Proceedings of The National Conference
On Undergraduate Research (NCUR) 2020
Montana State University, Bozeman MT
March 26-28, 2020

Effect of Cellphones on Traffic Violations

Vicky Weaver
Psychology Department – Human Factors
The University of Utah
Salt Lake City, Utah 84112 USA

Faculty Advisor: Dr. David Strayer

Abstract

As cellphone use continues to grow in this society, there is rising concern surrounding how, and when, individuals choose to interact with this technology—particularly while driving. The concern lies in the relationship between cellphone use and on-road driving performance in a naturalistic environment. As part of General Psychology courses, thousands of students across the country to be lay observers were recruited. They were instructed to stand with a partner at 4-way intersections and track if each driver was on their cellphone and if the driver committed a traffic violation. Recruitment of lay observers allowed for a drastic increase in sample size and hypothesis testing on a much larger scale than ever before. Based on previous research indicating that cellphone use leads to detriments in driving performance, the hypothesis is that there would be a strong correlation between cellphone use and the commission of a traffic violation. In order to confirm the reliability of the lay observers, the inter-rater reliability and confirmed high reliability between each dyad of lay observers was tested. A chi-square test was performed, and it was found that commission of a traffic violation was highly dependent on cellphone use, across all times of day and locations around the country. Both the odds and the probability that a driver committed a traffic violation increased when they were on a cellphone. It is proposed that these robust findings largely reflect how an increase in cognitive workload leads to detriments in task performance. This has implications for both traffic regulation and for the manufacturing of both cellphones and vehicles.

Keywords: Distracted Driving, Human Factors, Cellphone Use

1. Introduction

The introduction of mobile telephones in the beginning of the 1980's launched an era of technological advancement that could reach the lives of billions across the globe. Almost 40 years later, the expansion of cellphones now has implications that may not have been considered at their inception. Cellphones transitioned from being almost three pounds in weight with the sole function of making phone calls (which would last about half an hour) to a device weighing a few ounces and capable of taking pictures, doing mathematical equations, surfing the web and so much more within seconds. In fact, cellphones have expanded to the point where there is now a subcategory of "smartphones". These devices are defined as, "a mobile phone that includes advanced functionality beyond making phone calls and sending text messages." [1]. In other words, the functions of these smartphones can become close to limitless. Unsurprisingly, the implications following the emergence of cellphones now permeate multiple aspects of the average human life.

Studies have been conducted connecting cellphone use to detriments in sleep, homework and education performance, and a topic that has become very popular in the media recently: driving[9]. Because cellphone use has become so prevalent in the recent past, it has become quite an unanticipated issue for traffic safety officials and lawmakers. "Don't Text and Drive" slogans are plastered across freeway billboards that include harrowing images of death related to the issue. The Department of Transportation released statistics that stated cellphones were involved in 1.6 million automobile accidents every year, with thousands of injuries and deaths included[11]. Because of the

seriousness associated with these events, researchers have begun investigating how tightly intertwined cellphone use and driving behavior are and the effects that stem from that relationship.

Cellphone use while driving can have a negative effect on driving performance due to inattention and cognitive workload[8]. Whether people use this knowledge to refrain from acting on their impulse to use their phone while driving is a topic a few researchers have tackled. In 2016, the Theory of Planned Behavior (TPB), which predicts behavior based on motivation and ability, explored the relationship between cellphones and driving[10]. The study found that familiarity with cellphones predicted whether or not an individual would engage in distracted driving behavior. For example, an individual who regarded themselves highly familiar with cellphones would be more inclined to engage in distracted behavior, whether they were aware of their inattention or not. Similarly, a separate study found that participant's beliefs surrounding cellphone use in cars predicted the level of self-regulation these individuals demonstrated[6]. In other words, if someone believed that cellphone use in cars was bad, they would refrain from using the phone in potentially distracting situations. It was also observed that cellphone use increased when the demands in the simulated driving task were low, such as when the vehicle was stopped at an intersection. Prior to the advent of smartphones, researchers at the University of Utah conducted a series of high-fidelity simulated driving studies. The researchers found that cellphone use impaired attention, memory, reaction time, and signal detection[8,9]. One of the most shocking findings from this literature was that cellphone distracted drivers were found to be comparable in risk taking to drunk drivers[7]. The aforementioned study was conducted based on the growing evidence that the risks of driving while using a cellphone were similar to that of driving with high blood alcohol levels. Drunk drivers were found to be more aggressive in their driving styles and cellphone-distracted drivers had slower reaction times and difficulty with attention within driving tasks. The results of the study added to the evidence surrounding the dangers of using a cellphone while driving.

In 2010 (three years after the release of the first iPhone), there were 62.6 million smartphone users alone in the United States according to Statista[5]. It is predicted that by 2020, smartphone users will increase to 272.6 million. Considering the estimate of licensed drivers in the United States is near the same number, a cause for serious concern arises. The relationship between interacting with cellphones of any kind and operating a vehicle has not been favorable in the past based on literature and media coverage. With the integration of smartphones now prevalent in this society, it is likely that the relationship has propagated into something even more alarming.

Beginning in 2000, a nationwide database of information regarding cellphone use and traffic violations was put into action. This database, bolstered by college students and professors, includes hundreds of thousands of observations at street intersections. On the corners of these intersections, the observational researchers studied whether drivers stopped at an intersection stop sign and whether or not they were on a cellphone. This database will be the basis of this research. The literature surrounding how smartphones have impacted driving performance has gaps that must be filled. The goal of this current study is to understand whether there has been an increase in the rate at which drivers violate traffic laws at intersections if they were operating a cellphone (either with the phone to their ear or interacting with phone in hand). This hypothesis is that the rate at which cellphone use is observed while driving increases and has a positive relationship with the commission of traffic violations. It is also hypothesized that the rate at which users are on cellphones and commit traffic violations increases over time.

2. Method

2.1 Participants

The participants in this study included anonymous surveyed drivers and the observational coders who collected the data for the nationwide database. These observational coders consisted of 2,382 students who were enrolled in an introductory level psychology course from around the United States. These coders provided the data as an assignment given in their textbook from the course[4]. The coders collected data in pairs in order to ensure accuracy of the data collection. Therefore, there were two coders for every observation collected in the database.

2.2 Materials

Instructions for data collection were provided in the textbook *Exploring Psychology* by David Myers in order to teach psychology students about the negative impact of high cognitive workload on attention[4]. The coders completed the data collection as a course assignment, and course instructors were given instructions to upload the data into a SQL database housed online. A log in was created for each instructor to access the database data entry form from their own

computer. The database has information gathered from years 2000 to 2019. However, prior to 2009 only pilot data was collected therefore the linear regression was performed using years 2009 to 2019.

2.3 Procedure

The coders were instructed to stand on the corner of a four-way, stop sign intersection with a partner. The study required that the intersection be busy enough to capture many observations in one hour, but not too busy that the coders were unable to track each car. They were instructed to take a photo of the intersection they were at in order to ensure that they actually went to an intersection and that it was of appropriate business. The coders then tallied whether each driver committed a traffic violation or not, and if they were on their cell phone or not. They were instructed to collect observations for one hour. The coders also recorded the address of their location, the city and state they were in, the time of day, and the course for which they were completing the assignment. Currently, the dataset includes 326,917 observations by 2,382 coders.

Inter-rater reliability was measured using an intra-class correlation as a way to mitigate the limitation of having non-researchers collect the data. Intra-class correlations are used for studies that have at least two coders and all observations are rated by multiple coders, which is applicable to this study's dataset. The odds and probability that a driver on their cellphone committed a traffic violation was calculated, and a chi-square test was performed to assess the relationship between cellphone use and traffic violations. To test for longitudinal effect of year, a linear regression was performed.

3. Results

Inter-rater reliability was examined using a one-way, agreement, average-measures intra-class correlation (ICC) to obtain the degree that coders agreed on their observations. There was high agreement between coders regarding the number of drivers that were on their cellphone and committed a traffic violation (ICC=0.99). Similarly, there was high agreement between coders regarding the number of drivers that were on their cellphone but did not commit a traffic violation (ICC = 0.971). The same is true for drivers who were not on cellphones and did commit a traffic violation (ICC= 0.938) and for drivers who were neither on their cellphone nor committed a traffic violation (ICC=0.965). The ICC results convey that all observations fall within the excellent range of reliability (.75 and 1.0)[2]. This means the coders largely agreed about their observations and that minimal measurement error was introduced by the untrained coders. Therefore, statistical power for the following analyses is not diminished by using untrained coders.

Table 1. Counts and Probabilities of Traffic Violations.

Cellphone Use	Traffic Violation Count	No Traffic Violation Count	Probability of Traffic Violation
Yes	17479	24491	41.6
No	77629	206320	27.3

Because IRR was high and therefore the observations were largely reliable, the average of the observations of the two coders was created for each data collection session. This allowed a calculation for a total count of each of the four conditions: on cellphone and committed a traffic violation (17,479), not on cellphone and committed a traffic violation (77,628.5), on cellphone and did not commit a traffic violation (24,491), not on a cellphone and did not commit a traffic violation (206,319.5). The table of these counts can be seen in Table 1. The odds an individual will commit a violation if they are on a cellphone is 0.714. The probability of committing a violation if the driver is on a cellphone is 0.416 or 41.6%. The probability of committing a violation if a driver is not on a cellphone is .273 or 27.3% as is

seen in Table 1. A visualization of the percentages of cellphone versus no-cellphone traffic violations was created as can be seen in Graph 1.

To reiterate, it was hypothesized that a positive correlation with cellphone use and committing a stop sign violation would be found. A chi-square test of independence was performed to test if cellphone use and stop sign violation are related to each other. A significant dependent relationship between cellphone use and commission of a traffic violation was discovered, X^2 *(1)* = 3621.2, $p < .001$. This means that the commission of a traffic violation or not is dependent on whether a driver is on their cellphone or not.

To uncover whether time caused an increase in cellphone use and traffic violation, a linear regression analysis was conducted. The results of this test indicated that while traffic violations with cellphones did increase over time, the effect was not significant ($R^2 = .19$, $F(1,9) = 2.106$, $p > .05$).

The probability of committing a violation if the driver is on a cellphone is 0.416 or 41.6%. The probability of committing a violation if the driver is not on a cellphone is 0.273 or 27.3% (Figure 1). The correlation between using a cellphone and committing a stop sign violation is .47. The correlation between using a cellphone and not committing a violation is -.30. The correlation between not using a cellphone and committing a traffic violation is -.18. Finally, the correlation between not using a cellphone and not committing a traffic violation is .117. This suggests that drivers are more likely to commit a stop sign violation if they are on a cellphone than not on a cellphone.

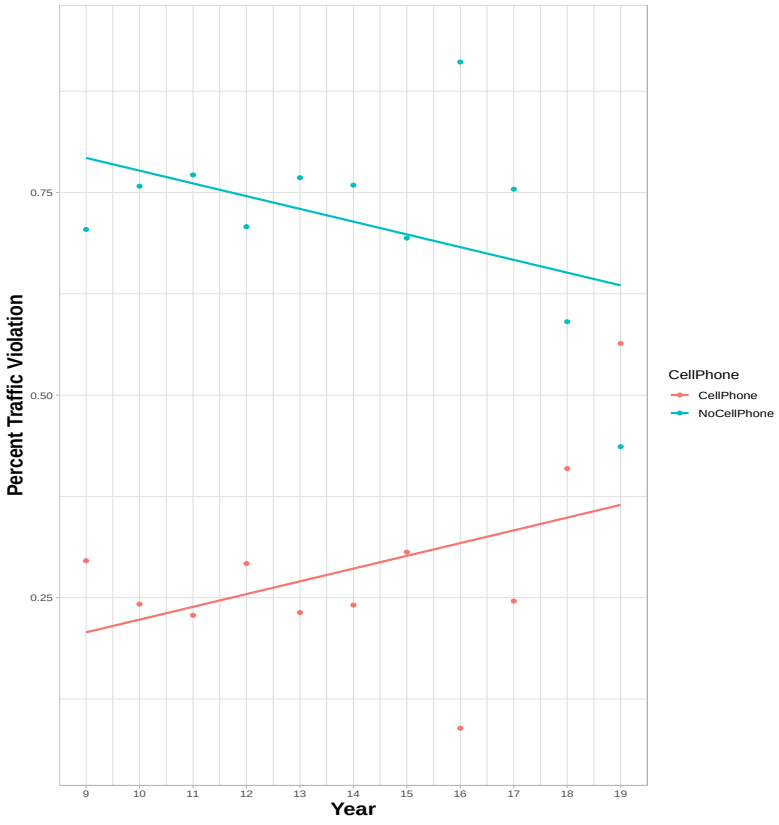

Figure 1. Graph depicting percentage of cellphone use versus no cellphone use traffic violations from 2009-2019.

4. Discussion

These results indicate that in real life circumstances, the risk of committing a traffic violation while operating a cellphone is considerably higher than when not using a cellphone. Attention researchers have hypothesized that this is due to cognitive workload increases (with the use of a cellphone), performance on the task at hand (driving) decreases[8]. Though it cannot be concluded that these are the causes of traffic violations observed in the database, there

is evidence to support the negative relationship between cellphone use and driving performance in the ever-evolving literature. With the dataset including hundreds of thousands of observations from all over the nation, this support contains significant implications.

Traffic laws have been implemented based on scientific research behind seatbelt use, intoxication, airbags, and now cellphone use[3]. More stringent laws could be put in place specifically at intersections given the odds and probabilities we have found of violating a law while on a cellphone at these locations. This is especially important in consideration of previous studies proving that users feel more inclined to use cellphones at intersections because they feel driving demands are lower[6]. Implications are especially dangerous when compounded with the fact that studies at the University of Utah have found evidence people who drive while on their cellphones are more likely to engage in risky behavior in general[9]. Together, what is being conveyed by previous studies and this current study is that combining driving and cellphone use may result in risky behaviors (in general and in relation to driving) as well as committing traffic violations.

The Effect of Cellphones on Traffic Violations is limited in the fact that it was compiled by coders who were likely untrained in research, however because of the simplicity of the coding and the high inter-rater reliability, the results of this study are still valid. Additionally, causality cannot be concluded due to the nature of the study and given the analysis was chi-square based. The results cannot be generalized to conclude which cellphones are most high-risk and what intersection laws are most violated because it is only known that people were observed on any sort of cellphone at a stop-signed intersection. Because cellphones are not the only variable that may have changed over the years, and cellphone models were not controlled for, a number of variables may be at play for this phenomenon. However, the database used to find these results is massive and has been compiled for more than a decade at the point of this study.

Traffic laws and vehicle production could still base progressive action from this study due to the high probability of violation given cellphone use. Again, more stringent laws could be put in place that focus on cellphone use at intersections. Vehicles could be manufactured to reduce handheld cellphone use by integrating eye-tracking software to warn users to keep eyes on the road, and/or automatically send text messages indicating the driver is preoccupied when users receive text messages while driving.

5. References

1. Christensson, P. (2010, July 30). Smartphone definition. Retrieved 2019, Sep 23, from https://techterms.com

2. Hallgren, K. A. (2012). Computing inter-rater reliability for observational data: An overview and tutorial. *Tutorials in Quantitative Methods for Psychology*, *8*(1), 23–34. doi: 10.20982/tqmp.08.1.p023

3. McCartt, A. T., Kidd, D. G., & Teoh, E. R. (2014). Driver cellphone and texting bans in the united states: evidence of effectiveness. *Annals of advances in automotive medicine. Association for the Advancement of Automotive Medicine. Annual Scientific Conference*, *58*, 99–114.

4. Myers, D. G., & DeWall, C. N. (2019). *Exploring Psychology*. New York: Worth Publishers, Macmillan Learning.

5. Number of smartphone users in the U.S. 2010-2023. (2019, February). Retrieved from https://www.statista.com/statistics/201182/forecast-of-smartphone-users-in-the-us/.

6. Oviedo-Trespalacios, O., Haque, M. M., King, M., & Washington, S. (2019). "Mate! I'm running 10 min late": an investigation into the self-regulation of mobile phone tasks while driving. Accident Analysis & Prevention, 122, 134–142. doi: 10.1016/j.aap.2018.09.020

7. Strayer, D. L., Crouch, D. J., & Drews, F. A. (2004). A Comparison of the cell phone driver and the drunk driver. *SSRN Electronic Journal*. doi: 10.2139/ssrn.570222

8. Strayer, D. L., Drews, F. A., & Johnston, W. A. (2003). Cell phone-induced failures of visual attention during simulated driving. *Journal of Experimental Psychology: Applied*, *9*(1), 23–32. doi: 10.1037/1076-898x.9.1.23

9. Strayer, D. L., & Johnston, W. A. (2001). Driven to distraction: dual-task studies of simulated driving and conversing on a cellular telephone. *Psychological Science*, *12*(6), 462–466. doi: 10.1111/1467-9280.00386

10. Tian, Y., & Robinson, J. D. (2016). Predictors of cell phone use in distracted driving: extending the theory of planned behavior. Health Communication, 32(9), 1066–1075. doi: 10.1080/10410236.2016.1196639

11. Teendriveadmin. (2019, February 19). Texting and driving crashes facts and statistics. Retrieved from https://teensafe.com/texting-and-driving-crashes-facts-and-statistics/.