Distortion and Distraction During Cognitive Control

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Distortion and Distraction during Cognitive Control

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Abstract

The ability to determine that some outcomes are generated by actions completed by the self is the sense of self-agency. This study tested the effects of distractions, such as texting, and distortion effects, such as visual impairment, on participants' self-agency. Participants were randomly assigned to one of three groups: a control group, a text message group, and a drunk group during a computer task. The drunk group wore goggles that simulate the effects of .08- .15 BAC. The texting group read text style message, and then read them back to the experimenter at a later point during the task. The control condition wore safety goggles. All three groups were asked to perform the same task; they were presented a screen with four letters and asked to move the letters using a game controller joy stick. The control condition was able to correctly guess the letter they were controlling, as well as the random letter, at a statistically significant rate. Drunk condition participants, although significantly worse than the control group, were able to choose the control and random letters at rates significantly above chance levels. The texting group was able to choose they letter they were controlling at a rate above chance that is statistically significant. However, when asked which letter was moving randomly, the participants in the texting condition did not choose correctly at a rate above chance that is statistically significant. These findings lead to implications about the effects of texting and alcohol on driving.

Distortion and Distraction during Cognitive Control

The ability to determine that some outcomes are generated by actions completed by the self is the sense of self-agency. This ability allows individuals to understand and monitor the relationship between plans of action, sensorimotor information, and the outcome perceived as a result of action. To be able to monitor mental states and outcomes generated by the self, one must have a concept of self (Couchman, 2015). Humans are not the only species with this ability. Studying rhesus macaques, Couchman (2012; 2015) determined that even these monkeys can distinguish between event outcomes that they control, and those which they do not. This knowledge of agentic control, leads to a conclusion that macaques, like humans, must have a level of self-awareness. They recognize that they are separate entities from the environment of which they are a part.

Rhesus macaques also prefer circumstances in which they can exert control over the outcomes (Jensen et al., 2013). Monkeys in the experiment by Jensen et al. (2013) preferred objects that they could control, which would ultimately result in predictable outcomes. Two male macaques were presented with layouts with two target regions, each possessing targets all of the same color. If a ball collided with a target of the same color, the macaques were rewarded with a food pellet, and if the ball and target were of different colors, there was no food reward and a five second timeout. Only the red ball could actually be controlled by the subject pushing or dragging it across the screen with a finger, which then collided with another color ball. The blue ball was a control or predictable ball that moved in the direction and at the angle of impact from which it was hit with the red cue ball. The macaques were more inclined to choose the predictable ball to hit toward the target suggesting that they understand that their actions have consequences. They also prefer the predictability of outcomes within their control.

Humans tend to be more aware of self-agency when their perception of the normal order of cause and effect is disrupted. When the performance of an action and the perceived outcome do not fit expectations, humans tend to be confused by the discrepancy, which is a direct indication of their knowledge of self-agency. They are influenced by thoughts from which inferences are made about expectations, the consistency between expectations and outcomes, and any hypotheses they make about other possible causes of the event (Wegner, 2002). Sensorimotor and perceptual cues may also influence thoughts about self-agency (Couchman et al. 2012; Repp & Knoblich 2007). A common example of this phenomenon is in multi-player videogames. In these, players must continuously identify the actions they make to control their avatar, while other players make similar distracting actions around them. Video games may help inhibit distracting information, and increase visual attention (Spence & Feng, 2010). Pacherie (2012) noted that these cues are also what help guide orchestral performances and other cooperative activities in which one must pay attention to their particular part and ignore the distraction of the others around them that could influence their activity. Self-agency is thought to be a kind of metacognition (Metcalfe & Greene, 2007), as well as an important factor for self-awareness (Kircher & Leube, 2003). Tasks involving self-agency require both bodily and sensorimotor information, which is tapped by mirror-recognition, and uses self-monitoring to guide behavior, identify events controlled by the self, and make decisions similar to those involved in metacognitive tasks.

There is some understanding of the neural processes involved in self-agency in addition to the cognitive understanding. Ridderinkof et al., (2004) discusses that the posterior medial frontal cortex is used to monitor performance and mediates goal directed behavior. It also has both direct and indirect projections to moto areas that help bring the sensorimotor information into cognitive awareness (Matsumoto and Tanaka, 2004).

The pre-frontal cortex, in several studies, has been suggested to have a role in monitoring motor and processing actions (Averbeck et al. 2002; Luu et al. 2000). A recent study by Desmurget et al., (2009) showed that in the inferior parietal regions higher levels of electrical impulse stimulation induce participants to believe they have acted even when no motor movement took place. Premotor cortex stimulations, similar to those in the inferior parietal cortex, produce unconscious motor movements; suggests that the parietal cortex may have a role in self-monitoring and judging whether actions are self-generated. PET scan examinations also look at the role of the cerebellum and there is evidence it receives motor command information and compares the information to the observed sensory outcomes (Blakemore et al., 2001). The process of comparing intention to outcome may be accounted for by this information.

Self-agency may be hindered by distractions, such as texting and social media, or by substances that may cause distortions in sensation or perception such as alcohol. Technology has yielded increasing levels of split attention in humans as constant access to information has facilitated the capacity to complete multiple tasks simultaneously. However, the division of attention tends to be detrimental to the performance or attention given to either one or all of the engaged tasks. This tends to be a problem, because most people overestimate their ability to multitask, and underestimate the effect multitasking has on their attention of the tasks (Finley et al., 2014). The use of technology to split attention has become extremely prevalent with texting, as it yields immediate conversational results with little effort. Lopresti-Goodman et al. (2012) tested participants' abilities to navigate through doorways while distracted. Participants were much better at determining doorway width and their ability to pass through without adjusting their shoulders to fit when not distracted. However participants who were texting while walking were less likely to adjust and turn their bodies to fit through smaller doorframes. Texters would often adopt compensatory strategies, such as walking more slowly and trying to be more cautious. This suggests that while they were still in control of their own actions, they were less aware of outside factors.

Alcohol also hinders people's cognitive abilities. The neuropsychological effects of alcohol are especially strong to developing brains (Gonzalez-Iglasias et al., 2014). Alcohol may also lead to higher impulsivity and lower inhibitions, particularly in younger people (Gonzalez-Iglasias et al., 2014). The *Attitudes on Drinking and Driving Scale* was used to assess participants' positive attitudes toward drinking and driving. Using the *Self-efficacy in avoiding a Dui Behavior* and the *Perceived driving Self-efficacy* scales, participants were evaluated on their perceived control. Finally, their use of alcohol was assessed with the *Alcohol Use Disorders Identification Test*. Males were the participants more likely to engage in drunk driving behavior, and perceived less disapproval from friends and family members. Males also felt as though they were less able to avoid these situations than females. These perceived attitudes of friends and perceived lack of alternatives often lead to males reporting higher levels of DUI behavior; however, they also report higher levels of alcohol use which is also a contributing factor. Both texting and alcohol have well known hindering effects on a person's ability to drive a car. A study done by Strayer, Drews, and Frank (2006) found that both texting and drinking, while qualitatively different from each other, are equally impairing to a person's ability to drive. So while the individual effects of the impairments are different, they are equally detrimental.

The current study seeks to test the influences visual distortions, and cognitive distractions have on an individual's cognitive control, extending the type of study done by Couchman (2015) to human subjects who were either operating normally, visually distracted in a way that mimicked texting, or visually distorted in a way that mimicked alcohol intoxication. We predicted that, under normal circumstances, humans would be able to identify their own actions – using self-agency information – and also random environmental actions that they did not directly cause (using visual cues alone). In simulated texting we predicted that there would be a decrease in awareness of environmental actions, and in simulated drunkenness an overall decrease in awareness.

Method

Participants

Participants were solicited from psychology classes at Albright College in exchange for extra credit. There were 60 participants (N=60); 9 males, 51 females randomly assigned into three groups. Ages ranged from 18-23, with a mean of 19.62.

Procedure

This study was conducted to determine self-agency using three groups: A control group, a text message group, and a drunk group, during a computer task. All three groups were asked to perform the same task; they were presented a screen with four letters and asked to move the letters using a game controller joystick. One letter moved exactly as they did, one letter moved in a pattern that was completely random, and the other two were distractors moving opposite the control letter (one moved opposite on the x-axis, and the other was opposite on both the x- and y-axes.) All letters were, in some sense, controlled by the participant: they moved when the participant moved, they covered the same distance on the screen, they overlapped each other when their movement patterns dictated, and visually they were identical in every way. The only differences were that the self-controlled letter followed participants' directional movements exactly, while the distractors only partially did so, and the randomly moving letter did not follow the participants' directional movements in any way (except when incidental). Couchman (2012, 2015) showed that this manipulation successfully produced strong feelings of self-agency for the self-controlled letter, and far less for the other types.

After being given 3 seconds to move the letters, participants were asked to identify either the letter they were controlling, or the one that was moving randomly using only the visual cues from the screen. Importantly, they were not cued to pick one or the other until after the movement phase, so that correct performance depended on them identifying both during that phase. Figure 1 shows a diagram of one possible trial in this paradigm. The letters, colors, and positions changed each trial. Participants each completed 64 trials, in 8-trial blocks with each block containing 4 trials in which they were asked to identify their own actions and 4 in which they were asked to identify the randomly moving letter. Trial type was randomly distributed within each block.

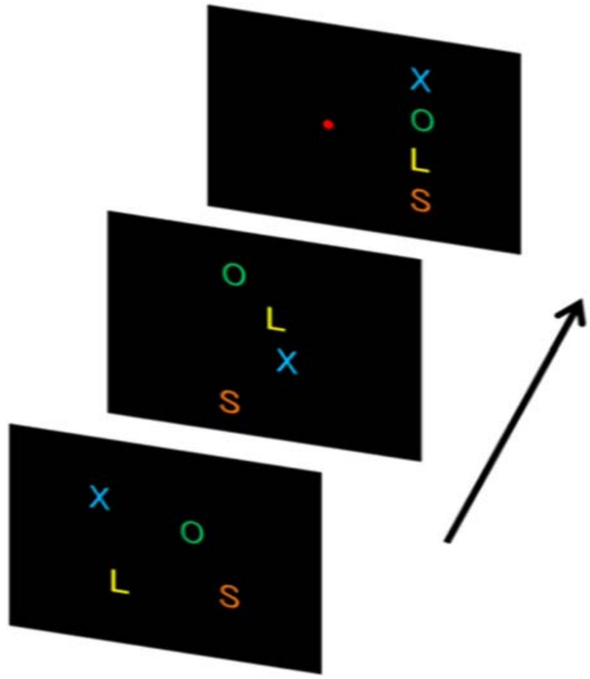

Figure 1. An example trial in the task. The first panel shows the letters, randomly distributed on the screen. The second panel shows one possible arrangement after the movement phase. The third panel shows the choice screen, in which participants used the red cursor to select the letter they had just been controlling or the one that was moving randomly. On the third panel, a cue would be given to the participant to pick either the cursor they were controlling or the one moving randomly (not shown).

The control group followed these procedures with no distractions or distortions, but did wear clear safety goggles to control for the confounding variable that wearing any kind of eyewear would impact the task. The texting group was asked to read text message phrases held up next to the screen, and read them back to the investigator while they were being asked to identify either the control or random letter. The drunk condition was assigned to wear vision impairment goggles that simulated a .08- .15 Blood Alcohol Content (BAC).

Results

As shown in Figure 2, the control group was able to correctly identify the letter they were controlling $\chi^2(3, N = 60) = 429.0$, $p < .001$, as well as the random letter $\chi^2(3, N = 60) = 52.0$, $p < .001$, at a rate above chance that is statistically significant.

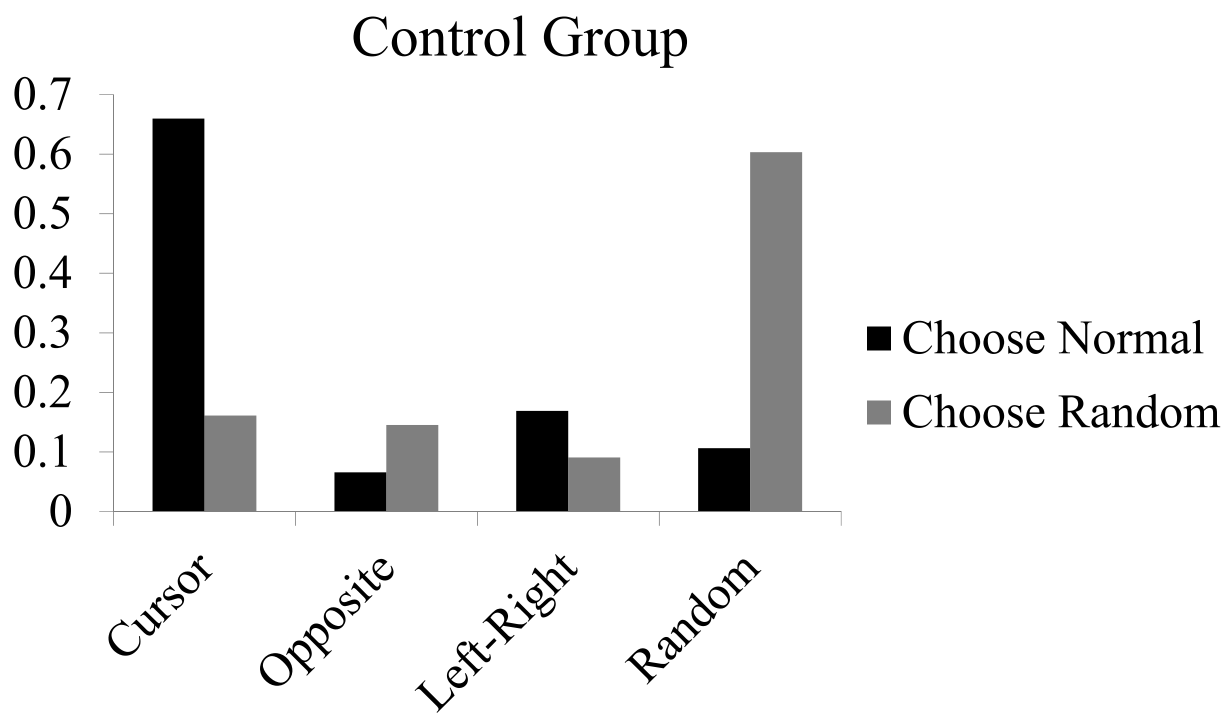

Figure 2. Black bars indicate the rate (proportion) at which the control group correctly chose the (self-controlled) Cursor or the distractors. Grey bars indicate the rate at which the control group correctly chose the Random cursor or the others

They also did not significantly choose the wrong letter in either type of trial, participants chose the incorrect letters at well below chance levels. Figure 3 shows how participants in the drunk condition followed the same pattern as the control. They were also able identify the correct letter that they were controlling $\chi^2(3, N = 60) = 216.0$, $p < .001$ and that was moving randomly $\chi^2(3, N = 60) = 58.0$, $p < .001$ at a rate that is statistically significant. However, the rate of correct guesses was much lower than for the control group (see below). Their rate of choosing the wrong letter was also significantly lower than chance.

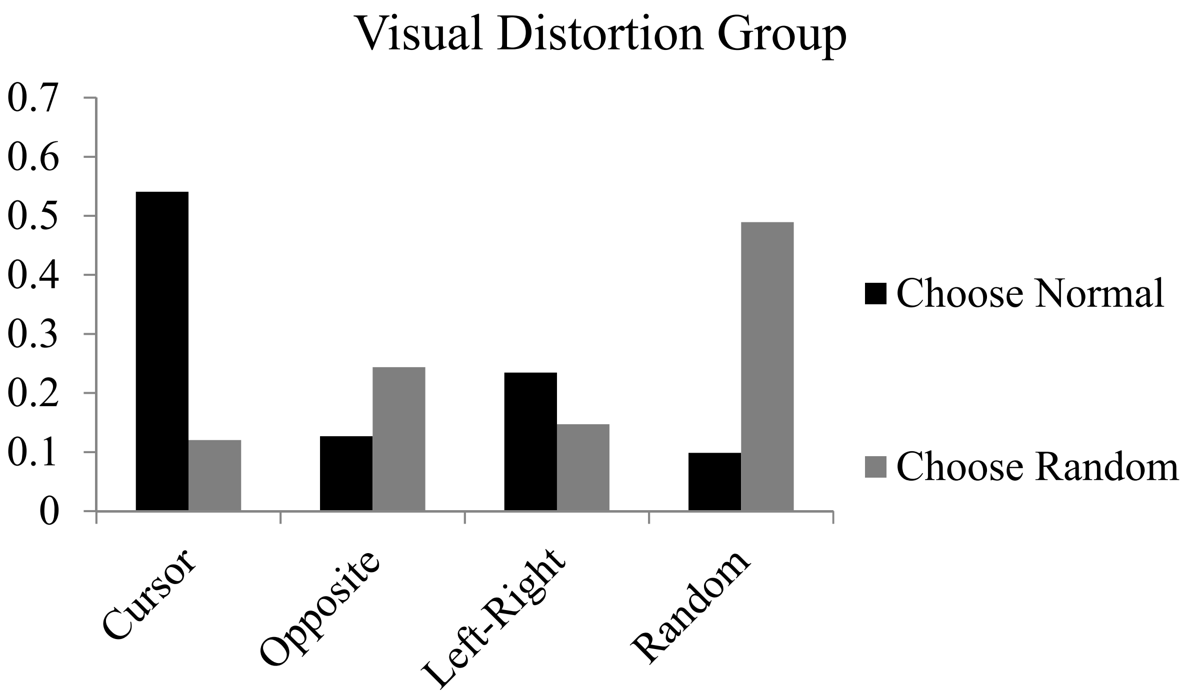

Figure 3. Black bars indicate the rate (proportion) at which the visual distortion group correctly chose the (self-controlled) Cursor or the distractors. Grey bars indicate the rate at which the visual distortion group correctly chose the Random cursor or the others

Figure 4 indicates that the texting group was able to choose they letter they were controlling at a rate above chance that is statistically significant, $\chi^2(3, N = 60) = 336.0$, $p < .001$. However, when asked which letter was moving randomly, the participants in the texting condition did choose correctly at a rate above chance that is statistically significant, $\chi^2(3, N = 60) = 40.0$, $p < .001$ although it was at a low level. This suggests the participants in the texting condition had a more difficult time identifying the random letter.

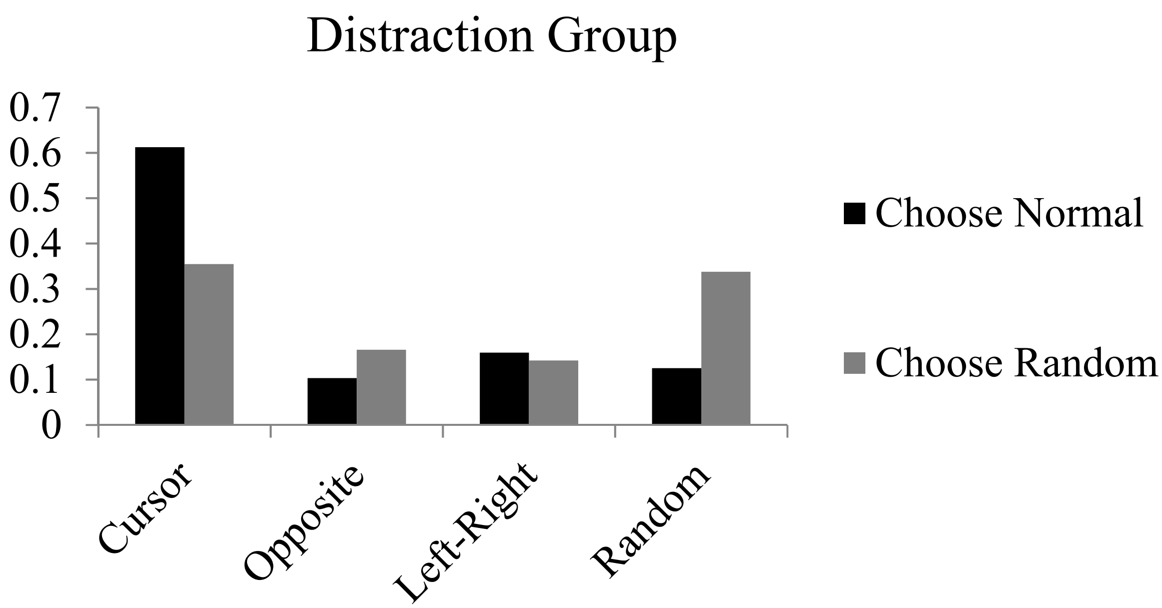

Figure 4. Black bars indicate the rate (proportion) at which the distraction group correctly chose the (self-controlled) Cursor or the distractors. Grey bars indicate the rate at which the distraction group correctly chose the Random cursor or the others

A one-way independent ANOVA on both self-controlled and random letter types was conducted to illustrate the differences between conditions. Overall there was a significant effect of condition, $F(2,1917) = 9.7$, $p < .001$, and Tukey's HSD tests ($p < .05$) showed that participants in the control and texting conditions had higher accuracy than the drunk. Control and testing groups did not differ from each other. There was also a significant effect of condition on selecting the random cursor, $F(2,1917) = 47.8$, $p < .001$, and Tukey's HSD tests ($p < .05$) showed that the control group was more accurate than the drunk group, which was in turn more accurate than the texting group.

Thus, as predicted, simulated drunkenness resulted in lower accuracy overall, while simulated texting resulted in less awareness (lower accuracy) for externally controlled items but not for self-controlled items. Interestingly, accuracy was lowest overall for the texting group identifying randomly moving letters – even lower than the drunk group – suggesting that texting might seriously impair the human ability to track non-self objects.

Discussion

These results showed that while the distorting effects of alcohol significantly reduced participants' abilities to identify the random and control letters, they could still identify it at levels statistically above chance. Simulating alcohol's effects diminished participant's abilities to choose letters they themselves moved, and those that moved without their direct control, correctly. One significant issue with this study, however, is that the goggles only simulated the visual effects of someone with .08-.15 BAC which we thought was appropriate given that the majority of participants are under the legal drinking age of 21. It would be very interesting to see how much the visual blurring and double vision played a part compared to the other effects of alcohol; if we had actually given people one or more alcoholic beverages and then had them play the game after a short wait, the differing brain chemistry because of the depressing effects of alcohol would probably have a greater impact on the results.

In contrast, texting had seemingly little effect on participants when they were asked to identify the letter they were controlling, but it significantly changed their ability to identify the letter moving randomly. Participants who were distracted were able to identify what was under their control, but were unable to identify things that were happening outside their control. This supports previous research, that information that may be sensed while distracted is not properly encoded. Participants often reported attempting to mainly focus on trying to identify the letter they were controlling before trying to focus on the letter moving randomly. Also, when participants got the control letter wrong, they often reported making a 50/50 guess between the control letter, and the letter that moved opposite Left/Right. This is because they often only moved the letters in one direction, which was up or down, so they had to choose between the two moving in the same direction. These results show that texting may be even more detrimental to activities with complex cognitive functions, as people often do not recognize what is going on outside their control. By splitting attention, people tend to focus on what they are splitting their attention to, and what they can control, this is why they tend to move slower, and bump into more things. The surrounding world outside their control receives far less attention. All the text messages that participants read were standard black, Times New Roman, and 12 point font. An issue with this study may have been that when people text they hold their phones a short distance from themselves. The size of the font may have been too small for participants to read quickly and comfortably. It would be interesting to see if larger font size or a different style, like Calibri have any effect on participant's abilities.

This research shows that alcohol and texting are both detrimental to a person's abilities to control their actions and thoughts. However, they have different types of effects on abilities. Alcohol diminishes all ability to function cognitively; including employing functions of self-agency, and determining occurrences outside control. This idea applies to drivers who have been drinking, as they tend to be not only less aware of their own abilities, but also of the actions going on around them. However, drunk drivers are also still somewhat aware. This is what causes greater following distances, and slower braking speeds and times (Strayer et al., 2006). However, distracted drivers, like those texting, have some increase in ability as compared to those drunk, but they have even greater diminished capabilities in other areas. Distractions allow for one to be consciously aware of things within their immediate control, so both things taking portions of attention are receiving attention, due to the conscious effort that goes into them. However what is outside the distracted person's control, random events are not coded for. This means distracted drivers may make riskier maneuvers than non-distracted drivers. The distracted drivers do not encode, the cars around them braking or changing lanes, so when they look, they do not see them. This causes distracted drivers to have to slam on their brakes as they process the information later and are more likely to cut over in lanes too close to other cars. Future directions I would like to take is to test the full effects of alcohol, by giving participants two drinks and waiting ten minutes and then having them complete the task. I would also like to try to replicate the study done by Strayer, Drews, and Frank but with texting behavior. Their study looked into how distracting talking on the phone is, I would want to not only compare distracted driving to drunk driving, but see how much more detrimental texting and driving is, because drivers must take their eyes off the road. This study would have a driving simulation where participants follow a pace car that randomly brakes in front of them. Being able to continue this research would be beneficial to help promote awareness

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