It Wait? Effects of Delayed Reinforcement and Social Variables on Cell-Phone Distracted Driving. California State University, Chico.

Klauer, S. G., Guo, F., Simons-Morton, B. G., Ouimet, M. C., Lee, S. E., & Dingus, T. A. (2014). Distracted driving and risk of road crashes among novice and experienced drivers. *New England journal of medicine*, *370*(1), 54-59. doi:10.1056/NEJMsa1204142

LaVoie, N., Lee, Y. C., & Parker, J. (2016). Preliminary research developing a theory of cell phone distraction and social relationships. *Accident Analysis & Prevention*, *86*, 155-160. doi:10.1016/j.aap.2015.10.023.

Madden, G. J., & Bickel, W. K. (2010). Impulsivity: The behavioral and neurological science of discounting. Washington, DC: American Psychological Association.

Madden, G. J., Francisco, M. T., Brewer, A. T., & Stein, J. S. (2011). Delay discounting and gambling. *Behavioural Processes*, *87*(1), 43-49. doi:10.1016/j.beproc.2011.01.012

Morrison, K. L., Madden, G. J., Odum, A. L., Friedel, J. E., & Twohig, M. P. (2014). Altering impulsive decision making with an acceptance-based procedure. *Behavior therapy*, *45*(5), 630-639. doi:10.1016/j.beth.2014.01.001

National Safety Council (2015). Retrieved from http://www.nsc.org/Connect/NSCNewsReleases/Lists/Posts/Post.aspx?ID=9

Pope, C. N., Bell, T. R., & Stavrinos, D. (2017). Mechanisms behind distracted driving behavior: the role of age and executive function in the engagement of distracted driving. *Accident Analysis & Prevention*, *98*, 123-129. http://dx.doi.org/10.1016/j.aap.2016.09.030

Salehinejad, M. A. (2015). *The Role of Informational Medium on Decisions to Respond to a Message*. (Master's thesis, University of Kansas). Retrieved from http://hdl.handle.net/1808/19495

Skinner, B. F. (1974). *About behaviorism*. New York: Knopf.

Spinella, M., 2005. Self-rated executive function: development of the executive function index. *International Journal of Neuroscience, 115*(5), 649-667. doi:10.1080/00207450590524304

Table 1

Topics and related terms

Texting while driving	**Delay discounting**
Distracted driving	Temporal discounting
TWD	Delay of gratification
Cellphone use while driving	
Text driving	

Note. There are possibly several other terms that could be related to both texting while driving and delay discounting. These are the ones that seemed most relevant. The search used in the databases was therefore: ("texting while driving" OR "distracted driving" OR "twd" OR "cellphone use while driving" OR "text driving") AND ("delay discounting" OR "temporal discounting" OR "delay of gratification").

Table 2

Databases used for literature search

Database	Nr. of articles
Google Scholar	108
Oria	18
ScienceDirect	13
Academic search premier	5
Web of science	5
PsychINFO	5
PubMed	4
ERIC	0
Sum before coding	158
Sum after coding	7

Note. Values are number of articles revealed from each database. There is possibly more literature examining variables that helps explain the mechanisms behind texting while driving, but because of the narrow and rigid criteria for inclusion the number of articles in this study is relatively low.

Article 2: Cellphone Use While Driving – a Behavioral Economic Analysis Utilizing a Delay Discounting Procedure

Eskil Johnsrud Sæterlien

OsloMet - Oslo Metropolitan University

Abstract

The prevalence of cellphone use while driving remains high despite an increase in regulations the last years. The present study utilized a framework inspired by Hayashi et al. (2016) with the purpose of examining a decision-making process underlying both texting- and calling while driving from a behavioral economic perspective. In two Delay Discounting Tasks (Call & Text), a sample of 189 students completed a discounting task where they rated their likelihood of using a cellphone while driving when they received either a phone call or a text message. Across several trials, variables such as time to one's destination and the differences in informational content were examined to see whether it affects the probability of cellphone use while driving. The results show that over 80% of the drivers had "initiated", "read" or "replied to" a text message while driving during the past 30 days. Furthermore, the likelihood of using the cellphone while driving increased as the time until destination increased. The drivers were 51% more likely to answer a text message that said "Text me as soon as possible" rather than one with "Hi how are you". Moreover, the participants tend to answer a call at a higher rate when driving alone rather than with passengers. Independent of whether they were driving alone or with passengers, they were 48% more likely to answer a phone call from a known caller than an unknown while driving. Besides, when controlled for number of days driven, male drivers 18-23 years reported that they text 44% of the days they drive compared to 18% for female drivers 24-29 years. The results support the conclusion that time until destination, informational content and whether driving with passengers or not correlates with cellphone use while driving. Future research should conduct more naturalistic studies and also explore the effectiveness of acceptance-based interventions and training in self-control, to shift the drivers' preferences from sooner–smaller to later–larger rewards and thereby reduce the frequency of cellphone use while driving.

Keywords: texting while driving, distracted driving, cellphone use while driving, delay discounting, behavioral economics, decision-making

Introduction

Have you ever been driving a car, received a text message and decided that you will wait to read it until you have arrived at your destination? Suddenly you sit there with your cellphone in your hand even if you told yourself that you should resist and not open it this time. Or have you ever been driving a car catching yourself not able to remember the last few kilometers you have passed because you were texting? You are probably not alone. A study conducted by Ehsani, Li, and Simons-Morton (2015) found that 83% of the drivers reported that they had engaged in the use of electronic devices while driving at least once during the last 30 days. More specifically, 71% made or answered a phone call, almost 65% read or sent a text message, 20% read or sent an email, 29% checked a website, 71% changed music, 12% used a tablet, and 53% looked at directions or a map.

Hayashi, Rivera, Modico, Foreman, and Wirth (2017) say that factors that lead to distracted driving and thereby increase the risk of a crash can be visual (i.e., looking away from the road), manual (i.e., taking a hand off the steering wheel and manipulate a device), or cognitive (e.g., thinking about something other than driving tasks). Texting while driving involves all these types of distractions (Hayashi et al., 2017). Cognitive processes is sometimes said to occur on scales so small that others cannot detect it. Much of this behavior (what goes on covertly) is verbal, because verbal behavior requires no environmental support (Skinner, 1974).

Cellphone use while driving

Cellphone use while driving (CUWD), a more comprehensive term than the otherwise well-known term Texting While Driving (TWD), includes all use of a cellphone while driving (i.e., texting, calling, social media etc.). Research has shown that the safety is strongly undermined for both the driver and other motorists on the road when using a cellphone while driving because using the cellphone prevents drivers maintain attention on driving (Klauer et al., 2014), Further, the authors claim teens engaging in this behavior are at higher risk of crashing than adults. The usage of a cellphone while driving is undoubtedly dangerous, and as a result of competing contingencies, it decreases the driver's overview of the road and traffic pattern. New technology has expanded the cellphones further, beyond the simple text message and phone call. With the smartphones nowadays the possibilities of what you can do on your cellphone have increased. It may be expected that all the multimedia, apps and direct internet access will require more attention by the driver in terms of time watching the cellphone while driving.

National Highway Traffic Safety Administration (NHTSA, 2012) reports that sending and receiving a text message removes the driver's eyes from the road for an average of 4.6 seconds, which is equivalent to driving the length of an entire football field at 55 miles per hour without seeing what might appear on the road. In the United States, 47 states have currently banned text messaging while driving for all drivers but only 15 states prohibit all drivers from using a hand-held cellphone while driving. In 2014, 27% of all car crashes in the United States were related to the use of a cellphone (National Safety Council, 2015). Data has also shown when a driver glances longer than 1 second away from the road, the risk of an accident increases remarkably. When engaging in handheld cellphone use while driving of 2 seconds or more, the driver has a 5.5-fold increased risk of a crash or near crash (Delgado, Wanner, & McDonald, 2016).

An annual In-Depth Analysis of Fatal Road Accidents from The Norwegian Public Road Administration points out causal factors behind accidents and injuries, both within driving behavior, vehicle safety and road conditions. For 2016 they report that distractions related to cellphone use, operation of radio, CD or other equipment is considered to be a contributing factor to 15 (12%) of fatal traffic accidents, against 3 (3%) in 2015 and 8 (6%) in 2014. Of the 15 accidents in 2016, the use of cellphone specifically was considered to be a contributing factor in 4 of them (Ringen, 2016). The Institute of Transport Economics (2016) – Norwegian Centre for Transport Research – reported the use of handheld cellphone has decreased during the last years. However, research has also shown that there is no significant difference between driving performance when sending a text message while driving using a handheld cellphone versus using an in-vehicle system (Owens, McLaughlin, & Sudweeks, 2011).

Struckman, Gaster, Struckman, Johnson, & May-Shinagle (2015) conducted a study that investigated the relation between cellphone dependency and texting while driving among 515 students. In an online questionnaire with a developed cellphone dependence scale (CDS) consisting of a pool of 100 statements, where 12 items were selected for each participant, the aim was to say something about how dependent a driver was to his or her phone or how anxious the driver was without the phone. Two factors were revealed. In the first factor (anxiety) the participants rated on a 5-point likert scale to what extent they agreed with statements about their need to have a cellphone constant available (i.e., “I feel secure when I have my cellphone”). In the second factor (“dependence”) the participants reported on five items that reflected an unwillingness to be without a phone (i.e., “I am not dependent on my cellphone”). Based on their results, Struckman et al. (2015) states that cellphone dependence, as measured by the CDS, is one of the strongest predictors of texting while driving for both men and women. However, they say the relationship is not yet understood.

Behavioral Economics and Delay Discounting

Behavioral economics refers to the application of economic concepts and approaches to the molar study of individuals’ choices and decisions (Bickel et al., 2014). Furthermore, it represents the interplay between economic principles and behavior change considerations (Reed, Niileksela, & Kaplan, 2013). From a behavioral economic perspective, texting while driving involves a trade-off between immediate and delayed outcomes, and it is showed behaviorally as a preference for smaller immediate rewards over larger delayed rewards (Hayashi, Russo, & Wirth, 2015). This notion shares some similarities with the process of delay discounting, a term used in economic theory in general but especially well known in behavioral economic theory.

Delay discounting can be defined as the tendency to devalue temporally distant rewards or punishments, even though they may greatly outbalance the immediate benefit of our choices (Madden & Bickel, 2010). In other words, delay discounting describes a specific form of impulsive choice: preference for a smaller-sooner over a larger-later reward and the opposite preference involving aversive events (Madden, Francisco, Brewer, & Stein, 2011). Impulsivity has many definitions and is said to be evident in many cases of problematic and addictive behavior such as substance use, gambling and self-injurious behavior (Morrison, Madden, Odum, Friedel, & Twohig, 2014). When a person selects the smaller immediate payoff over the later and larger benefits, we may say that the person (e.g., driver) shows impulsive behavior. Oppositely, a person who chooses the delayed larger reward and thereby resists the smaller immediate reward (e.g., text now and not wait until destination) is said to show self-control (Pierce & Cheney, 2013).

A study that functions as a cornerstone within this field of interest is the one conducted by Atchley and Warden (2012). They were the first to link the tendency of texting to the performance on tasks that involved and measured delay discounting. Here, the participants were offered a choice to "text now" and hence receive a smaller monetary reward versus "text back at a later time" and thereby receive a larger monetary reward. When these choices were provided over a range of delays, Atchley and Warden (2012) tried to establish a delay-discounting function of information (the ability to text or call) and money.

The results imply that the discounting function determines individuals' willingness to delay the response (text or call someone back), and this shows similarity with their willingness to delay the receipt of monetary rewards. They also found that the value of immediacy with regard to information is much greater than monetary rewards. They support this by providing an interesting statement; while money loses value on the time span of weeks, days or months, information loses value within minutes. This, they say, may explain why a behavior such as texting often occurs in inappropriate situations such as when driving. However, the results from this study cannot uncritically or blindly be transferred to texting while driving since they utilized a more universal approach to texting, not specifically while driving.

Reed, Becirevic, Atchley, Kaplan, & Liese (2016) did not investigate texting in driving conditions either, but they utilized a behavior economic framework and developed a new Delay Discounting of Texting Questionnaire (2TQ). Reed et al. (2016) continued on the work of Atchley & Warden (2012), which implies that texting while driving is showing some similarities with other behaviors we in an everyday language can speak of in terms of addictive behavior. The new 2TQ involves a hypothetical scenario where respondents are asked to choose whether they are willing to pay to receive and read a text immediately or wait to receive a free text message in the future. Based on their findings, Reed et al. (2016) conclude that the 2TQ is a valid and potentially useful tool for examining markers of a text-messaging dependence within a behavioral economic model of addictive behavior.

Delay Discounting and Cellphone Use While Driving

How delay discounting correlates with CUWD will for instance be to choose a short text message while driving over a longer conversation sometime later when not driving (Hayashi et al., 2015). Here there is not only the duration and impact of the communication that plays a part, it also has to be taken into account that CUWD is associated with higher risk of accidents and the fact it is illegal. Because drivers who frequently text while driving discount the value of a delayed opportunity to reply to a text message to a greater extent, they may devalue the benefits of safety to a such degree that these "devalued benefits" cannot sufficiently compete with the immediately rewarding consequences of texting while driving (Hayashi, Miller, Foreman, & Wirth, 2016).

The first to utilize a behavioral economic analysis to investigate texting while driving through the delay discounting procedure was, to the author's knowledge, Hayashi et al. (2015). The purpose of their study was to gauge to what degree a delay discounting procedure can differentiate drivers who frequently text while driving from drivers who do not. The results from Hayashi et al.

(2015) showed that students who frequently texted while driving discounted delayed rewards at a greater rate than the matched control students. Hayashi et al. (2015) concluded that texting might be related to individual differences in impulsivity as measured by the discounting of delayed hypothetical monetary rewards.

A year following their first study, Hayashi et al. (2016) developed a new discounting task to examine an impulsive decision-making process underlying texting while driving from a behavioral economic perspective. In this, they presented the participants with a hypothetical scenario where they, after receiving a text message while driving, rated the likelihood of replying to the text immediately versus waiting to reply for six different delays (30 sec., 3 min. 15 min. 1 hour. 2 hours and 6 hours). Participants also completed a delay discounting task with monetary rewards. They made hypothetical choices between having a smaller amount of money available immediately versus an equal or larger amount of money available after seven different delays: 1 or 2 weeks, 1 or 6 months, and 1, 3, or 10 years.

The results from Hayashi et al. (2016) indicates the time until destination is an important variable for whether people text while driving. Their data shows that participants who reported a higher frequency of texting while driving discounted the opportunity to reply to a text message at a greater rate. Anyway, there was no correlation between the rates of discounting of hypothetical monetary rewards and the frequency of texting while driving (Hayashi et al., 2016).

To understand the relationship between cellphone use and driving, two different behaviors and sets of contingencies, one first need to consider the relationship between the driver and the person with whom he or she is communicating (LaVoie, Lee, & Parker, 2016). Lavoie et al. (2016) reports that previous research shows that the social distance, which is explained by the relationship between the driver and the person he or she is communicating with, is a strong predictor of CUWD. Surprisingly then, little research has been directed towards whom the drivers are talking or texting to. In their study, Lavoie et al. (2016) found that adults are more likely to talk with their spouses and that teens are more likely to talk with their parents. As a possible reason for this, they state as an effort to compensate for the risk associated with the use of a cellphone while driving, the drivers choose to only answer the most important calls.

Furthermore, Johnson, Ingersoll, and Freitas (2016) and Ingersoll (2017) made their participants rank their 20 “closest” persons, where number 1 would probably be a parent or a significant other. Based on their data, both authors found that the likelihood of CUWD correlates with what they called “social closeness” (the relation to the person contacting the driver). They also found differences in likelihood of CUWD between number of passengers (0 versus 3) as well as type of contact (call versus text). Here, individuals showed a higher probability of waiting to respond to a text message compared to a phone call. Lastly, consistent with previous findings (Hayashi et al. 2016), they found the likelihood of engaging in CUWD increased as the delay until destination increased.

While this field of research seems to be pervasive with young drivers, less research has focused on the frequency of these behaviors in other age groups (Hayashi et al. 2016; Pope, Bell, & Stavrinos, 2017). In addition, other literature promotes a need for investigating the effect of the information received on the cellphone and how this affects the probabilities of cellphone use while driving (Salehinejad, 2015). Despite increased regulation and stricter sanctions by the government, the frequency of CUWD remains relatively high (Hayashi et al., 2016). This is an area of research with impact and importance for the community. People who use a cellphone while driving do not only expose themselves to danger but also passengers and other drivers.

To the extent people use their cellphone while driving, and why they do so, is an important field of research. The idea here is that this issue can be studied within a behavioral analytic framework. Previous research has already studied CUWD within a behavioral economic perspective utilizing a delay discounting procedure and thereby provided a solid basis for understanding different behavioral factors that help explain the decision-making process underlying cellphone use while driving.

The present study

A behavioral analytic approach to the investigation of cellphone use while driving would be to focus on the behavior-environment relations and detect which variables control these responses we call distracted driving. Also, environmental variables such as reinforcing consequences and motivating operations need to be considered. In general, the goal of the present study is to investigate cellphone use while driving utilizing a delay discounting procedure. By doing this, the study further expands findings from previous research with procedures similar to especially Hayashi et al. (2016) and Ingersoll (2017).

The first purpose of the present study is to examine how the probability of cellphone use changes as a function of delay until destination. The second purpose is to further investigate how the information received affects the probability of responding. In other words, how different contents in a text message may change the probability of texting while driving. The third purpose of this study is to evaluate differences in the likelihood of replying to a phone call while driving with passengers or alone, and also whether the caller is known or unknown.

Method

Participants

Participants were recruited through four undergraduate courses at Oslo Metropolitan University. Also, Facebook and word of mouth were used to ensure an acceptable and diverse sample. Participation was voluntary and something that was agreed upon prior to completion of the study. The criteria for inclusion in this study were drivers at the age of 18 and older reporting they have driven during the last 30 days. In Norway the legal age to drive a vehicle is 18, compared to 16 in the United States. This is important to keep in mind when analyzing the impact of cellphone use among teens.

Material and Procedure

Participants conducted an online survey with the aim of mapping driving behavior and especially cellphone use while driving, as well as investigating the importance of various factors that can help explain the reason behind cellphone use while driving. The survey was made through Google Forms, which is a free online tool for making questionnaires and tests. The survey could easily be distributed to the respondents via a link.

Demography. The survey was initiated with a demographic part. The participants reported gender, age, years of driving, years of higher education, and if they are driving their own car. They were also asked if they had been driving within the last thirty days and about how many days per month they drive. For the individuals to be included in the study they had to report one or more days of driving per month and that they had been driving for the last 30 days. Therefore, the demographic part determined which participants were included in the study and who were not.

Frequency. To quantify the frequency of texting while driving, a similar procedure to Hayashi et al. (2016) was applied. After the demographic part, the questionnaire included three questions in which the participants were asked how many days they had (1) initiated, (2) read, and (3) replied to a text message (text, messenger etc.) while driving during the past 30 days. The questionnaire also measured self-reported frequency of TWD. Here, the participants rated on a 7-point scale whether they usually text while driving (1 = never and 7 = always).

Driving behavior. To map some information with regard to driving behavior, the participants were asked about frequency of safety belt use while (1) driving and (2) as a passenger. They reported on a 5-scale (1= never and 5 = always). Next, they ranked their own quality of driving on a 5-point scale from bad to exemplary. Inspired by LaVoie et al. (2016), two questions were added; who are you most likely to (1) call and (2) text while driving? Here, the alternatives were friend, parent, significant other (girl- or boyfriend, spouse etc.), child, boss or coworker and others. This will reveal important information about who we talk and text to while we drive, which is important knowledge in the treatment and further prevention of this undesired driving behavior.

Perceived risk. In this section of the questionnaire, the participants were given a task where they rated to what degree they think certain distracting driving behaviors is associated with risk. They ranked the risk on a 7-point scale (1 = not at all and 7 = to a very high extent). The behaviors were: writing a text or email, talking on the phone (with and without handsfree)**,** checking social media (Facebook, Instagram, etc.)**,** eating or drinking, reading newspapers online, and adjusting the radio/CD in the car.

Delay Discounting Text Task (DDTT). The procedure of this task was based on the "Delay discounting task with a hypothetical opportunity to text", developed by Hayashi et al. (2016). The aim here was to capture the impact of how the information received in the text message affects the probability of using the phone while driving. This will be a necessary and further extension of the task conducted by Hayashi et al. (2016). Participants were asked to rate their likelihood of waiting to respond to an incoming text message (text, messenger, etc.) until they reached their destination, versus replying while driving. Time until destination varied between six delays (30 sec., 3 min., 15 min., 30 min., 1 hour, and 2 hours). First, the task presented the following scenario:

> Imagine that someone close to you or an acquaintance has just sent a text message saying: "Hi, how are you?" while you are driving. You will arrive at your destination in 3 minutes. Please rate how likely you are to wait the 3 minutes to respond.

The second scenario was the same except from now the text message said: "Text me as soon as possible". These scenarios were presented simultaneously across the six different delays (see Appendix A for illustrative extract). Since the task illustrated a hypothetical scenario, the participants were asked to answer as honestly and accurately as possible (see appendix for complete questionnaire).

Delay Discounting Call Task (DDCT). This task is similar to the Distracted Driving Delay Discounting Task by Ingersoll (2017), but with a procedure based on the Delay Discounting Text Task. Here, half of the participants were asked to rate their probability of replying – while the other half rated likelihood of not replying to an incoming phone call while driving. Everything except for the formulation (positive and negative) was the same. This was to see if the wording affects how people respond to the probability of engaging in social unacceptable or even illegal activities, in this case cellphone use while driving. The delays also varied between 30 seconds and 2 hours. The task was extended to include an incoming call from either a known (someone close) or an unknown caller. There was also a manipulation with either passengers or no passengers. This provides four different conditions: (1) alone-known caller, (2) alone-unknown caller, (3) passengers-known caller and (4) passengers-unknown caller. The likelihood of answering the incoming phone call was measured in these four conditions across the six delays (see Appendix B for complete questionnaire).

Self-perceived cause of CUWD. As a final question after the delay discounting call task, the participants were asked: "which statement do you mean best describes the reason behind you using the phone while driving?" The options were; "I get satisfied"**, "**I cannot resist"**, "**I am cellphone dependent"**, "**I only use it to control the music (e.g., AUX)"**, "**Boredom" and "Must have something to do while driving". The last three options were; "I am using the phone if I receive a message or an incoming call"**, "**If I get a message I usually only read it and then answer it later", and "I never use the mobile while driving". There could be reason to believe that the individuals who discount TWD at a higher rate will answer statements such as "I can not resist" or reports that their cellphone use while driving is because of so-called boredom.

Data analysis

Mean and standard deviation were calculated for the variables describing the demographic characteristics of the participants (e.g., age, years of driving and higher education). A linear regression analysis was conducted to evaluate the relationship between different discounting rates in both the DDTT and DDCT. The Pearson's r (shortened: *r*) is the correlation coefficient ranged from -1 to +1, where -1 indicates strongest possible disagreement and +1 the strongest possible agreement. The statistical analysis was done with Microsoft Excel for Mac 2011, Version 14.

Results

Demography

In total, 220 participants completed the online survey through Google forms. Of these, 189 (86%) respondents met the criteria for inclusion (i.e., had been driving a car for the last 30 days and reported an average of 1 or more day of driving per month). The sample of 189 participants subject to this analysis consists of 108 (57%) females and 81 (43%) males. The participants ranged from 18-60 years old (M_{age} = 29.28, SD = 9.03).

Furthermore, the participants were divided into six groups based on age and gender. The first two were (1) male and (2) female 18-23 years (N = 19 and 38), the third and fourth were male and female 24-29 years (N = 31 and 37), and the fifth and sixth group were male and female 30 years and older (N = 31 and 33). Table 1 presents the demographic characteristics of the respondents in the six groups.

Frequency

When the participants rated their frequency of TWD on a 7-point scale, the mean reported frequency across gender and age groups was 2.5. The group with male drivers 18-23 years reported highest frequency of TWD with 3.1, while female drivers 24-29 years reported lowest, with a mean of 1.8 (see Table 1 for mean across each of the six groups). Moreover, 52 (27.5%) of the participants reported here that they never text while driving. Figure 1 shows the full distribution of self-reported frequency of TWD in the six different groups.

Regarding the question about how many days the participants had (1) initiated, (2) read, and (3) replied to a text message (text, messenger etc.) while driving during the past 30 days, the results indicate male drivers engage in texting while driving 45 % more frequently than female drivers. See Table 1 for mean days of TWD per month across gender and age groups. Although the average number of days may seem low (i.e., 1 day of initiating and reading a text while driving per month), the number ranged from 1-30 days per month. Discussed later, when controlled for number of days driven the last month, the impact of texting frequency may look quite different. Figure 2 shows the differences in mean number of days initiating, reading, and replying to a text message while driving during the last 30 days between male and female drivers.

As mentioned, on the 7-point scale 52 (27.5%) of the participants reported they never text while driving. However, based on the self-reported numbers of days initiating, reading, and replying to a text only 33 (17.5%) of the participants reported no TWD during the last 30 days. In other words, 156 (82.5%) of the drivers reported that they had been either initiating, reading or replying to a text message while driving more than 1 day during the last 30 days (Range = 1-30. Mean = 4.6. SD = 5). Figure 3 displays the apportionment of respondents (in group level) reporting no texting while driving during the last 30 days.

An interesting observation is when frequency of texting while driving is controlled for numbers of days driven, how often the drivers actually engage in TWD may be derived. Based on the data from the group “male 18-23 years”, the average driver in this group initiates TWD almost every other time he is driving (44% of the days). Compared to the group with lowest scores, females age 24-29, they engage in TWD under one fifth of the days (18%) they drive. Figure 4 illustrates the differences in the percentage of days with TWD across the six groups, when controlled for number of days driven the last 30 days (i.e., 15 days driven and 15 reported days with TWD = 100%).

Driving behavior

In total, 182 (96%) of the participants reported that they always wear a seatbelt while driving. The other 7 reported “often” (N = 6) and “now and than” (N = 1). Further, 178 (94%) of the individuals reported they always wear a seatbelt as a passenger. Here, the last 11 reported “often” (N = 9), “now and than” (N = 1), and “rarely” (N = 1). When the participants were asked to rate the quality of their own driving, 102 of the 189 respondents reported driving quality at a “very high” level. In addition, 65 of the 189 drivers reported “good”. While 12 drivers claimed the quality of their driving to be at an “exemplary” level, only 8 said their driving was “decent”. Table 2 shows the distribution of self-reported quality of driving across the six groups.

As a final part of this section, the participants were asked two questions; who are you most likely to (1) call and (2) text while driving? The result reveals that over 80 % answered that they are most likely to text either their significant other (43%) or friends (39%) while driving. Additionally, the drivers were most likely to call their significant other (46%), friends (25%) or parents (15%). See Table 3 for full distribution of answers.

Perceived risk

It would be easy to say one’s perceived risk of doing one thing or another would determine whether he or she actually does it or not. Even when engaging in distracting driving behaviors, the perceived risk associated with cellphone use while driving cannot simply be taken as an explanation. However, it might be what the driver tells him- or herself (inner verbal behavior) before engaging in this behavior. The results show the three behaviors the participants associated with highest risk for a driver were (1) writing a text, (2) scrolling some social medium, and (3) reading news online (mean: 5.8, 5.8 and 5.9). Talking on the phone with handsfree was rated as the activity associated with lowest risk (mean: 2.7) for a driver across all six groups. Figure 5 shows the full distribution of mean rated risk associated with different distracting driving behaviors across the six groups. The participants reported to what extent they think these activities are risky for a driver (1 = not at all. 7 = very high degree).

Delay Discounting Text Task

In the Delay Discounting Text Task, participants rated their likelihood of waiting to reply when receiving two different text messages while driving. Including all six groups, there was a high linear correlation (r = .91) between the text messages “HI” and “ASAP”. The group “male 18-23 years” was the single group with highest linear correlation (r = .99). This means that these drivers show the most similar inclination in their two discounting rates, which is the relation between the two text messages and reported likelihood of waiting.

As Figure 6 illustrates, even though the linear correlation is high, there is a significant difference in probability of engaging in TWD across the two texts. For instance, when the delay was 30 seconds, the participants reported 96% mean likelihood of waiting to reply when they received the text “HI”. Likewise they reported 90% mean likelihood of waiting to reply when they received the text “ASAP”. When the delay was 2 hours the mean reported likelihood of waiting were 65% (“HI”) and 34% (“ASAP”). Figure 6 is fitted to all six groups with the two types of text messages across the six delays and illustrates how likelihood of waiting changes across the six groups and delays until destination. See also Table 4 for complete list of each group’s likelihood of replying in the two different conditions at each delay.

Informational content. The impact of how different informational content changes the probability of replying to a text has, to the author’s knowledge, not been investigated in previous studies. In the DDTT there were two different text messages manipulated; one command that may imply some sort of urgency (“Text me as soon as possible”) and one question that functions both as a way to say “hello” and also as a way to ask about how one person feels (“Hi, how are you?”). As we earlier could say something about how often drivers engage in TWD (i.e., the male drivers 18-

23 years engage in TWD on average 44% of the days they drive), we can now say something about how the participants in the present study are more likely to answer one kind of text message while driving over another kind.

As Figure 6 shows, although the linear correlation is high, the percentage difference in probability of engaging in TWD across the two text messages received is high as well. The result implies that drivers tend to answer a text message that says: “text me as soon as possible” at a significant higher rate than one that says “Hi, how are you”. In fact, the results imply that mean likelihood of replying to the text “ASAP” was 51% higher than the “HI” text message. Figure 7 displays the mean likelihood of replying to the two different text messages as a function of delay until destination. The figure also displays the percentage difference from “ASAP” to “HI” at each delay.

Delay Discounting Call Task

A two-tailed t-test was conducted to see if there was any significant difference between mean values in the two groups who got different tasks where only the formulation was changed from one to the other (see method). Based on the results, no significant difference was found between the participants who got one or the other. In other words, there was a high correlation in the answers independent of whether the participants reported on probability of “replying” or “not replying” to an incoming phone call while driving (correlation = .95, p = .03). The answers, and hence all the participants, are therefore gathered in the same pool and the results will be presented together.

After a linear regression analysis of the overall mean likelihood of replying to a phone call at group levels, no significant difference was found in likelihood of replying with or without passengers when the caller is known for the driver (r = .99). Similarly, there was no significant difference in responding with or without passengers when called by an unknown caller (r = .99). Again, this means that the drivers discount the opportunity to talk on a cellphone at a relatively similar rate across the four calling conditions (see Figure 8). However, this does not mean that the likelihood of replying is the same level for all conditions.

When given the scenario where the participants are driving alone and they get a call from a known caller, the mean likelihood of replying was 60%. Furthermore, when driving with passengers, the call was 49% likely to be answered. Similarly, the participants reported in average 31% likelihood of replying when driving alone and an unknown caller reached out. With passengers, the call had 26% mean likelihood of being answered. Moreover, when mean reported likelihood over all six delays are taken into account, the results show that independently of whether the drivers are alone or having passengers they are 48% more likely to answer a phone call from a known caller than an unknown. See Table 5 for complete list of each group's likelihood of replying in the four different conditions at each delay.

Of the six groups, the group "male 18-23 years" was the one most likely to reply to an incoming phone call by a known caller. Here, the mean likelihood of replying to a call when driving alone was 73%. Likewise, when driving with passengers the drivers reported 62% mean likelihood of replying to a known caller. However, when receiving a phone call by an unknown caller, the group "male 24-29" was most likely to reply. When the drivers in this group were driving alone, they reported 39% mean likelihood of replying to the unknown caller. With passengers, they were on average 34% likely to answer when taking all delays into account.

Although it is more useful to talk here about likelihood of replying to a phone call, Figure 8 shows mean reported likelihood of not replying to an incoming phone call until one´s destination is reached, as a function of delay until destination (in min.). This will display the results in a way that is illustrative comparable to the results of the Delay Discounting Text Task. Also, it illustrates how the likelihood of not replying to an incoming phone call decreases as a function of delay until destination. The figure is fitted to all six groups with the four sets of conditions (see method).

Differences between TWD and CWD

Previous research has found the likelihood of responding to a phone call is higher than responding to a text while driving (LaVoie et al. 2016; Ingersoll, 2017). In the present study, the participants reported an overall mean probability of TWD of 31.5% accounting for both text messages and all six delays. Likewise, the mean probability of CWD was 41.5%. Probability of TWD is evidenced by the mean probability of answering (read: not waiting) to the two text messages while driving across the delays until destination for each group. Probability of CWD is evidenced by the mean probability of answering to a phone call while driving across the four different conditions and the delays until destination for each group (see method for description). Table 6 displays the reported probability of both CWD and TWD at group-levels across.

Self-perceived cause of CUWD

After the DDCT, the participants were asked what statement that best describes the reason why they are usually using their phone while driving. In this last question, 48 (25%) participants reported that if they get a text message while driving, they usually only read it while driving and reply later. Furthermore, with 57 (30%) of the participants reporting, the most chosen statement implied that the drivers usually operate their phone if they are receiving a text message or an incoming phone call. In other words, 30% of the participants claim they usually do not initiate in texting or calling while driving, but when they first receive either a text or a call they tend to use their phone anyway.

The fact that many drivers tend du read incoming text messages but not necessarily reply while driving supports why the mean number of days reading a text while driving is higher relative to the number of days initiating and replying to a text (see Figure 2). Table 7 displays the distribution of what statement the driver's think best describes the cause of why they engage in CUWD. An interesting observation here is only 11 drivers say they never use the cellphone while driving (Table 7). Moreover, 17 respondents responded "other" which means there was another reason why they engage in cellphone use while driving. Here, they mentioned reasons such as using the cellphone to navigate with a GPS or to send a Snapchat.

Discussion

Behavioral economic concepts are not well documented in nonclinical settings (Reed et al., 2013). The purpose of the present study was to apply a delay discounting procedure in the study of cellphone use while driving, to see how the probability of cellphone use changes as a function of given delays until destination. Furthermore, this study focused on how different contents in a text message received affect the probability of TWD. Also, how likelihood of replying to a phone call while driving changes when driving with passengers versus driving alone was examined. Lastly, this study investigated differences in the likelihood of replying to a phone call when the caller is known versus unknown. Previous literature within distracted driving such as CUWD points to a need for investigating a more diverse sample of drivers (Hayashi et al., 2016). The present study was conducted with a sample of 189 participants aged 18-60 years. The average age was 29 years and number of drivers 30 years and older was 64 (34%). This is in other words not a typical study conducted with teen drivers, which is characteristic of the previous studies in this field of research.

In both the DDTT and DDCT, the likelihood of delay cellphone use (waiting or not replying) while driving decreased as a function of a given time until destination. This is consistent with previous studies (Hayashi et al. 2016; Johnson et al. 2016; Ingersoll, 2017). Results from the DDCT, inspired by Johnson et al. (2016) and Ingersoll (2017), reveal that when participants got a call from a known caller, the mean probability of replying was 60% when driving alone. Moreover, when driving with passengers, the call was 49% likely to be answered when all delays were taken into account. Similarly, with an unknown caller the participants reported on average a 31% likelihood of replying when driving alone and 26% when driving with passengers. Based on the reported data, independent of whether the drivers were alone or had passengers, they were 48% more likely to answer a phone call from a known caller than from an unknown while driving.

Suggested by previous research, there was also a need for investigating how the informational content received in a text message while driving affects the probability of replying (Salehinejad, 2015). The prompt "text me ASAP" used by Hayashi et al. (2016) is assumed to depend on individuals' history of reinforcement to such degree there is an opportunity to share information which is useful over a very short period of time. This message may also imply some sort of urgency that requires "extraordinary actions", where drivers in some situations behave in ways they would not otherwise behave under similar circumstances but without that prompt. In the present study, when the participants were provided two different text messages, the likelihood of replying to the text message "text me ASAP" was 51% higher than the "Hi, how are you?" text message. This significant difference in likelihood of replying to the two text messages illustrates there are several variables that need to be considered. It may therefore be insufficient to simply say that texting while driving is an impulsive choice made by the driver. The argument here is that an individual's history of reinforcement potentially plays a more crucial role than previously thought, as an explanation of the decision-making process that leads to the use of a cellphone while driving.

Consistent with previous findings, the participants were most likely to text either their significant other (43%) or friends (39%) while driving. Also, they were most likely to call their significant other (46%), friends (25%) or parents (15%). An important aspect to keep in mind when analyzing probability of calling versus texting while driving is that these two sets of behavior are involved in different contingencies of reinforcement. When receiving a phone call while driving, the driver can reply and thereby increase the probability of reinforcement. The driver can also choose not to reply and as a consequence receive no reinforcement because consequences of answering the phone call are only available for a limited time. That is, a limited hold is in effect. On the other hand, when receiving a text message the driver can either read it or not read it. If the driver reads the message, he or she can also answer it immediately or later.

In the present study, there was a high correlation between the percentage of days with texting while driving (see Figure 4) and the mean likelihood of replying to a text in the DDTT (see Figure 7). Based on the reported frequency of texting while driving controlled for numbers of days driven, the percentage of days where the driver's reported on TWD was 44% for male 18-23 years, 27% for male 24-29 years, 30% for male 30+ years, 28% for female 18-23 years, 18% for female 23-29 years, and 24% for female 30+ years (Mean = 28.5%). When comparing these numbers with mean reported likelihood of replying to a text across the two different text messages the numbers in the respective order was: 43.5%, 38.25%, 33%, 31%, 19%, and 24% (Mean = 31.5%). The fact that self-reported frequency of texting while driving correlates with how the participants would behave in the given hypothetical scenarios, gives an extra strength to the internal validity and makes the participants' responses realistic and trustworthy.

Another interesting observation is that based on the questions asked earlier with regards to the frequency of TWD, the results showed that 52 (28%) of the participants reported they never text while driving. Moreover, based on self-reported data about how many days during the last 30 days the participants had been initiating, reading or replying to a text message, only 32 (17%) of the 189 participants actually reported data indicating no TWD. Additionally, when the participants were asked why they are using their cellphone while driving, only 11 (6%) answered clearly they never use a cellphone while driving.

So far, the focus have been directed mainly toward the frequency of CUWD, how it changes as a function of delay until destination, and how the informational content in text message affects the probability of CUWD. Nevertheless, why do people engage in cellphone use while driving? When asked, 25% of the respondents reported that if they get a text message while driving, they usually only read it while driving and reply later. Besides, 30% claim they usually do not initiate in texting or calling while driving. However, when they first receive either a text message or a call they tend to use their phone anyway. The fact many drivers tend du read incoming text messages but not necessarily reply while driving supports why the mean number of days reading a text while driving is higher relative to the number of days initiating and replying to a text (see Figure 2). However, because only 11 (6%) answered clearly they never use a cellphone while driving, this means 94% of the drivers made an answer indicating cellphone use while driving (see Table 7 for full distribution of self-perceived cause of CUWD).

In real driving situations, when a driver receives either a text message or a phone call, he or she does not only face two choices – using the cellphone while driving or waiting until destination – he or she can also pull over and receive the same reinforcing consequence (when cellphone use is reinforcing) as if he or she waited until destination. This third option was not included in any of the two delay discounting tasks (texting and calling), though some participants reported no cellphone use without pulling over. The purpose of the study and hence what is measured is the individuals' likelihood of discounting reinforcement. In other words, to what degree they postpone cellphone use in driving situations as a function of time until destination. Therefore, the aim is not to measure the likelihood of pulling over when receiving either a phone call or a text message while driving.

Nevertheless, this delimitation could potentially put some participants in a trap of two choices of action they would never have encountered in real life. Let us say that every time you are driving and the time until destination is 15 minutes or more (four out of the 6 delays), you always find a spot and pull over to make that phone call or text back. In cases where time until destination is shorter than 15 minutes you always wait. In both the DDTT and DDCT, what would be the right answer when the delay is 15 min., 30 min., 1 hour, or 2 hours? How likely are you to wait for these given delays? In this case, the answer can hardly be anything except from wrong or not representative of your probability of action. If you answer 0% (definitely replying) this will be wrong because you never use the phone without pulling over. On the other hand, if you answer

100% (definitely replying), this will also be wrong because you always stop since you cannot wait more than 15 minutes. With that said, there is no further reason to believe this applies to many of the individuals in this study. Still, it must be taken into account as a possible risk of bias.

In behavioral analytic terms, if one were to explain cellphone use while driving one would start by looking at the different sets of competing contingencies. In general, the conditions that affect the probability of operant behavior are in the person's history – not in the immediate environment (Skinner, 1974). This supports the argument that a driver's probability of using his or her cellphone while driving is a product of that driver's history of cellphone use. A person who never answers a phone call from an unknown caller at home will most likely not answer the phone call while driving. However, if the same person starts answering the phone call at home and such answering is reinforced, he or she may have an increased likelihood of replying to the unknown caller next time he or she is driving. In other words, the probability a person will respond in a given way because of a history of reinforcement changes as the contingencies or schedules of reinforcement change (Skinner, 1974).

When one stimulus is blocking the eliciting function of another stimulus, this would be explained in everyday language by saying one can only pay attention to one thing and not multiple things at the same time. Since the causes of our behavior are not conspicuous, we tend to attribute our behavior with some inner feelings or state of mind. Therefore, most people would explain cellphone use while driving to occur when a person chooses to reply to a text because he or she devalues the risk associated with texting while driving. It is the fact that the driver engages in TWD despite the risk associated we may say the driver devalues the risk. Therefore, the cause of TWD has to be found somewhere else than in the risk. In a behavioral analytic perspective, one may say the contingencies of reinforcement are responsible for the behavior of operating the cellphone while driving. Some sort of devaluation of risk can at best be a by-product of the contingencies of reinforcement.

The social reinforcement associated with cellphone use while driving usually implies immediate reinforcement. As mentioned, information is often available only for a limited time. Moreover, the value of information decreases as a function of time. Hence, the immediacy of the consequences associated with CUWD may explain why using the cellphone may be valued over the punishing consequences of CUWD (i.e., ticket, accidents, etc.). To reduce this unwanted behavior, it may be more feasible to manipulate the reinforcing effect of the consequences through a motivating operation (MO), than manipulating the immediate consequences directly. Laraway, Snycerski, Michael, and Poling (2003) state the main function of a MO is to establish (or abolish) the reinforcing effectiveness of some event and to evoke behavior that previously has led to these reinforcers (or aversive stimuli). Motivating operations relevant for CUWD may therefore be a source of effective interventions to reduce CUWD.

The results in the present study showed 25% of the respondents reported that if they get a text message while driving, they usually only read it while driving and reply later. Furthermore, 30% reported when they first receive either a text message or a call they tend to use their phone. Hence, we may assume that over 50% of the drivers tend to read incoming text messages and possibly check other notifications while driving as well. Because texting while driving occurs in a behavioral chain after reading the text message while driving, the greatest potential in preventing TWD may therefore be to prevent the driver reading the text message or notification. A kind of drive-mode on the cellphone may reduce motivating operations associated with CUWD, as the drive-mode reduces behavior (cellphone use) that previously led to the social reinforcement assumed to be associated with CUWD. If most of the CUWD is directed toward friends and family, it may be reasonable to direct interventions towards those who frequently send text messages and make calls to people they know drive at that time.

Sending and receiving a text message removes the driver’s eyes from the road for an average of 4.6 seconds (NHTSA, 2012). Moreover, when engaging in handheld cellphone use while driving of 2 seconds or more, the driver has a 5.5-fold increased risk of a crash or near crash (Delgado et al., 2016). There is no doubt CUWD implies a major safety issue. One action to reduce the frequency of CUWD may be to let drivers experience how dangerous it can be to move their attention away from the road. Conducting simulator training, with a computer screen or a virtual reality headset, will expose drivers to aversive consequences of CUWD such as unsteady driving and near-crashes. Training of alternative behavior such as procedures for letting people know you are driving or simply activate a drive-mode combined with simulator training, may reduce motivating operations of importance for the reinforcing effect of CUWD.

Another variable one should consider as a reason for why the frequency of cellphone use while driving remains relatively high is the contingencies of punishment. A possible reason for why people engage in CUWD despite its perceived high risk is that many are not in contact with the punishing stimuli as a consequence of the behavior. Most of the times we initiate or reply to a text or an incoming phone call, the police do not stop us. Neither do we crash every time we use a cellphone while driving. Since initiating or replying to a call or a text message produces positive reinforcement, it is more likely to occur even in driving situations. In addition, since initiating or replying to a call or text message produces punishment less frequent than reinforcement, the frequency is less likely to be reduced or extinguished.

One important thing to keep in mind is that delay discounting affects a wide variety of important domains related to human behavioral outcomes. Almost any behavior for which the consequence occur in the future are in competition with behaviors where consequences are immediately available (Reed et al., 2013). Methods for reducing behavior normally associated with a high degree of discounting have focused on delivery timing of reinforcement and implementation of token economy systems. Reed et al. (2013) say that one method to help reduce effects of delay is to deliver reinforcers immediately. However, this cannot be viewed as a viable option in the case of cellphone use while driving, which means the driver should respond immediately to all phone calls and text messages. To reduce cellphone use while driving one first need to identify and understand how the cellphone is controlling the behavior of the driver. Thereafter, to promote a desired outcome we can arrange interventions such as naturalistic simulating tasks to make the driver encounter the punishing consequences of cellphone use while driving.

Previous research (Hayashi et al., 2015, 2016) has denoted the driver's decision to respond to an incoming text message while driving as an impulsive choice. This is shown through a preference for a sooner and smaller reward, in this case the opportunity to reply to a short text message while driving instead of a longer conversation later. Impulsive behavior depends on the contingencies of reinforcement at the moment of choice as well as one's history of learning with respect to immediate and delayed reinforcement (Pierce & Cheney, 2013).

Despite more regulation and increased sanctions by the government, the prevalence of cellphone use while driving is high. One can analyze frequency of CUWD, risk assessment, and the effects of traffic rules in an endless spiral. What needs to be considered is the impact of the contingencies of reinforcement and variables such as reinforcing consequences and motivating operations that cellphone use is a major part of. Modern cars have an ever-increasing number of support systems, such as lane assistant and adaptive speed control that, as an unintended effect, most likely leads to reduced alertness by the driver. One also have apps that will limit the functions and possibilities of what a driver can do on his or her cellphone while driving, but the driver's do not use it (Sagberg & Sundfør, 2016).

Limitations

A problem with hypothetical scenarios in the study of people's decision-making is that it quickly can become artificial. Therefore, it was necessary to ensure that the questions in the DDTT and DDCT were as real as possible and reflected environmental variables where cellphone is assumed used in driving situations. Furthermore, in delay-discounting research, it is common to find non-systematic patterns of responding due to a number of variables, such as carelessness or random responding (Hayashi et al. 2015).

All studies have limitations and the present one is no exception. The survey conducted and the results are based on self-report data of past cellphone use with respect to both texting and calling together with amount of driving. Since the data does not constitute actual call-, text- and driving logs, these patterns may not be completely accurate. Also, since this survey is based on data obtained from tasks involving hypothetical scenarios, actual choices are not measured. Nevertheless, there is a reason to believe what the participants reported is as precise and accurate as may be expected. There is also a reason to believe the individuals reported based on their experiences and patterns of behavior: their history of reinforcement. Thereby, since the scenarios were made as natural as possible, the individuals would report based on previous behavior under similar circumstances. If this is the case, the study will have sufficient reliability and validity.

Underreporting can potentially be an issue of concern in studies where inacceptable or even illegal behaviors such as CUWD are reported. In this study however, due to the strong agreement between the reported frequency of TWD and the probability of TWD in the DDTT, there is no reason to believe the numbers are underreported. In delay discounting research, Hayashi et al. (2015) claim it is common to find patterns of responding that are nonsystematic. In the present study, no algorithm was applied to detect nonsystematic response patterns within a certain criteria. As a result, there is a chance that some of the drivers included in this study would have been excluded from the study of Hayashi et al. (2015). There is also a chance the results in this study are due to study parameters, the selection and selection process of respondents, and their characteristics.

Another aspect with the present study as well as previous studies investigating texting while driving with the use of hypothetical scenarios is that the task implies the driver actually check his or her received text message while driving. In the questionnaire, the participants were asked: “imagine that you receive a text while driving that says...” This implies that the driver actually check the text message received when while driving, since the driver knows what the content is. In the survey, there was no option to answer that the driver would never check the information in the text message received and thereby he or she would not have replied anyway. In other words, the question about the probability of responding to the text where the driver already know the content in the message could possibly force the participants to make a choice in a scenario they would never be in anyway.

Direction for future studies

One can reasonably say that people engage in CUWD despite it’s perceived risk. A behavioral scientific explanation of CUWD points to the contingencies of reinforcement that defines the relation between the content in the text message and the behavior that is the usage of the cellphone. Because of the contingencies of reinforcement, one can say that the cellphone exerts some control over the driver’s behavior. Madden et al. (2011) state acceptance-based treatments have shown positive effects in reducing gambling, substance abuse and obesity, behaviors that correlate with high rates of delay discounting. These treatments utilize a variety of behavior change strategies with the purpose of increasing one’s psychological flexibility and teach techniques for experiential avoidance.

Psychological flexibility refers to the ability to act consistently with one’s values even when distressing thoughts and feelings seem to get in the way of doing so (Biglan & Embry, 2013). On the other hand, experiential avoidance keeps us away from discomfort such as coming into contact with pain or danger. It would be interesting to see future research exploring the effectiveness of acceptance-based interventions with the purpose of reducing the frequency of cellphone use while driving. In addition, derived from Reed et al. (2013), viewing self-control as a type of discounting may have implications on how to arrange and manage behavior interventions. It may therefore be possible to design and arrange interventions (i.e., training) to promote self-control. Future studies should examine the effectiveness of self-control training (i.e., simulation of driving situations) in reducing cellphone use while driving with the aim of shifting the drivers' preferences from sooner–smaller to later–larger rewards.

Concluding remarks

Previous research has shown that younger drivers are more likely to use a cellphone while driving and the drivers who text frequently are more likely to discount future rewards at a greater rate (see Hayashi et al. 2016). However, research in this field has pointed to a need for examining the frequency of cellphone use in other age groups and how the value or content in the information received affects the probability of using the phone while driving. This study applied a method that built on the work by especially Hayashi et al. (2016), LaVoie et al. (2016) and Ingersoll (2017). The aim was to utilize a delay discounting procedure for investigating driving behavior and underlying factors of cellphone use while driving. This study was exploratory and hence tried to reveal and confirm important factors describing how people's cellphone use is related to driving. Several factors have shown significance for the probability of cellphone use while driving such as time until destination, the content of the text message received, and whether the driver is alone or has passengers.

Finally, this study is a preparatory investigation of people's decision-making process related to cellphone use while driving. Calling and texting patterns have been revealed together with probability of engaging in CUWD. As a result, this study may contribute as an empirical foundation for future interventions with the aim of reducing these undesirable sets of behavior. As stated by Hayashi et al. (2016), one can say that a behavioral economic approach may be a useful research tool for investigating the decision-making processes underlying secondary tasks such as cellphone use while driving. However, variables such as time until destination and the informational content in the message received is only two ways of studying the correlation between cellphone uses and driving. Future research should validate the findings of the present study. Also, one should conduct a more naturalistic approach in the study of cellphone use while driving. Hence, further investigation is needed to fully understand the variables underlying individuals' decisions to engage in such risky behaviors.

References

Atchley, P., & Warden, A. C. (2012). The need of young adults to text now: Using delay discounting to assess informational choice. *Journal of Applied Research in Memory and Cognition*, *1*(4), 229-234. doi:10.1016/j.jarmac.2012.09.001

Bickel, W. K., Johnson, M. W., Koffarnus, M. N., MacKillop, J., & Murphy, J. G. (2014). The behavioral economics of substance use disorders: reinforcement pathologies and their repair. *Annual review of clinical psychology*, *10*, 641-677. Retrieved from http://dx.doi.org/10. 1146/annurev-clinpsy-032813-153724

Biglan, A., & Embry, D. D. (2013). A framework for intentional cultural change. *Journal of Contextual Behavioral Science*, *2*, 95-104.

Delgado, M. K., Wanner, K. J., & McDonald, C. (2016). Adolescent cellphone use while driving: an overview of the literature and promising future directions for prevention. *Media and communication*, *4*(3), 79. doi:10.17645/mac.v4i3.536

Ehsani, J., Li, K., & Simons-Morton, B. G. (2015). Teenage drivers portable electronic device use while driving. *The National Academies of Sciences, Engineering Medicine*, 219-225.

Hayashi, Y., Miller, K., Foreman, A. M., & Wirth, O. (2016). A behavioral economic analysis of texting while driving: Delay discounting processes. *Accident Analysis and Prevention*, *97*, 132-140. doi:10.1016/j.aap.2016.08.028

Hayashi, Y., Rivera, E. A., Modico, J. G., Foreman, A. M., & Wirth, O. (2017). Texting while driving, executive function, and impulsivity in college students. *Accident Analysis and Prevention*, *102*, 72-80. doi:10.1016/j.aap.2017.02.016

Hayashi, Y., Russo, C. T., & Wirth, O. (2015). Texting while driving as impulsive choice: A behavioral economic analysis. *Accident Analysis & Prevention*, *83*, 182-189. doi:10.1016/j.aap.2015.07.025

Ingersoll, B. L. (2017). Behavior economic and social variables influencing cell-phone distracted driving. (Master's thesis, California State University). Retrieved from http://hdl.handle.net/10211.3/196372

Johnson, P. S., Ingersoll, B. L., & Freitas, M. C. (2016). Can It Wait? Effects of Delayed Reinforcement and Social Variables on Cell-Phone Distracted Driving. California State University, Chico.

Klauer, S. G., Guo, F., Simons-Morton, B. G., Ouimet, M. C., Lee, S. E., & Dingus, T. A. (2014). Distracted driving and risk of road crashes among novice and experienced drivers. *New England journal of medicine*, *370*(1), 54-59. doi:10.1056/NEJMsa1204142

Laraway, S., Snycerski, S., Michael, J., & Poling, A. (2003). Motivating operations and terms to describe them some further refinements. *Journal of Applied Behavior Analysis, 36,* 407–414. doi:10.1901/jaba.2003.36-407

LaVoie, N., Lee, Y. C., & Parker, J. (2016). Preliminary research developing a theory of cell phone distraction and social relationships. *Accident Analysis & Prevention*, *86*, 155-160. doi:10.1016/j.aap.2015.10.023

Madden, G. J., & Bickel, W. K. (2010). Impulsivity: The behavioral and neurological science of discounting. Washington, DC: American Psychological Association.

Madden, G. J., Francisco, M. T., Brewer, A. T., & Stein, J. S. (2011). Delay discounting and gambling. *Behavioural Processes*, *87*(1), 43-49. doi:10.1016/j.beproc.2011.01.012

Morrison, K. L., Madden, G. J., Odum, A. L., Friedel, J. E., & Twohig, M. P. (2014). Altering impulsive decision making with an acceptance-based procedure. *Behavior therapy*, *45*(5), 630-639. doi:10.1016/j.beth.2014.01.001

National Highway Traffic Safety Administration. (2012). Blueprint for ending distracted driving. Retrieved from nhtsa.gov/CPSCreative/blueprint/CA/brochure/8747-811629-060612-v4-FPO.pdf

National Safety Council (2015). Retrieved from http://www.nsc.org/Connect/NSCNewsReleases/Lists/Posts/Post.aspx?ID=9

Owens, J. M., McLaughlin S. B., & Sudweeks, J. (2011). Driver performance while text messaging using handheld and in-vehicle systems. *Accident Analysis and Prevention, 43*(3), 939-947. doi:10.1016/j.aap.2010.11.019

Pierce, W. D. & Cheney, C. D. (2013). *Behavior analysis and learning*. (5th ed.) Philadelphia, PA: Psychology Press.

Pope, C. N., Bell, T. R., & Stavrinos, D. (2017). Mechanisms behind distracted driving behavior: the role of age and executive function in the engagement of distracted driving. *Accident Analysis & Prevention*, *98*, 123-129. doi:10.1016/j.aap.2016.09.030

Reed, D. D., Becirevic, A., Atchley, P., Kaplan, B. A., & Liese, B. S. (2016). Validation of a novel delay discounting of text messaging questionnaire. *The Psychological Record*, *66*(2), 253-261. doi:10.1007/s40732-016-0167-2

Ringen., Svein. jr. (2016). *In- Depth Analysis of Fatal Road Accidents in the year 2016*. No. 640. The Norwegian Public Roads Administration.

Sagberg, F., & Sundfør, H. B. (2016). Inattention at the wheel: Prevalence, consequences and countermeasures. *Norwegian Centre for Transport Research*, *1481*. Retrieved from https://www.toi.no/getfile.php?mmfileid=43409

Salehinejad. M. A. (2015). *The Role of Informational Medium on Decisions to Respond to a Message*. (Master's thesis, University of Kansas). Retrieved from http://hdl.handle.net/1808/19495

Skinner, B. F. (1974) *About Behaviorism*. New York: Knopf.

Struckman-Johnson, C., Gaster, S., Struckman-Johnson, D., Johnson, M., & May-Shinagle, G. (2015). Gender differences in psychosocial predictors of texting while driving. *Accident Analysis & Prevention*, *74*, 218-228. doi:10.1016/j.aap.2014.10.001

Table 1

Characteristics of respondents

Gender	Male		Female		Male		Female		Male		Female	
Age	18-23		18-23		24-29		24-29		30+		30+	
Measure	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Demography												
Age in years	21.9	1.3	21.5	1.6	25.7	1.6	25.6	1.5	41	7.5	39	7.5
Years of HE	1.5	.8	2.1	1.5	3.8	1.6	3.9	1.8	3.2	2.1	3.7	2
Years of driving	3.9	1.2	3.6	1.6	7.6	1.7	6.9	1.8	21	9.2	19.5	8.4
Days of DPM	19.8	9.7	16.6	9	19.9	9.7	17.5	10.9	23	8.6	22.5	9.4
Frequency												
Days of TWD	5.2	4.6	2.6	2.5	4	4.7	1.5	1.8	4.9	6.8	3.3	3.8
Freq. of TWD	3.1	1.1	2.6	1.6	2.9	1.7	1.8	.9	2.4	1.6	2.2	1.2
Risk												
Seen risk TWD	5.2	1.8	5.3	2.3	5.9	1.2	6.2	1.8	6.1	1.7	6.2	1.6
Seen risk CWD	3.6	1.5	4.2	2	3.8	1.4	5.2	1.7	4.6	1.5	4.5	2

Note. Values are means (and standard deviations). HE = Higher Education. DPM = driving per month. TWD = Texting While Driving. CWD = Calling while driving (without handsfree).

Table 2

Quality of driving

Quality:	Decent	Good	Very good	Exemplary	N
Male 18-23		6	10	3	19
Male 24-29	2	8	18	3	31
Male 30+		13	14	4	31
Female 18-23	4	11	22	1	38
Female 24-29		14	22	1	37
Female 30+	2	13	16	2	33
Total	8	65	102	12	189

Note. Values are number of participants reporting the given quality of their own driving.

Table 3

Most likely to call and text

Gender	Male		Female		Male		Female		Male		Female	
Age	18-23		18-23		24-29		24-29		30+		30+	
Measure	C	T	C	T	C	T	C	T	C	T	C	T
Significant other	6	7	19	18	8	10	18	17	20	17	16	13
Friend	3	7	7	16	16	19	9	15	4	7	5	10
Child									1	3	7	4
Parent	8	1	11	2	2		8	1	3		1	
Boss / coworker	1	1			5	1			3	3	2	4
Others	1	2					2	1			1	
No one	1	1	1	2		1				1	1	4

Note. Values are number of participants in each group reporting who they are most likely to call (C) and text (T) while driving. A "significant other" was specified in the questionnaire to be either girlfriend, boyfriend, or spouse.

Table 4

Delay Discounting Text Task (DDTT)

	Male 18-23		Female 18-23		Male 24-29		Female 24-29		Male 30+		Female 30+	
Delay	HI	ASAP	HI	ASAP	HI	ASAP	HI	ASAP	HI	ASAP	HI	ASAP
30 sec	97	91	99	88	92	86	97	95	92	87	98	95
3 min	81	69	94	80	83	71	96	90	85	77	95	87
15 min	66	42	77	57	72	52	94	70	80	62	89	68
30 min	59	33	76	47	68	43	91	59	71	49	84	58
1 hour	50	22	70	37	59	35	89	53	67	42	77	46
2 hours	49	23	69	34	50	30	89	45	57	32	74	40

Note. Values are mean percent likelihood of replying to a text message while driving as a function of time until destination. HI = the text message received is: ”Hi, how are you”. ASAP = the text message received is: ”Text me as soon as possible (asap)”.

Table 5

Delay Discounting Call Task (DDCT)

Delay	M 18-23	F 18-23	M 24-29	F 24-29	M 30+	F 30+
			Alone - known caller			
30 sec	60	40	49	32	48	45
3 min	66	43	58	30	53	51
15 min	76	56	72	39	60	58
30 min	77	60	74	46	62	64
1 hour	79	62	78	50	66	73
2 hours	79	68	79	58	70	77
			Alone - unknown caller			
30 sec	25	19	31	19	35	38
3 min	30	12	32	17	34	30
15 min	33	16	40	16	38	36
30 min	38	17	40	18	40	38
1 hour	40	18	43	20	43	39
2 hours	36	22	43	24	46	44
			Passenger(s) - known caller			
30 sec	47	32	43	22	38	46
3 min	53	35	51	27	43	36
15 min	63	40	60	34	52	42
30 min	68	43	62	38	53	52
1 hour	71	47	68	41	59	58
2 hours	67	51	69	45	61	60
			Passenger(s) - unknown caller			
30 sec	19	12	29	18	29	30
3 min	23	13	31	15	31	22
15 min	30	13	35	16	35	25
30 min	33	13	35	14	38	30
1 hour	30	15	36	16	41	34
2 hours	34	18	37	18	43	35

Note. Values are mean percent likelihood of replying to an incoming phone call while driving as a function of time until destination. M = male and F = female.

Table 6

Cellphone Use While Driving

Group	Male 18-23	Female 18-23	Male 24-29	Female 24-29	Male 30+	Female 30+
Prob. of TWD	43,5 %	31 %	38.25 %	19 %	33 %	24 %
- ”Hi”	33 %	19 %	29.5 %	17 %	24 %	14 %
- ”ASAP”	54 %	43 %	47 %	31 %	42 %	34 %
Prob. of CWD	49 %	32 %	50 %	28 %	46,5 %	44 %
- Call #1	73 %	55 %	68 %	43 %	60 %	61 %
- Call #2	34 %	17 %	39 %	19 %	39 %	37 %
- Call #3	61 %	41 %	59 %	34 %	51 %	49 %
- Call #4	28 %	14 %	34 %	16 %	36 %	29 %

Note. Values are means (in percent). TWD = Texting While Driving. CWD = Calling while driving (without handsfree). Probability of TWD is evidenced by the mean probability of answering (read: not waiting) to the two text messages while driving across the delays until destination for each group. Probability of CWD is evidenced by the mean probability of answering to a phone call while driving across the four different conditions and the delays until destination for each group. Call #1 refers to the condition: “alone-known caller”, call #2 refers to “alone-unknown caller”, call #3 refers to “passengers-known caller”, and call #4 refers to “passengers-unknown caller”. See method for full description.

Table 7

Self-perceived cause of CUWD

Cause of CUWD	Women	Men
I satisfy my need	1	4
I can not resist	7	6
I am cellphone dependent	0	2
I am using the phone to play music	24	1
Boredom	2	6
Must have something to do	3	0
Using the phone if I receive a message or an incoming call	21	36
If I get a message while driving, I usually read it immediately and respond later	29	19
I never use the cellphone while driving	10	1
Other	11	6
Total	108	81

Note. The values are number of participants responding the statement that best described the reason why they engage in CUWD. The 17 participants responding "Other" wrote a comment or a statement in the questionnaire, such as Snapchat or GPS.

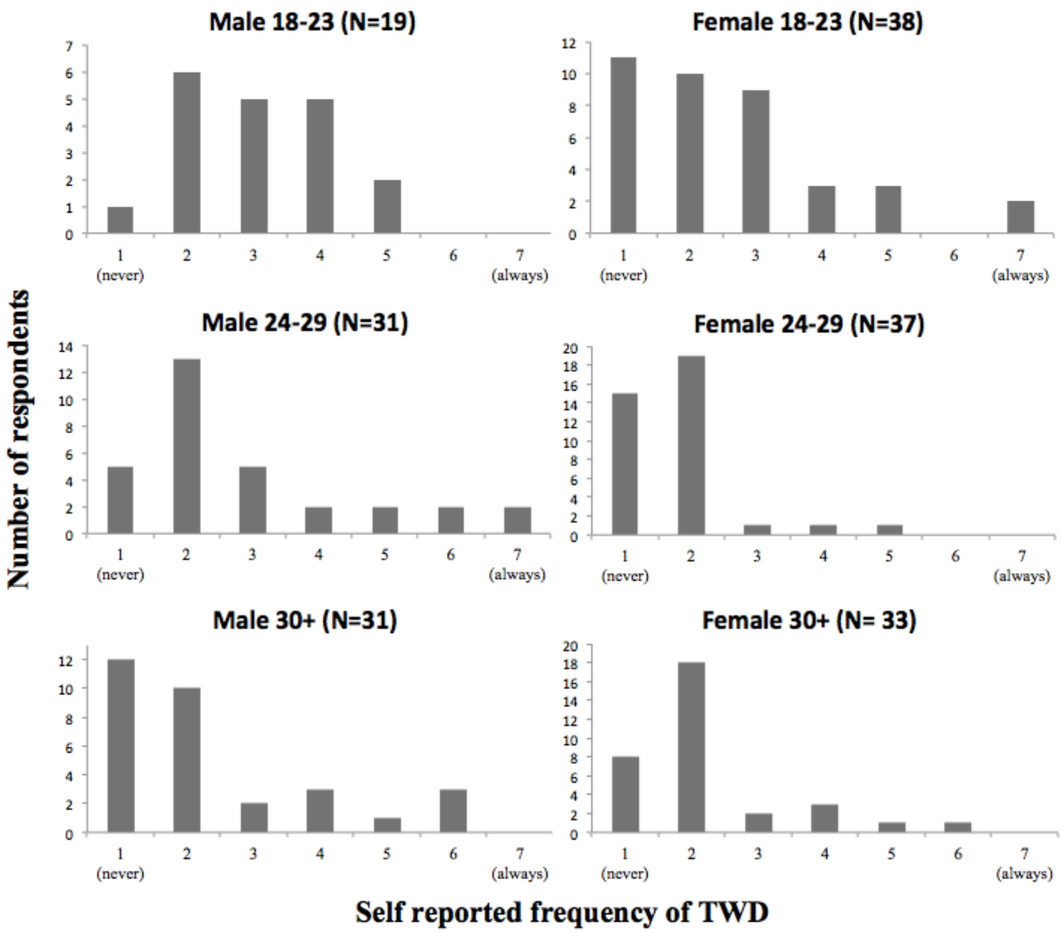


Figure 1. Frequency of Texting While Driving (TWD). The respondents reported their frequency of TWD from 1 (never) to 7 (always). Values are number of respondents in each group.

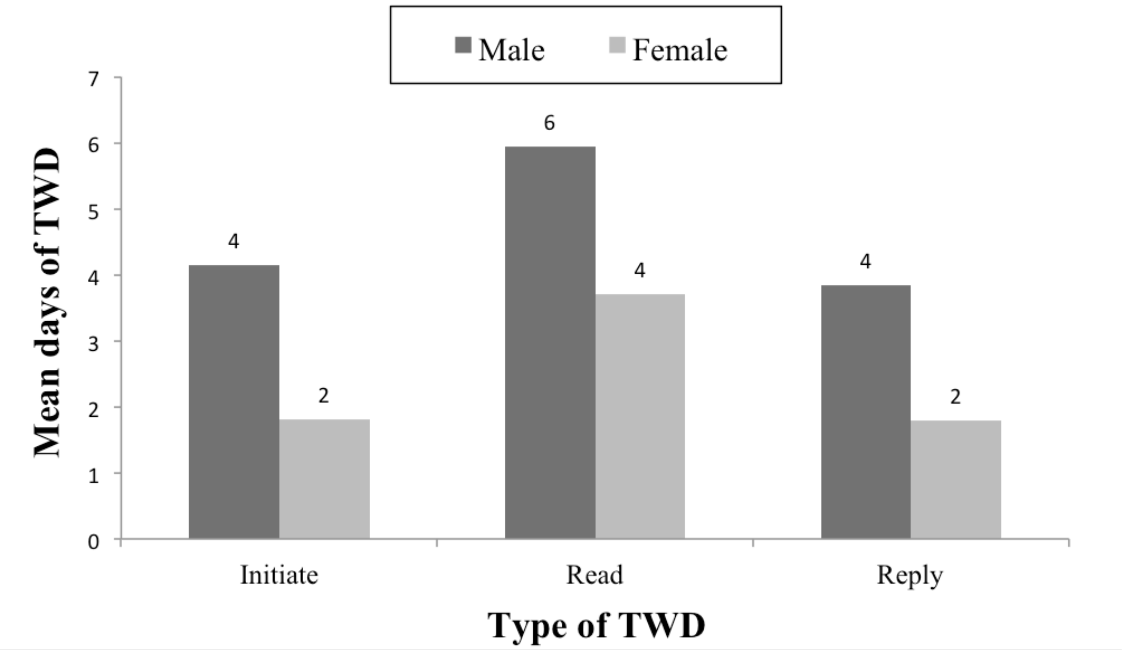


Figure 2. Mean number of days with TWD. Values are mean self-reported days with TWD during the last 30 days for male and female drivers.

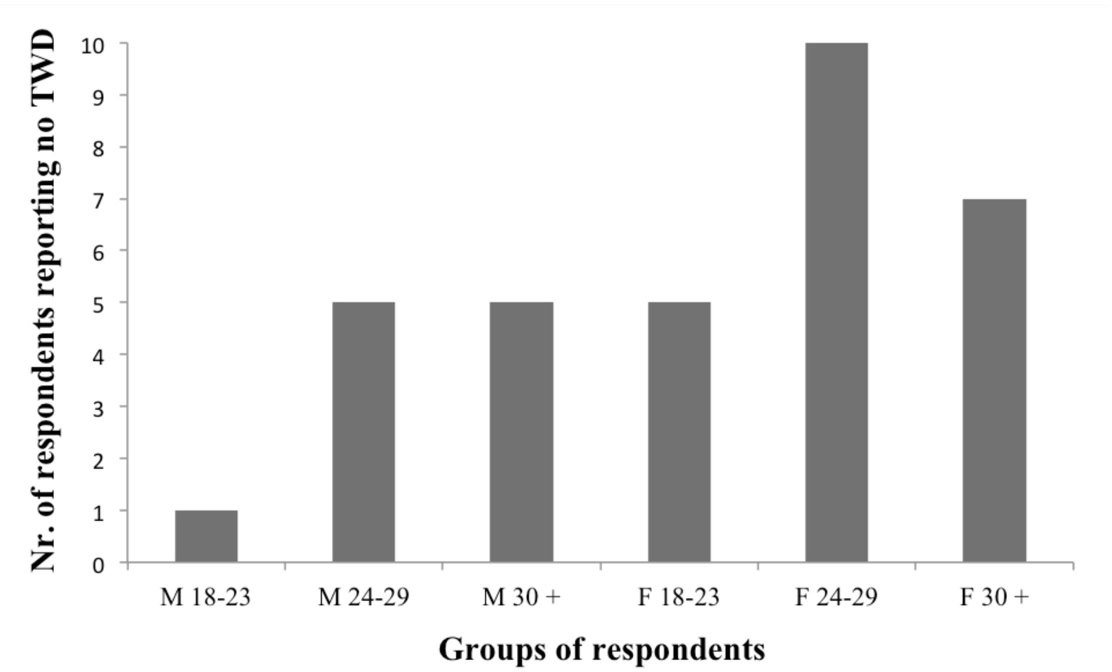


Figure 3. Respondents with no reported TWD. M = male and F = female. Values are number of respondents in each group with no reported days of texting while driving.

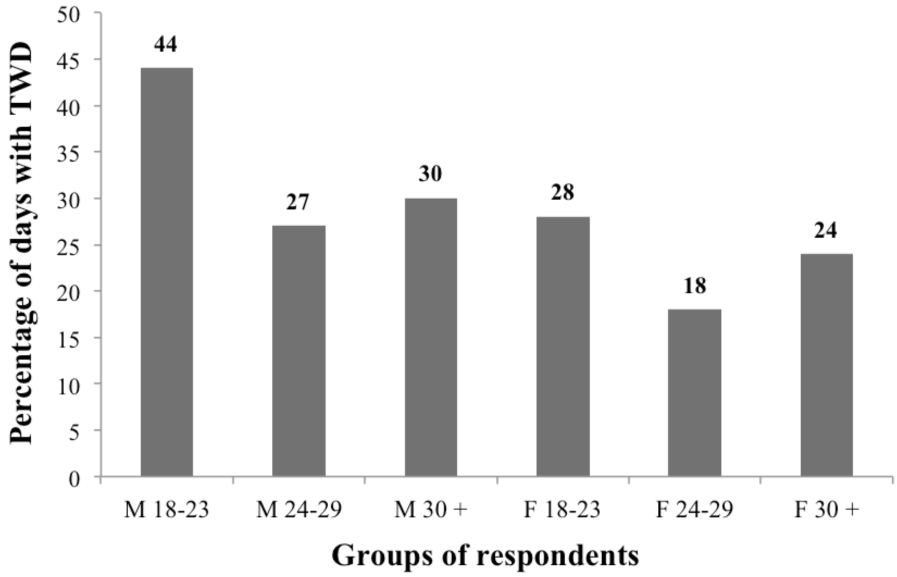


Figure 4. Drivers' percentage of days with TWD. M = male and F = female. Values are mean percent of days with TWD based on individual reports on frequency of TWD controlled for number of days driven the last 30 days (i.e., 15 days driven and 15 reported days with TWD = 100%).

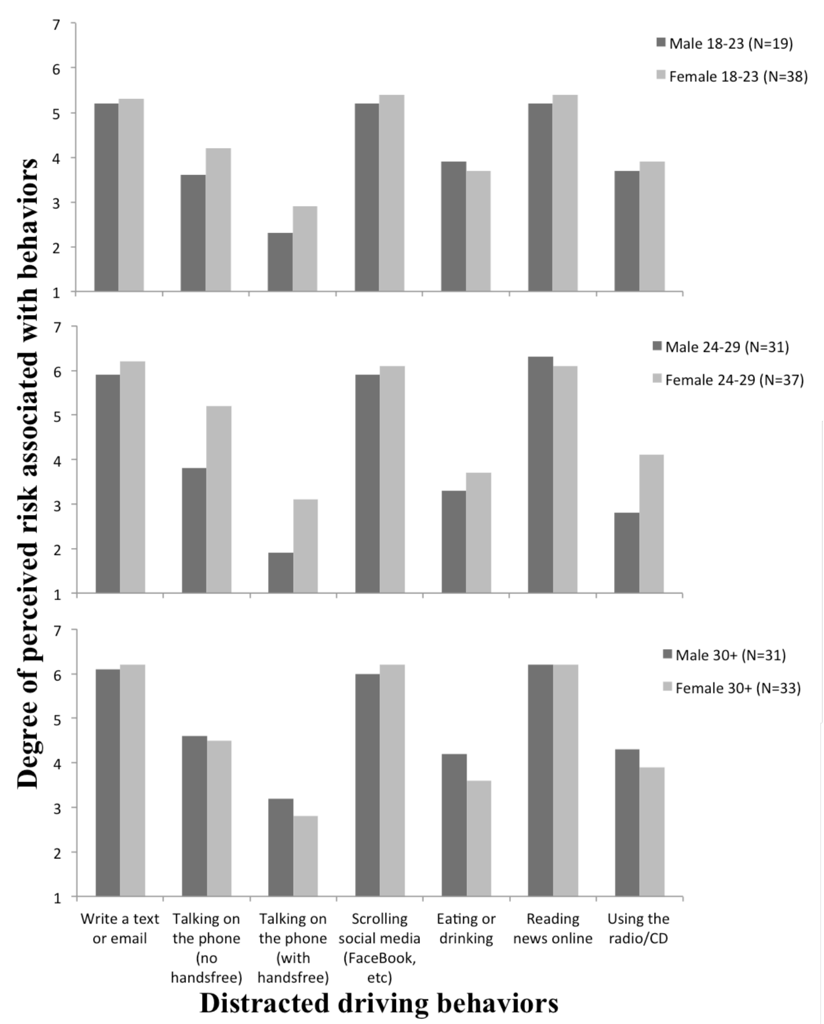


Figure 5. Risk assessment of different distracted driving behaviors. Values are mean rated risk associated with different distracting driving behaviors across the six groups. The participants reported to what extent they think these activities are risky for a driver (1 = not at all. 7 = very high degree).

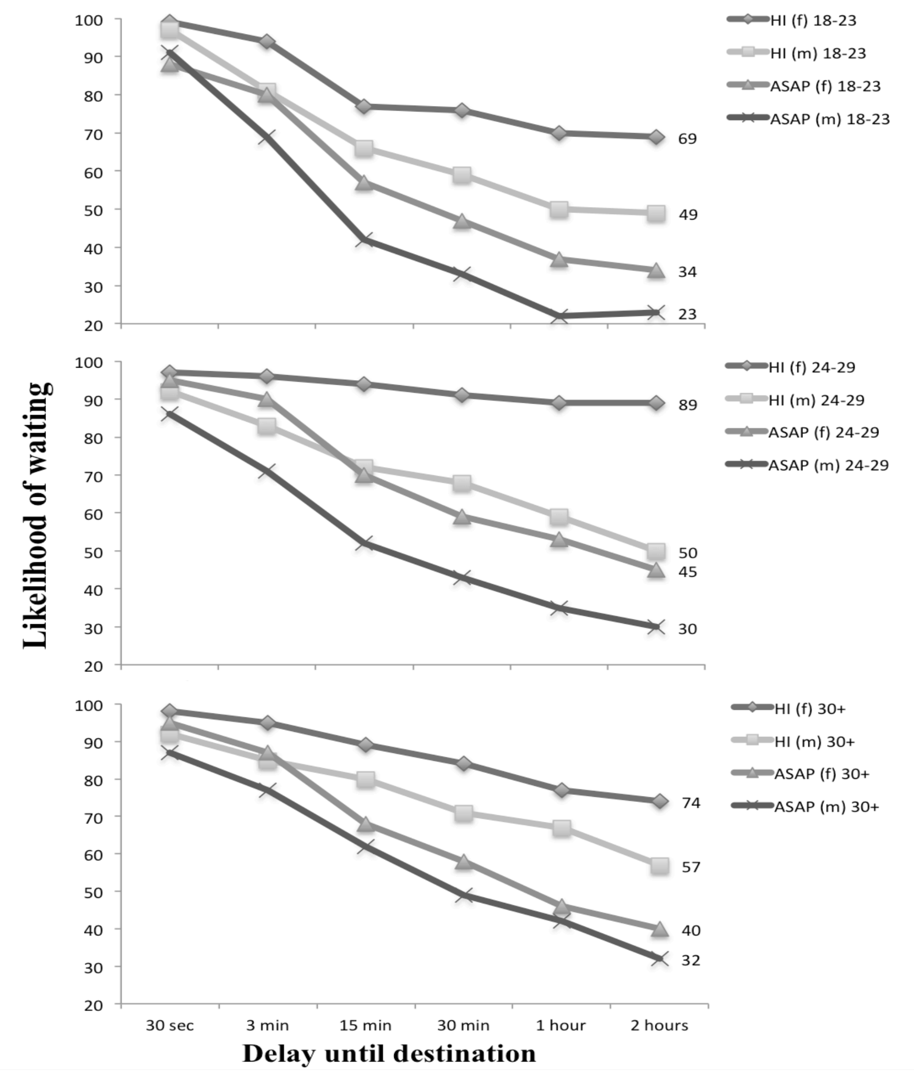


Figure 6. Delay Discounting Text Task (DDTT). Likelihood of waiting as a function of delay until destination, where (m) = male and (f) = female. “HI” means that content in the message received while driving was ”Hi, how are you”. “ASAP” means that in the text message received while driving it was written ”Text me as soon as possible”. The figure is fitted to all six groups with the two types of text messages across the six delays. For complete chart of values of all six delays and across the six groups, see Table 4.

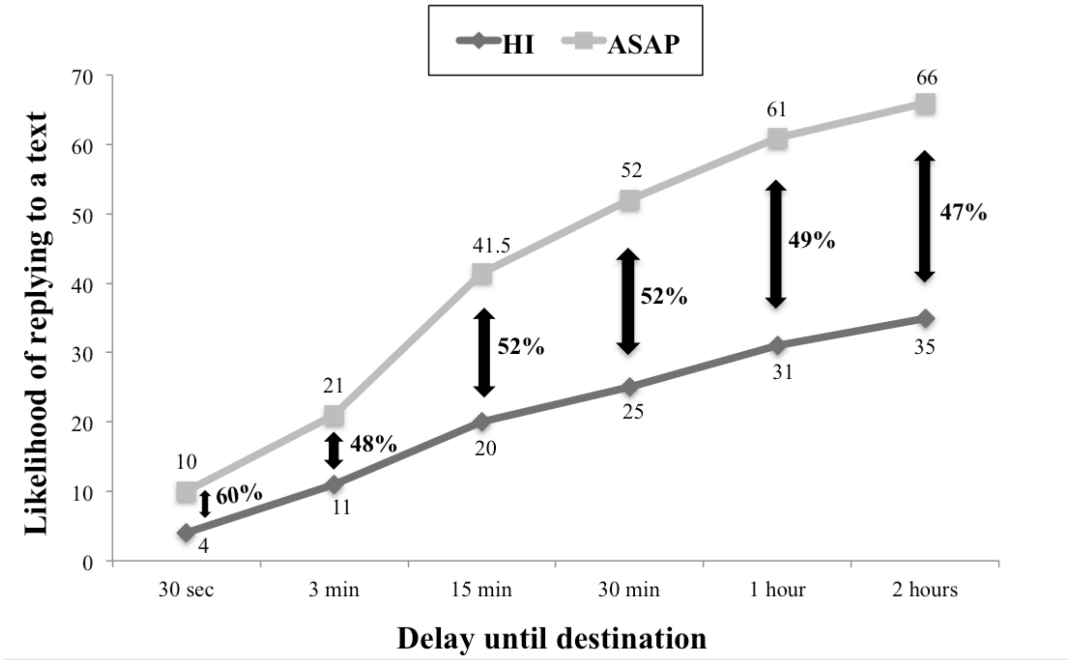


Figure 7. Probability of TWD and informational content. Values are based on data from all six groups and indicate mean likelihood of replying to the text messages “HI” and “ASAP” as a function of delay until destination. The figure also displays the percentage difference from “ASAP” to “HI” at each delay.

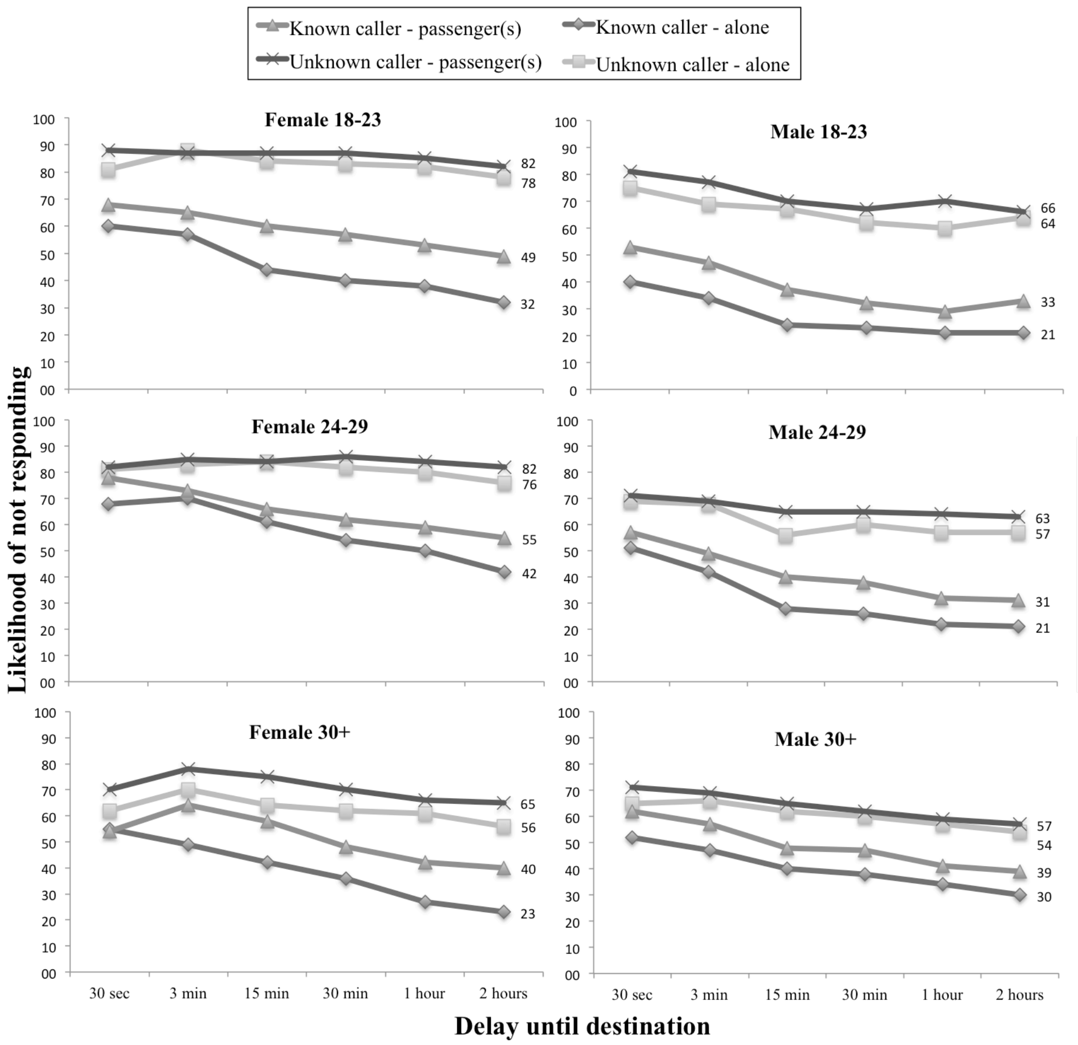
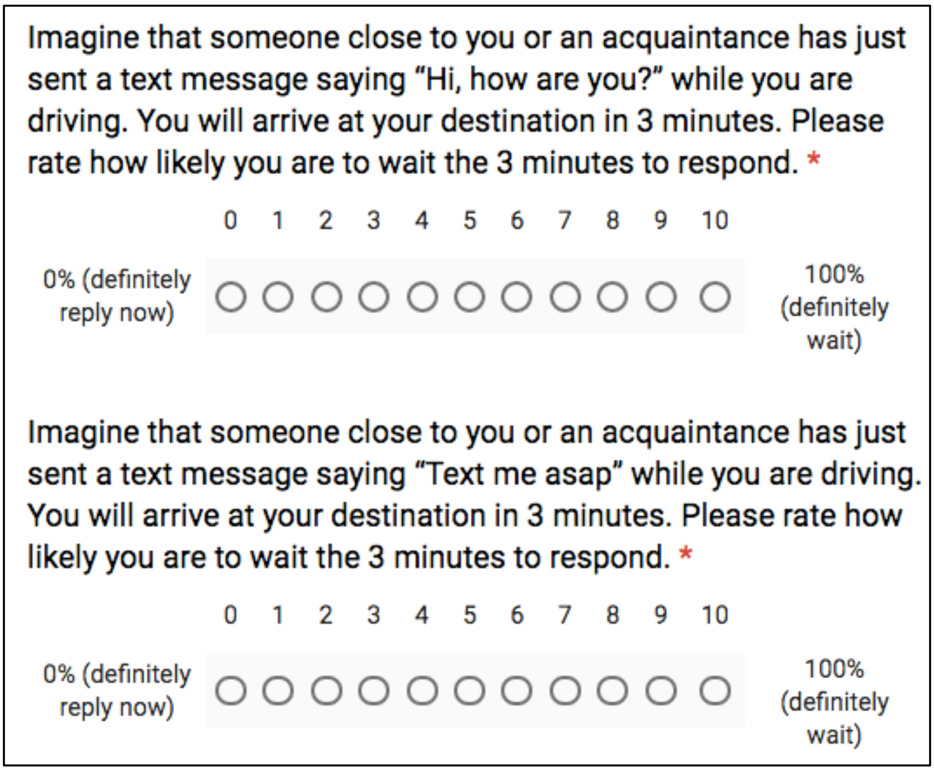


Figure 8. Delay Discounting Call Task (DDCT). The figure illustrates the participants' likelihood of not replying to a phone call as a function of delay until destination across six delays. The figure is fitted to all six groups with the four sets of conditions (see method). For complete list of values of all six delays and across the six groups, see table 5.

Appendix A



Imagine that someone close to you or an acquaintance has just sent a text message saying "Hi, how are you?" while you are driving. You will arrive at your destination in 3 minutes. Please rate how likely you are to wait the 3 minutes to respond. *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely reply now)	○	○	○	○	○	○	○	○	○	○	○	100% (definitely wait)

Imagine that someone close to you or an acquaintance has just sent a text message saying "Text me asap" while you are driving. You will arrive at your destination in 3 minutes. Please rate how likely you are to wait the 3 minutes to respond. *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely reply now)	○	○	○	○	○	○	○	○	○	○	○	100% (definitely wait)

Extract of the Delay Discounting Text Task with the delay of 3 minutes.

Appendix B

Imagine that someone close to you or an acquaintance is calling you while you are driving. You have no passengers, no handsfree but you will arrive at your destination in 30 minutes. Please rate how likely you are to reply the call. *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)	○	○	○	○	○	○	○	○	○	○	○	100% (definitely replying)

Imagine that you receive an incoming call from a unknown number while you are driving. You have no passengers, no handsfree but you will arrive at your destination in 30 minutes. Please rate how likely you are to reply the call. *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)	○	○	○	○	○	○	○	○	○	○	○	100% (definitely replying)

Imagine that someone close to you or an acquaintance is calling you while you are driving. You have passenger(s), no handsfree but you will arrive at your destination in 30 minutes. Please rate how likely you are to reply the call. *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)	○	○	○	○	○	○	○	○	○	○	○	100% (definitely replying)

Imagine that you receive an incoming call from a unknown number while you are driving. You have passenger(s), no handsfree but you will arrive at your destination in 30 minutes. Please rate how likely you are to reply the call. *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)	○	○	○	○	○	○	○	○	○	○	○	100% (definitely replying)

Extract of the Delay Discounting Call Task with the delay of 30 minutes.

Appendix C

Cellphone use in traffic - A Behavioral Economic Investigation

*Needs to be filled out

This survey will form the empirical basis for a master's thesis at Oslo Metropolitan University (former HiOA), program for Learning in Complex Systems. The aim of this survey is to map out driving behavior and especially cellphone use in traffic, as well as investigate the importance of various factors that can help explain the reason behind cellphone use while driving. It is voluntary to participate in the survey and you can at any time choose to withdraw without giving any reason. As a participant you will be completely anonymous. Although some of the questions are hypothetical scenarios, you are still asked to answer as real and precisely as possible.

The study is reported and approved by the Norwegian Centre for Research Data

1. **Consent to participation** *

☐ I have received information about the study and I am willing to participate

Demographic part

2. **Gender** *

◯ Male
◯ Female

3. **Age** *

____

4. **Years of higher education (after High School)** *

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- Other: ____________

5. **Years with driver´s license** *

____

6. **Driving your own car?** *

- Yes
- No

7. **About how many days in average do you drive a car per month?** *

____

8. **Have you been driving the last 30 days?** *

- Yes
- No

Cell phone use

9. **During the past 30 days, on how many days did you initiate a text (text, messenger etc) while driving?***

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- Other: ____________

10. **During the past 30 days, on how many days did you read a text (text, messenger etc) while driving?** *

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- Andre: ____________

11. **During the past 30 days, on how many days did you replied a text (text, messenger etc) while driving?** *

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- Andre: ____________________

Driving behavior

12. **I use safety belt while I´m driving:** *

- Never
- Rare
- Occasionally
- Often
- Always

13. **I use safety belt when I´m a passenger:** *

- Never
- Rare
- Occasionally
- Often
- Always

14. **The quality of my driving is:** *

- Bad
- Decent
- Good
- Very good
- Exemplary

15. **Who are you most likely to call while driving?** *

- Friend
- Girlfriend/Boyfriend/Spouse
- Parent
- Child (if child)
- Boss or others at work
- Others

16. **Who are you most likely to text while driving?** *

- Friend
- Partner/cohabitant/spuse
- Parent
- Child (if child)
- Boss or others at work
- Others

17. **I´m texting while driving** *

	1	2	3	4	5	6	7	
Never								Always

Perceived risk

To what extent do you think the following activities are risky for a driver:

18. **Writing a text or email** *

	1	2	3	4	5	6	7	
Not at all								To a very high degree

19. **Talking on the phone (no handsfree)** *

	1	2	3	4	5	6	7	
Not at all								To a very high degree

20. **Talking on the phone (with handsfree)** *

	1	2	3	4	5	6	7	
Not at all	⬭	⬭	⬭	⬭	⬭	⬭	⬭	To a very high degree

21. **Scrolling social media (Facebook, Instagram etc.)** *

	1	2	3	4	5	6	7	
Not at all	⬭	⬭	⬭	⬭	⬭	⬭	⬭	To a very high degree

22. **Eating or drinking** *

	1	2	3	4	5	6	7	
Not at all	⬭	⬭	⬭	⬭	⬭	⬭	⬭	To a very high degree

23. **Reading news online** *

	1	2	3	4	5	6	7	
Not at all	⬭	⬭	⬭	⬭	⬭	⬭	⬭	To a very high degree

24. **Using the radio/CD** *

	1	2	3	4	5	6	7	
Not at all	⬭	⬭	⬭	⬭	⬭	⬭	⬭	To a very high degree

Delay discounting task (text)

In this section of the survey, your are asked to rate your probability of waiting to respond to an incoming text message (text, messenger, etc.) until you reach your destination. Note that the time until destination will vary. You are asked to answer as honestly and accurate as possible.

25. **Imagine that someone close to you or an acquaintance has just sent a text message saying "Hi, how are you?" while you are driving. You will arrive at your destination in 30 s. Please rate how likely you are to wait the 30 s to respond.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely reply now)	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	⬭	100% (definitely wait)

26. **Imagine that someone close to you or an acquaintance has just sent a text message saying "Text me asap" while you are driving. You will arrive at your destination in 30 s. Please rate how likely you are to wait the 30 s to respond.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely reply now)												100% (definitely wait)

27. **Imagine that someone close to you or an acquaintance has just sent a text message saying "Hi, how are you?" while you are driving. You will arrive at your destination in 3 minutes. Please rate how likely you are to wait the 3 minutes to respond.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely reply now)												100% (definitely wait)

28. **Imagine that someone close to you or an acquaintance has just sent a text message saying "Text me asap" while you are driving. You will arrive at your destination in 3 minutes. Please rate how likely you are to wait the 3 minutes to respond.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely reply now)												100% (definitely wait)

29. **Imagine that someone close to you or an acquaintance has just sent a text message saying "Hi, how are you?" while you are driving. You will arrive at your destination in 15 minutes. Please rate how likely you are to wait the 15 minutes to respond.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely reply now)												100% (definitely wait)

30. **Imagine that someone close to you or an acquaintance has just sent a text message saying "Text me asap" while you are driving. You will arrive at your destination in 15 minutes. Please rate how likely you are to wait the 15 minutes to respond.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely reply now)												100% (definitely wait)

31. **Imagine that someone close to you or an acquaintance has just sent a text message saying "Hi, how are you?" while you are driving. You will arrive at your destination in 30 minutes. Please rate how likely you are to wait the 30 minutes to respond.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely reply now)												100% (definitely wait)

32. **Imagine that someone close to you or an acquaintance has just sent a text message saying "Text me asap" while you are driving. You will arrive at your destination in 30 minutes. Please rate how likely you are to wait the 30 minutes to respond.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely reply now)												100% (definitely wait)

33. **Imagine that someone close to you or an acquaintance has just sent a text message saying "Hi, how are you?" while you are driving. You will arrive at your destination in 1 hour. Please rate how likely you are to wait 1 hour to respond.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely reply now)												100% (definitely wait)

34. **Imagine that someone close to you or an acquaintance has just sent a text message saying "Text me asap" while you are driving. You will arrive at your destination in 1 hour. Please rate how likely you are to wait 1 hour to respond.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely reply now)												100% (definitely wait)

35. **Imagine that someone close to you or an acquaintance has just sent a text message saying "Hi, how are you?" while you are driving. You will arrive at your destination in 2 hours. Please rate how likely you are to wait the 2 hours to respond.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely reply now)												100% (definitely wait)

36. **Imagine that someone close to you or an acquaintance has just sent a text message saying "Text me asap" while you are driving. You will arrive at your destination in 2 hours. Please rate how likely you are to wait the 2 hours to respond.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely reply now)												100% (definitely wait)

Delay discounting task (call)

In this section of the survey, your are asked to rate your probability of replying to an incoming phone call while driving rather than wait until you have arrived at your destination and call back. Note that the time until destination will vary. You are asked to answer as honestly and accurate as possible.

37. **Imagine that someone close to you or an acquaintance is calling you while you are driving. You have no passengers, no handsfree but you will arrive at your destination in 30 seconds. Please rate how likely you are to reply the call.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)												100% (definitely replying)

38. **Imagine that you receive an incoming call from a unknown number while you are driving. You have no passengers, no handsfree but you will arrive at your destination in 30 seconds. Please rate how likely you are to reply the call.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)												100% (definitely replying)

39. **Imagine that someone close to you or an acquaintance is calling you while you are driving. You have passenger(s), no handsfree but you will arrive at your destination in 30 seconds. Please rate how likely you are to reply the call.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)												100% (definitely replying)

40. **Imagine that you receive an incoming call from a unknown number while you are driving. You have passenger(s), no handsfree but you will arrive at your destination in 30 seconds. Please rate how likely you are to reply the call.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)												100% (definitely replying)

41. **Imagine that someone close to you or an acquaintance is calling you while you are driving. You have no passengers, no handsfree but you will arrive at your destination in 3 minutes. Please rate how likely you are to reply the call.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)												100% (definitely replying)

42. **Imagine that you receive an incoming call from a unknown number while you are driving. You have no passengers, no handsfree but you will arrive at your destination in 3 minutes. Please rate how likely you are to reply the call.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)												100% (definitely replying)

43. **Imagine that someone close to you or an acquaintance is calling you while you are driving. You have passenger(s), no handsfree but you will arrive at your destination in 3 minutes. Please rate how likely you are to reply the call.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)												100% (definitely replying)

44. **Imagine that you receive an incoming call from a unknown number while you are driving. You have passenger(s), no handsfree but you will arrive at your destination in 3 minutes. Please rate how likely you are to reply the call.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)												100% (definitely replying)

45. **Imagine that someone close to you or an acquaintance is calling you while you are driving. You have no passengers, no handsfree but you will arrive at your destination in 15 minutes. Please rate how likely you are to reply the call.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)												100% (definitely replying)

46. **Imagine that you receive an incoming call from a unknown number while you are driving. You have no passengers, no handsfree but you will arrive at your destination in 15 minutes. Please rate how likely you are to reply the call.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)												100% (definitely replying)

47. **Imagine that someone close to you or an acquaintance is calling you while you are driving. You have passenger(s), no handsfree but you will arrive at your destination in 15 minutes. Please rate how likely you are to reply the call.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)												100% (definitely replying)

48. **Imagine that you receive an incoming call from a unknown number while you are driving. You have passenger(s), no handsfree but you will arrive at your destination in 15 minutes. Please rate how likely you are to reply the call.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)												100% (definitely replying)

49. **Imagine that someone close to you or an acquaintance is calling you while you are driving. You have no passengers, no handsfree but you will arrive at your destination in 30 minutes. Please rate how likely you are to reply the call.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)												100% (definitely replying)

50. **Imagine that you receive an incoming call from a unknown number while you are driving. You have no passengers, no handsfree but you will arrive at your destination in 30 minutes. Please rate how likely you are to reply the call.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)												100% (definitely replying)

51. **Imagine that someone close to you or an acquaintance is calling you while you are driving. You have passenger(s), no handsfree but you will arrive at your destination in 30 minutes. Please rate how likely you are to reply the call.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)												100% (definitely replying)

52. **Imagine that you receive an incoming call from a unknown number while you are driving. You have passenger(s), no handsfree but you will arrive at your destination in 30 minutes. Please rate how likely you are to reply the call.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)												100% (definitely replying)

53. **Imagine that someone close to you or an acquaintance is calling you while you are driving. You have no passengers, no handsfree but you will arrive at your destination in 1 hour. Please rate how likely you are to reply the call.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)												100% (definitely replying)

54. **Imagine that you receive an incoming call from a unknown number while you are driving. You have no passengers, no handsfree but you will arrive at your destination in 1 hour. Please rate how likely you are to reply the call.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)												100% (definitely replying)

55. **Imagine that someone close to you or an acquaintance is calling you while you are driving. You have passenger(s), no handsfree but you will arrive at your destination in 1 hour. Please rate how likely you are to reply the call.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)												100% (definitely replying)

56. **Imagine that you receive an incoming call from a unknown number while you are driving. You have passenger(s), no handsfree but you will arrive at your destination in 1 hour. Please rate how likely you are to reply the call.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)												100% (definitely replying)

57. **Imagine that someone close to you or an acquaintance is calling you while you are driving. You have no passengers, no handsfree but you will arrive at your destination in 2 hours. Please rate how likely you are to reply the call.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)												100% (definitely replying)

58. **Imagine that you receive an incoming call from a unknown number while you are driving. You have no passengers, no handsfree but you will arrive at your destination in 2 hours. Please rate how likely you are to reply the call.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)												100% (definitely replying)

59. **Imagine that someone close to you or an acquaintance is calling you while you are driving. You have passenger(s), no handsfree but you will arrive at your destination in 2 hours. Please rate how likely you are to reply the call.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)												100% (definitely replying)

60. **Imagine that you receive an incoming call from a unknown number while you are driving. You have passenger(s), no handsfree but you will arrive at your destination in 2 hours. Please rate how likely you are to reply the call.** *

	0	1	2	3	4	5	6	7	8	9	10	
0% (definitely not replying)												100% (definitely replying)

61. **What statement does best describe the reason why you are using the mobile while driving?** *

- I get satisfied
- I cannot resist
- I am cellphone dependent
- I am using the phone to play music
- Boredom
- Must have something to do
- Using the phone if I receive a message or an incoming call
- I never use the cellphone while driving
- Other