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Texting while driving, executive function, and impulsivity in college students

Yusuke Hayashi[a,*], Esteban A. Rivera[a], James G. Modico[a], Anne M. Foreman[b], Oliver Wirth[b]

[a] Pennsylvania State University, Hazleton, 76 University Drive, Hazleton, PA 18202, USA
[b] National Institute for Occupational Safety and Health, 1095 Willowdale Rd, Morgantown, WV 26505, USA

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ABSTRACT

The purpose of the present study was to investigate the cognitive processes underlying texting while driving. A sample of 120 college students completed a survey to assess how frequently they send and read a text message while driving. Based on this information, students were assigned to one of two groups: 20 students who frequently text while driving and 20 matched-control students who infrequently text while driving but were similar in gender, age, years of education, and years driving. The groups were compared on the extent to which they differed in self-reported measures of executive function and impulsivity. The groups were also compared on a behavioral measure of impulsivity: the extent to which they discounted hypothetical monetary rewards as a function of the delay. For this measure, the students made repeated choices between smaller monetary rewards available immediately and larger rewards available after delays ranging from 1 week to 6 months. The results show that the group of students who frequently text while driving showed (a) significantly lower levels of executive function and (b) higher levels of self-reported impulsivity, although the groups did not differ significantly on the behavioral measure of impulsivity. These results support a general conclusion that drivers with lower levels of executive function and higher levels of impulsivity are more likely to text while driving.

1. Introduction

In 2014 in the United States, 3179 people were killed and an estimated additional 431,000 people were injured in motor vehicle crashes caused by distracted driving (National Highway Traffic Safety Administration [NHTSA], 2016). The NHTSA (2014) defined distracted driving as driving with drivers' attention away from the driving task to focus on another activity. Distracted driving can be visual or sensory (e.g., looking away from the roadway), manual (e.g., taking a hand off the steering wheel and manipulating a device or object), or cognitive (e.g., thinking about something other than driving), all of which increase the risk of a motor vehicle crash (NHTSA, 2014). It is estimated that, in 2010, the total economic costs associated with motor vehicle crashes due to distraction in the United States were at least $40 billion (Blincoe et al., 2015).

Texting while driving involves all three types of distractions discussed (Sherin et al., 2014). The National Safety Council (2015) estimated that, in 2013, 6–16% of motor vehicle crashes, or 341,000 to 910,000 crashes, in the United States are likely attributable to text messaging. Despite its danger, 31.2% of drivers aged 18–64 years in the United States reported that they had read or sent text messages while driving in the past 30 days, and in seven European counties surveyed, the percentages ranged from 15.1% in Spain to 31.3% in Portugal (Centers for Disease Control and Prevention, 2013). Texting while driving is particularly pervasive among young drivers. In the United States, for example, 74–92% of college students surveyed reported they engage in texting while driving (Atchley et al., 2011; Cook and Jones, 2011; Harrison, 2011).

To predict who is most likely to text while driving, previous research has identified various psychological factors associated with this risky behavior. These factors can be grouped into four broad categories: (a) attitude, tendency, and intention toward mobile phone use, (b) risk perception and risk tendency, (c) impulsivity and lack of self-control, and (d) emotional regulation. Each of these will be discussed below.

Previous research has found a positive correlation between the self-reported frequency of texting while driving and several attitudes, tendency, and intention toward mobile phone use. These

* Corresponding author at: Division of Social Sciences and Education, Pennsylvania State University, Hazleton, 76 University Drive, Hazleton, PA 18202, USA.
E-mail address: yuh26@psu.edu (Y. Hayashi).

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include cell phone dependency (Struckman-Johnson et al., 2015), perceived need for a mobile phone while driving (Musicant et al., 2015), tendency to automatically engage in texting (Bayer and Campbell, 2012; Panek et al., 2015), and intention to text while driving (based on the theory of planned behavior; Benson et al., 2015; Nemme and White, 2010; Prat et al., 2015). As expected, those who are dependent on a mobile phone and those who have high need or intention to text while driving tend to engage in texting while driving more frequently.

The second category is individuals' perceived risk of texting while driving and risk tendency. In general, there is a negative correlation between risk perception and tendency and frequency of texting while driving, but the relation is moderated by gender. Struckman-Johnson et al. (2015) investigated gender differences in psychological predictors of texting while driving and found that, for male college students, higher perceived texting distractibility (how distracted they are from driving when they text) was significantly associated with a lower frequency of texting while driving, whereas, for female students, higher risky behavior tendencies were significantly associated with a lower frequency of texting while driving.

The third category is the personality trait of impulsivity. Here, impulsivity refers to "a tendency to act on a whim and, in so doing, disregards a more rational long-term strategy for success" (Madden & Johnson, 2010, p. 11). It is synonymous with lack of self-control. Several studies have found a significant correlation between texting while driving and self-reported measures of impulsivity and self-control (Lantz and Loeb, 2013; Panek et al., 2015; Quisenberry, 2015; Struckman-Johnson et al., 2015; see also Bıçaksız and Özkan, 2016, for review on impulsivity and other driving behaviors). Using a *delay discounting* paradigm, Hayashi et al. (2015) compared the extent to which students, who frequently or infrequently text while driving, discounted the subjective value of hypothetical delay monetary rewards. They found that students who frequently texted while driving were more impulsive as measured by the delay discounting task. In a subsequent study by Hayashi et al. (2016) using a hypothetical texting while driving scenario, impulsivity was measured by delay discounting of both monetary and social rewards (i.e., opportunities to reply to a text message). Consistent with the previous study, students who frequently texted while driving were more impulsive, only with the social reward.

Finally, the fourth category is the ability to regulate negative emotions. Pearson et al. (2013) found that the personality trait of negative urgency, which refers to "the tendency to act impulsively when experiencing negative affect" (p. 142), was a significant predictor of frequency of texting while driving in college students: the higher the negative urgency, the greater the frequency of texting while driving. They also found that the trait of positive urgency, which refers to "behaving impulsively when experiencing positive affect" (p. 142), was a significant predictor of some driving outcomes (e.g., traffic citation) but not of texting while driving. Similarly, Feldman et al. (2011) and Panek et al. (2015) investigated a relation between the frequency of texting while driving and individual differences in the personality trait of *mindfulness*. Mindfulness refers to the awareness that emerges through paying attention to particular experiences in the present moment (Kabat-Zinn, 2003) and is associated with abilities to regulate emotions (Feldman et al., 2007). Studies show that students who are low in mindfulness are more likely to text while driving (Feldman et al., 2011; Panek et al., 2015).

Although previous studies have made progress in identifying who is more likely to text while driving, the behavioral, cognitive and neurological processes underlying drivers' decision to read and send text messages while driving are not well understood. For example, one hallmark of texting while driving is that drivers engage in texting while driving despite awareness of its negative consequences (Atchley et al., 2011). The decision-making process underlying this impulsive behavior warrants further investigation (cf. Hayashi et al., 2015). As an initial step, the identification of cognitive and neurological factors that are relevant to the underlying processes of texting while driving is of great importance. One potential candidate is *executive function*.

Executive function is defined as "cognitive abilities for adaptive functioning, allowing for behavior that is more goal-oriented, flexible, and autonomous" (Spinella, 2005). These abilities are said to be "executive" because they are essential for the integration and processing of the information obtained from a wide range of internal and external experiences (Christ et al., 2011). Although researchers have yet to identify a definitive list of components of executive function (Schmeichel and Tang, 2015), it is presumed to encompass cognitive processes, such as inhibition, planning, switching, self-monitoring, self-regulation, attention, and working memory, that are carried out by prefrontal areas of the frontal lobe (Goldstein et al., 2014).

Previous research has shown that executive function is inversely associated with addictive disorders, such as substance abuse (Goldstein and Volkow, 2011) and pathological gambling (e.g., Reid et al., 2012) as well as various impulsivity-related problems, such as obesity (e.g., Smith et al., 2011), internet addiction (e.g., Zhou et al., 2014), texting dependency (Ferraro et al., 2012), and hypersexual behavior (e.g., Reid et al., 2010). If texting while driving shares some key features with these addictive, risky, and impulsive behaviors, executive function should also be an important factor in understanding the cognitive mechanism that underlies texting while driving.

With respect to driving behavior, previous research has demonstrated a strong link between executive function and driving behaviors other than texting while driving. For example, lower levels of executive function were associated with poorer simulated and on-road driving performance (Adrian et al., 2011; Guinosso et al., 2016; Mäntylä et al., 2009). Similarly, a group of older drivers who had three or more motor vehicle crashes in the last 5 years showed lower levels of executive function than the control group with no history of crashes (Daigneault et al., 2002). In addition, drivers who had been caught for speeding by the police and drivers who lost points due to traffic violation showed lower levels of executive function than non-offenders (León-Domínguez et al., 2016; O'Brien and Gormley, 2013). Interestingly, however, higher levels of executive function, as measured by a working memory task, were associated with higher levels of self-reported risky driving in adolescent drivers (Starkey and Isler, 2016). Starkey and Isler reasoned that higher levels of executive function, such as better attention or memory capacity, may actually increase drivers' risk taking because these individuals may feel confident about dealing with unplanned or unforeseen consequences (Patrick et al., 2008).

Taken together, previous research suggests that executive function should be an important factor in understanding the cognitive and neurological mechanism that underlines texting while driving. Despite its potential significance, a relation between executive function and texting while driving has received little empirical attention. One notable exception is Pope et al. (2017), in which lower levels of executive function were related to a higher frequency of distracted driving in young, middle age and older drivers. It is important to note, however, that Pope et al. (2017) averaged data from multiple behaviors (e.g., drinking, eating, talking, using a GPS, and texting) and employed a general index of distracted driving as a dependent variable. Although all of these behaviors are distracting, the cognitive mechanism underlying these behaviors may differ. In addition, the frequency of each behavior may also differ. For example, those who frequently engage in voice calls while driving may not text while driving. Therefore, it is still important