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Real Reminders: How Signage Affects Distracted Driving Law Compliance

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This is to certify that the doctoral dissertation by

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Abstract

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Dissertation Submitted in Partial Fulfillment

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Abstract

Mobile communication and time demands converge to encourage people to use their phones while driving, leading to greater numbers of motor vehicle accidents and fatalities. While multiple states have implemented legislation prohibiting the use of mobile devices while driving, the problem continues unabated. Grounded in situational crime prevention theory, this study examined the influence of environmental changes, specifically sign installation, as a way to increase compliance with legislation and reduce the number of automotive fatalities. This quantitative study used secondary data and applied a paired-sample, two-tailed *t* test to compare the mean of the number of motor vehicle fatalities on Georgia interstates before and after legislative changes. Multiple studies have investigated the influence of legislation on distracted driving practices, as well as the associative dangers thereof, though none could be found that address the impact of signage on legislative compliance. The research found that signs had no effect on the number of motor vehicle fatality accidents on Georgia interstates. Limitations of the study included the lack of primary research, specifically the use of both quantitative and qualitative surveys, as well as the expansion of secondary data and the addition of covariates. Recommendations based on the findings of this study include advising policymakers to redirect funds to install more signs and increase education and enforcement opportunities for law enforcement. This study served to promote positive social change by filling the knowledge gap in this area to reduce motor vehicle fatalities and save lives.

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Chapter 1: Introduction to the Study

The expansion of technology over the last 20 years has created a society accustomed to multitasking and constant information accessibility. Studies have indicated most individuals understand the dangers associated with driving while texting or manipulating a mobile device, yet numerous individuals continue to engage in this activity (Li et al., 2018; Lipovac et al., 2017; Telemaque & Madueke, 2015). During the 2018 legislative session, Georgia's Congress passed a law updating the distracted driving law prohibiting the use of mobile devices while operating a motor vehicle on the state's roadways from one that barred texting while driving. Georgia implemented the update to an old law in response to an accident claiming the lives of five nursing students on Interstate 16 (Stevens, 2016); increased accident numbers, even with augmented enforcement efforts, further prompted the law change (Georgia Governor's Office of Highway Safety [GOHS], 2017). Georgia installed signs and changed electronic signs to educate drivers on the new law and its consequences. The topic of interest for the dissertation was to measure the impact of signage on driver compliance with Georgia's distracted driving law through evaluating the number of motor vehicle accidents and fatalities between July 1, 2016, through June 30, 2020, on Georgia interstates by comparing the numbers in the two years prior to the law against the two years after.

Background of the Study

Scholarly literature and research focused on distracted driving prevention via *universal texting ban* (UTB) and *universal handheld ban* (UHB), as well as the propensities of individuals to participate in distracted driving. Gariazzo et al. (2018)

provided information on the pervasiveness of the problem of texting and driving from a global standpoint. Gliklich and Bergmark (2016), Li et al. (2018), Lipovac et al. (2017), and Telemaque and Madueke (2015) researched the impact of distracted driving among American drivers. White et al. (2018) introduced data contradicting previous findings, though they included information related to prominent issues among young drivers participating in distracted driving with harmful consequences. Qiao and Bell (2015), Rudisill et al. (2018a), and Rudisill et al. (2018b) wrote about the impact of legislation on individual participation in distracted driving. Ruppet et al. (2016) researched the effect of individual risk of distracted driving based on participant perception of internal and external distractions. Quisenberry (2015) proposed the application of the general theory of crime to explicate distracted driving participation while noting the minimal impacts of legislation on distracted driving. Clarke (1995) introduced the concept of situational crime prevention theory (SCPT), a crime theory involving a focus on a specific crime to reduce crime occurrence through environmental manipulation.

This study was the first to apply the idea of SCPT to signage placement and its effect on distracted driving law compliance. As noted, studies on the influence of distracted driving legislation and studies on signage exist, but a search of existent literature could not provide any studies that tested the effectiveness of signs on distracted driving law compliance. Considering the cost in lives lost to distracted driving and a need to understand the potential success of signs in increasing UHB compliance, this study filled the research gap to save lives, save money, and properly utilize resources.

Problem Statement

In the United States, most people own a smartphone. Smartphones can cause distractions while driving. A literary review by Lipovac et al. (2017) of 60 articles demonstrated a direct correlation between distracted driving caused by mobile device use and reduced driving performance. Research indicated a 10% reduction in driver fatalities in states with mobile device use prohibitions, or UHBs, for all drivers versus only a 3% reduction in the presence of a UTB (Rudisill et al., 2018a), whereas other studies have suggested no statistically significant relationship between legislation and reduction of distracted driving (Quisenberry, 2015). A motor vehicle crash led to the death of five nursing students when a tractor-trailer driver crossed into their lane of traffic while texting and driving, prompting Georgia to implement legislation banning all mobile device usage while operating a motor vehicle, replacing the previous texting while driving ban. However, legislation implementation alone cannot guarantee law compliance, so Georgia opted to use signage to promote knowledge of the law to increase compliance to save lives and prevent motor vehicle crashes.

The efficacy of signage on distracted driving law compliance is not well-known. My quantitative study sought to fill this knowledge gap and discover the effectiveness of two types of signage aimed at reducing distracted driving: static signage and dynamic message signage (DMS). The definition of static signage is stationary metal signs displaying the law. In contrast, DMS involves electronic signs that can change messages, be moved from place to place, or both. Examining the number of motor vehicle fatalities on interstates in the 2 years before the law versus the number of motor vehicle fatalities

on Georgia interstates after the law demonstrates the possible effectiveness of signage on UHB compliance in Georgia since the state placed the signs at the time of the legislation.

Purpose of the Study

Distracted driving diminishes drivers' ability to operate motor vehicles, leading to increased motor vehicle accidents (Rudisill et al., 2018a), augmenting the importance of finding concrete, definitive ways to minimize this behavior. The purpose of this quantitative study was to discover whether a correlation exists between signage warning drivers that distracted driving is illegal and the number of fatal motor vehicle accidents in the state of Georgia after UHB implementation using a comparison of means *t* test. The independent variable of the study is the presence or absence of state-installed distracted driving law signs on Georgia interstate rights-of-way from July 1, 2016, through June 30, 2020. The dependent variable is the number of motor vehicle fatality accidents on Georgia interstates from July 1, 2016, through June 30, 2020. This study used no covariates.

Research Question and Hypotheses

The research question and corresponding hypotheses for this study were as follows:

- RQ: What is the impact of roadway signage on the number of fatality motor vehicle accidents on Georgia interstates?
- H_0: Roadway signage has no influence on the number of vehicle accidents with fatalities on Georgia interstates as measured by a comparison of means *t* test.

- H_1: There is a negative correlation between roadway signage and the number of fatal vehicle accidents on Georgia interstates as measured by a comparison of means *t* test.

Theoretical Foundation

This quantitative study used Clarke's (1995) SCPT to explicate the usefulness of signage in distracted driving reduction. Researchers use SCPT to direct environmental manipulations to minimize the occurrence of a crime (Clarke, 1995); SCPT concentrates on the crime itself rather than the criminal. SCPT does not consider why an individual commits a crime but instead focuses on the method of perpetration for prevention (Clarke, 2010). SCPT is tested by measuring the occurrence of crimes before a chosen intervention, then checking the crime occurrence after measure placement to determine levels of change (Clarke, 2010). The testing for SCPT is typically straightforward: if the specific crime occurs less, the manipulation worked, in which case SCPT is verified, but if the crime remains the same or increases, then the manipulation failed, and SCPT is determined to be inadequate to explain crime prevention measures.

This study applied SCPT by testing the presence of signage against its absence on the number of motor vehicle accidents. Collecting crash data from across the state from 2 years before the distracted driving law implementation and signage installation against the 2 years following the law and sign installation permitted a comparative analysis of the effectiveness of signage in preventing motor vehicle accidents via comparison of means *t* test; in this way, SCPT either proved effective or a failure related to the crime of distracted driving. Since the data only involved the presence or absence of signage and

the number of fatal motor vehicle accidents, the secondary data analysis proved a practical test of SCPT on distracted driving law compliance.

Nature of the Study

Quantitative secondary data provided the methodology for the study to address the identified gap in knowledge of signage efficacy and distracted driving law compliance. Data from the National Highway Traffic Safety Administration (NHTSA) roadways provided the accident data, verifiable through secondary sources including the Georgia Department of Public Safety, the GOHS, and the agency responsible for installing state-owned signs on the rights-of-way of Georgia. Data on sign presence came from the agency responsible for installation and maintenance of road signs on Georgia rights-of-way. Using the secondary data promoted a nonexperimental quantitative research design with the dependent variable of motor vehicle accidents and the independent variable of signage; this study included no control variables. Entering the data into IBM SPSS allowed manipulation to conduct appropriate tests.

After data collection, the assessment of analysis strategies must gain consideration. Using a comparison of means *t* test allowed for a straightforward evaluation of the efficacy of signs on the number of motor vehicle fatalities on Georgia interstates. Since the data involved work on a single dependent variable (motor vehicle fatality accidents) tested against a predictor variable (signage), the outcomes lent themselves to a comparison of means with a paired-sample, two-tailed *t* test (O'Sullivan et al., 2017). This *t* test utilized the dichotomous predictor variable of signage and the dependent numerical variable of the number of motor vehicle accidents. A minimum

sample size of 15 for each group determined by the number of accidents in a given month on Georgia interstates, for a total of 30 samples, provided the necessary dataset for evaluation. The theory tested whether signage prevents motor vehicle fatality accidents caused by distracted driving.

Definitions

Universal handheld ban (UHB): The legislative prohibition preventing drivers from using a mobile device while operating a motor vehicle (Rudisill et al., 2018a).

Universal texting ban (UTB): The legislative prohibition preventing drivers from using a mobile device to send text messages while operating a motor vehicle (Rudisill et al., 2018a).

Commercial vehicles: Vehicles owned by recognized corporations or entities other than governmental to facilitate business (Riahi Samani & Mishra, 2022).

Dynamic messaging signage (DMS): Electronic, programmable signs, either mobile or stationary, that can display prescribed messages to inform, warn, or educate drivers (Kelarestaghi et al., 2020).

Publicly maintained roadways: Public roads maintained by state or local governments for general travel by all persons (Johnson et al., 2014).

Static signage: Stationary metal signs found on the side of roadways used to inform, warn, or educate drivers (Bongiorno et al., 2017).

Assumptions

Several assumptions presented for the study to address the research questions. The initial assumption was the ability to collect reports for all motor vehicle fatality accidents

on Georgia interstates; the study would not be valid without the ability to collect all reports. Additionally, the assumption of a positive, appropriate sample size permitted the study to provide generalizable information.

Scope and Delimitations

The use of mobile devices while operating a motor vehicle provides dangerous distractions for the driver, placing those traveling the roadway with them at risk (Gliklich & Bergmark, 2016; Li et al., 2018; Lipovac et al., 2017, Telemaque & Madueke, 2015; White et al., 2018). Georgia implemented a UHB to reduce the danger, including installing signage to notify drivers of the illegality of using a mobile device while driving. One specific aspect of this study is the determination of the efficacy of signage in reducing motor vehicle accidents, a measure to save lives.

The scope of the study includes the state of Georgia, with the target population the number of motor vehicle accidents across the state. One delimitation was that only accidents reported and occurring on publicly maintained roadways, specifically interstates, within the state of Georgia were included in the study. A second delimitation was the exclusion of all private property accidents (accidents that occur on private, non-government-maintained property), as the study's predictor variable is signage installed and controlled by the state, making the exclusion of private property accidents a logical move. The use of quantitative secondary data prevented bias intrusion. Lastly, the information gleaned from this study could inform other states regarding the applicability of signage installation in concert with UHB legislation and direct the expansion or reduction of sign usage across Georgia relating to the UHB.

Limitations

Some limitations presented for consideration in this study. The exclusion of data on driver acknowledgment of the signs, as well as the impact of the signs on driver compliance with the law is a limitation; without knowledge of whether drivers notice the signs, the study relied solely on the numbers of accidents. Another limitation involved the determination of signage efficacy by looking at the accident numbers themselves, not if distracted driving was listed as a contributing factor; this limitation also works as a delimitation, as proving mobile phone usage while driving as a contributing factor can prove difficult for law enforcement professionals, making the limitation positive toward results accuracy (Nevill et al., 2017; Rudesill & Zhu, 2021).

Another limitation of the study involved the signs themselves. Georgia's governor signed the legislation on May 2, 2018, with the law going into effect on July 1, 2018, giving the state agency with responsibility for installing state-owned signs on Georgia's rights-of-way a two-month window to install the signs on Georgia interstates (GOHS, n.d.). The signs were installed during this time, but the static signs were covered with black plastic coverings to obscure the message until the law went into place. This could be a limitation, as the signs were covered, creating a potential interference in the accident numbers for this time frame, but the use of longitudinal data should overcome this limitation. The lack of inclusion of control variables could be considered a limitation, but the reality that multiple factors and conditions cause accidents is a simple reality that led to the exclusion of control variables. The final limitation of this study is the concentration on Georgia interstates to the exclusion of all others; a concentration on only Georgia

roads means reduced generalizability, as those accidents not contributed to distracted driving could be related to reduced driving ability or other impairment which may not be present in other states, though an appropriate sample size should overcome this limitation. Additionally, the requirement of interstate roadways to follow strict federal regulations in building and maintenance helped expand generalizability, shrinking its limitation status.

Significance

The significance of this study is the determination of resource allocation toward reduced distracted driving across the state. This study identified whether signage reduces distracted driving motor vehicle accidents with implications toward funding access, insurance premium cost reductions, increased driver confidence and protection, and ultimately, protection of life from reduced numbers of motor vehicle accidents. This quantitative study filled a gap in the literature of determining the efficacy of situational crime prevention on the crime of distracted driving, a heretofore unexplored application, by extrapolating whether signs warning about the illegality of mobile phone use while driving reduced the number of motor vehicle fatality accidents on Georgia interstates.

Significance to Theory

The study had significance for theory in discovering the impact of SCPT on distracted driving legislation. Some studies showing difficulty in legislative adherence among individuals related to UHBs (Qiao & Bell, 2015; Rudisill et al., 2018a, 2018b). Conversely, this study provided guidance toward gaining compliance from drivers should

the research confirm reduced accidents after the sign installation, grounding the concept of SCPT.

Significance to Practice

Legislators must answer to constituency regarding resource allocation and value of laws enacted. The growth of mobile device usage, especially while driving, causes increased concern for drivers prompting legislators to enact laws, but the question remains about the best way to convince people to comply (Rudisill et al., 2018b). The presence of static signage costs money, so discovering whether signs work toward reducing motor vehicle accidents can inform legislatures regarding funding for static signs and increased use of DMS.

Significance to Social Change

This study filled the knowledge gap regarding whether signs can limit distracted driving behavior and prevent motor vehicle accidents. The findings from this study could be used by policymakers to develop laws, policies, and programs that reduce distracted driving. Reducing distracted driving can save lives, protect property, and potentially lower insurance premiums, so drivers can worry less about their safety if they believe signage is preventing fellow travelers from using handheld devices while driving. Finally, the study failed to demonstrate a direct correlation between the signage after the law activation and driver compliance with the law, eliminating indications for necessary replication for other states with distracted driving laws in place or those considering such legislation.

Summary and Transition

This study was organized into several key sections. The current chapter provided an overview of the entire study, including the background and research gaps, identification of the research problem, the study purpose, the research question and hypotheses, the nature of the study, noted delimitations and limitations, and the study significance. The purpose of the study and increase to the knowledge base was stated clearly, including a summarization and application of the theoretical framework of SCPT for this study, a heretofore unexplored application for SCPT. The research design to explore a potential relationship between signage and reduced motor vehicle accidents could advise public administrators to direct resources toward greater signage; an inverse relationship would educate the same toward diversion of funding for signage.

Chapter 2 provides a detailed literature review that encompasses a synthesis of current research related to the introduced problem statement and research questions. The literature review covers information related to the overall effect of UHB legislation, including its impact on motor vehicle accidents, driver behavior, and enforcement efficacy. Then, research on the effect of signage on motor vehicle accident reduction is evaluated, followed by a review of signage efficacy in general across multiple platforms. The literature review also comprises information related to SCPT and its relevancy to the issue in question, including previous applications of SCPT on crime reduction.

Following the Chapter 2 review of the literature, Chapter 3 explains the research method used in the study, including the quantitative non-experimental design using secondary data, the methodology, the analysis structure and application of paired-sample,

two-tailed *t* test to analyze the data, as well as validity threats and possible biases. Information related to the statistical powers and sample size is also discussed. Then, Chapter 4 provides the data analysis and results for this study, including tables and figures to explicate the findings. Chapter 5 includes discussion of the results, as well as limitations and suggestions for future research. The final chapter also specifies the social implications of this research. Findings from this research may be used to inform legislators about the inefficacy of signage on distracted driving law compliance to determine better ways to enforce the law and save lives.

Chapter 2: Literature Review

This chapter provides a comprehensive review of distracted driving laws and signage. It also reviews the literature on SCPT, the theoretical framework used for this study. Because of the relative newness of mobile device technology and recognition of its interference with safe driving, the literature review is limited to the last 20 years. The literature is presented in three distinct categories for discussion.

The first section covers literature related to SCPT, including its origin and various applications. A detailed description of SCPT helps in understanding its appropriateness for this study, as well as its expansion through the years. Review of policies and public safety impacts, its varied applications to prevent myriad crimes, like driving offenses, white-collar crime prevention, organized crime prevention, medical marijuana production, crimes on college campuses, green crime, terrorism, and sex offenses, help explicate the relationship and application of SCPT to the current study.

Following the review of the SCPT literature, Chapter 2 continues with a depiction of UHB compliance, the dependent variable for this study as measured by the number of motor vehicle fatalities occurring on Georgia interstates. The consideration for distracted driving law includes support for the law, impacts on motor vehicle accidents and fatalities, the influence on driver behaviors and distracted driving overall, as well as preventative efforts such as new technology and enforcement. A key study identified in this literature review is a study by White et al. (2018) that found no positive correlation between motor vehicle accidents and the number of cellphone contracts in Kentucky, yet the authors still supported laws preventing distracted driving.

The final section comprises literature related to the independent variable of signage. This includes the impact of signage on driver behaviors, specifically with discourse on a variety of signage interventions, including possible driver information overloads, warning signage for downgrades and wrong-way driver prevention, work zones, pedestrian safety, intersections, exit ramps, railroad crossings, and finally, rural roadways. Then, an evaluation on overall efficacy of signage across various formats and applications, such as various driving applications unrelated to motor vehicle accident reduction, waste disposal behaviors, public space interactions, retail signage applications, various emergency signage related to navigating a complex building, locating emergency medical equipment, and emergency evacuation, and finishing with discourse on medical signage effectiveness.

Literature Search Strategy

Sources for this literature review include peer-reviewed journals, text from professional meetings, and data from national repositories for research, gleaned from digital records found on the NHTSA official website, the Governors Highway Safety Association website, and searches through the Walden University library database, Google Scholar, Sage journals, and ScienceDirect databases. I conducted searches using specific key words, including *UHB*, *UTB*, *universal handheld ban*, *UHB compliance*, *mobile devices and driving*, *texting and driving*, *distracted driving*, *signage*, *signage and traffic accident prevention*, *signage efficacy in general*, *situational crime prevention theory*, *situational crime prevention*, *situational crime prevention application*, and *signage and distracted driving*.

SCPT and Crime Reduction

The theoretical framework for this study is SCPT. The following section reviews literature relevant to SCPT to justify its application in this research. Introduced by Ronald Clarke (1980), SCPT posits that manipulating the environment to reduce criminal behavior. SCPT integrates both routine activities theory and rational choice theory, which argue that individuals engage in criminal behavior because they think the rewards of their criminal behavior outweigh the risks of getting caught. Instead of focusing on individual behavior, SCPT focuses on preventative structural measures to reduce crime (Clarke 1980, 1995). Additionally, the structural prevention (e.g., signage) makes potential criminals reconsider engaging in criminal behavior by instilling the fear of being caught. This study uses SCPT because signage manipulates the environment to reduce the criminal behavior of using a handheld device while driving and warn drivers of the risk of repercussions if caught doing so. Essentially, this study investigates whether the manipulation of the environment via signage reduces the use of handheld devices while driving. A review of the literature failed to identify articles applying SCPT to distracted driving suggesting a gap in the literature, which this study addresses.

A number of studies have effectively used SCPT as a theoretical framework. These studies demonstrate how criminal behavior can be reduced through environmental manipulation. This research suggested that SCPT could have the same explanatory power for UHB and UTB signage. It is informative to examine criminology studies using SCPT to get a sense of how the theory is applied as a theoretical framework.

Chiu et al. (2020) used SCPT to study sex offenses against women. The researchers collected self-report questionnaires from 140 sex offenders convicted of sex crimes against women to rate the likelihood of committing a sex offense if there was a guardian in three hypothetical scenarios. Study participants rated the scenarios and their probability of engaging in sexual assault on a five-point Likert scale to designate the efficacy of guardians as a preventative measure against sex crimes. Using hypothetical scenarios, the researchers examined whether the placement of a guardian in either a private or public location would make the offender less likely to commit a sex offense. The researchers found that having a guardian was effective in both public and private locations for both victims known and unknown to the offender. Overall, the greatest deterrent to crime, according to the offenders, involved fear of discovery. The study tested and validated SCPT by demonstrating how an intervention (i.e., guardians) can deter crime.

Padayachee (2016) examined how system controls can mitigate information access to reduce insider threats using information security. The system controls included multiple factor authentication for access to information, requiring authorization to access certain information, limitations on amount of information any individual could access, and password protections for information access, among other controls. The research produced 125 various techniques, with only 23% achieving highly effective ratings; principle of least privilege produced the highest score, meaning experts believed the control of information access worked best to reduce insider threats. The study indicated

that direct controls, consistent with SCPT, proved more effective to reduce insider information security threats.

Lynch et al (2018) used SCPT as a theoretical framework to investigate whether dyeing rhinoceros horns helped detect poaching and reduced rhinoceros horn theft. The study found that this intervention was effective in reducing poaching and horn theft. Though the researchers noted SCPT-driven interventions alone could not alleviate all ecological crimes, the study validated SCPT by demonstrating that an intervention, in this case the dyeing of rhinoceros horns, deterred poaching and theft through increased fear of incarceration if caught with a dyed horn.

Distracted Driving and UHB Compliance

Mobile device usage continues to increase as the applications for its use in everyday life expand. With this expansion, the propensity to use a mobile device while driving continues to tempt individuals, even though they know it can be dangerous for themselves and others (Gliklich & Bergmark, 2016; Li et al., 2018; Lipovac et al., 2017; Telemaque & Madueke, 2015; White et al., 2018). In 2017, distracted driving killed 3,166 people, accounting for 9% of all fatal crashes across the United States (National Center for Statistics and Analysis, 2019). Currently, 24 states, the District of Columbia, Puerto Rico, Guam, and the U.S. Virgin Islands enforce a UHB as a primary enforcement law, meaning an officer can stop and cite drivers for this offense alone (Governors Highway Safety Association, 2020). Studies have indicated that UHB reduces motor vehicle accidents overall (French & Gumus, 2018; Lim & Chi, 2013; Rudisill et al., 2018a, 2018b), explicating the implementation of UHB law; however, not all agree with

the enhanced emphasis on UHB, noting a lack in commensurate motor vehicle accidents with expansion of cellphone contracts (White et al., 2018). Cooccurring factors such as signage gain little attention in present research, a gap I sought to fill in this study. A review of the academic literature failed to identify studies specifically investigating UHB and road signage. There were, however, several studies on UHB compliance including driver demographics and vehicle alterations to improve UHB compliance.

Advocacy for and Efficacy of Law

McCartt et al. (2014) questioned the effectiveness of UHB and UTB legislation. Their study reviewed findings of 11 peer-reviewed papers or technical reports on UHB and UTB, focusing on the rates of phone usage and crash occurrences where bans exist, including laws centered on controlling use of cellphones while driving by teenage drivers. McCartt et al. could not conclusively say whether UHB or UTB reduced motor vehicle crashes, citing inconsistent evidence throughout the studies, as well as significant limitations in data collection and methodologies. Though noting the importance of research on UHB and UTB efficacy, their evaluation could not provide clear answers for readers.

Williams (2015) focused only on UTB law, calling for a federal mandate, complete with punitive guidelines, to ban texting while driving, citing the effectiveness of federal intervention related to drinking and driving during the 1980s. Williams included examples of media coverage, public service announcements, as well as available research on the deleterious effects of texting and driving to emphasize the scope of the problem, as well as the public’s recognition of and support for intervention, even while continuing the

practice. After articulating the extent of the problem, Williams supported a proposal for a national mandate against texting and driving, known as the Avoiding Life-Endangering and Reckless Texting by Drivers Act (ALERT Drivers Act), modeled after the National Minimum Drinking Age Act of 1984, which linked federal highway funding to state-level compliance with a minimum drinking age of 21; the ALERT Drivers Act would reduce available funds for roadways by 25% instead of only 5% reduction faced for non-compliance with the National Minimum Drinking Age Act, an impediment to acceptance. Williams presented ideas for a universal financial penalty for texting violations. In conclusion, Williams urged using the National Minimum Drinking Age Act as a blueprint for a national UTB, hoping for similar success in reduced fatal car accidents.

Sherin et al. (2014) of the American College of Preventive Medicine (ACPM) released a statement supporting UTB law in order to save lives. After noting that 12% of all fatal motor vehicle accidents involved at least one distracted driver, the ACPM felt led to publicly denounce distracted driving and encourage research and education. The article predominately focused on the negative impact of distracted driving on teenage drivers because of their driving inexperience combined with a significantly higher propensity to engage in texting, including multiple educational strategies to reduce the behavior among this group. Sherin et al. encouraged combined educational and enforcement initiatives to reduce texting while driving behaviors, while also noting difficulty for law enforcement to determine whether drivers committed a violation with only a UTB in place. The ACPM strongly recommended a UTB in all states, with an extensive educational advertisement campaign combined with strict enforcement to gain compliance,

supplemented by medical practitioners educating teenage patients on the negative effects of distracted driving and expanded research on distracted driving impacts.

Fewer Car Accidents and Injuries

Ferdinand et al. (2019) studied the impact of UTB on motor vehicle crash related emergency room (ER) visits from 2007 to 2014. Using the Healthcare Cost and Utilization Project State Emergency Department Databases and State Inpatient Databases from 16 states to determine how many people required ER treatment because of distracted driving related crashes, the study found a 4% reduction in ER visits in states with any UTB across all age groups, with greater reductions in states with UTB as a primary offense (officer can stop the driver for this offense alone) versus those with secondary offense (officer must have another reason for stopping the driver) UTB; drivers aged 22 to 33 years saw the greatest reductions in treatment. Ferdinand et al. noted the lack of inclusion of individuals who sought other treatment options and did not account for individual-level treatment choices, nor did they enumerate the total number of motor vehicle accidents occurring in the states evaluated.

Gliklich et al. (2016) conducted a study on the correlation between motor vehicle crashes and distracted driving using a logistic regression analysis to compare the Distracted Driving Survey (DDS) results against the number of self-reported motor vehicle accidents; the DDS measures the number of distracted driving behaviors a respondent admits to participating in while operating a motor vehicle. Results indicated an inverse relationship between age and increased DDS scores; no other demographic information (education levels, gender, geographic region, driving setting) affected DDS

scores. Additionally, the study found a direct relationship between DDS scores and the number of self-reported motor vehicle crashes, with a 7% increase in crash reporting for every point increase in DDS score. This study did not include information on UHB or UTB but demonstrated a direct correlation between distracted driving and motor vehicle accidents, even when relying on self-reporting.

A study by Chen and Lym (2021) evaluated the influence of built environment on distracted driving crashes post-incident in Ohio from 2013 to 2017, which has a UHB. Researchers used data from the Ohio Department of Transportation, including accident data collected from law enforcement agencies and the Ohio Department of Public Safety, to perform a negative binomial regression and generalized ordered logit regression, interpreted as an incidence rate ratio, to measure the relative change of likelihood of frequency of crashes against the independent variable of built environment. Findings revealed an increased number of distracted driving crashes in urbanized areas, and decreased crash numbers in areas with a median and asphalt shoulders. Additionally, crash severity increased in distracted driving related accidents and in work zones and on interstates, whereas roundabouts produced a mixed effect, supporting the hypothesis that frequency and severity of crashes increased with distracted driving and on urban roads and in work zones. The authors suggested increased and improved traffic signs and law to reduce distracted driving behaviors.

UTB and UHB Law Effect on Fatalities

Rudisill et al. (2018a) examined whether the driver's age played a role in UHB and UTB on driver fatalities. Using the Fatality Accident Reporting System (FARS),

Rudisill et al. looked at UTB and/or UHB with the primary outcome of the number of driver fatalities in the state with consideration for each quarter and year. The study also evaluated locations, cell phone coverage, the number of residents with cell phone contracts per capita, annual per capita income, yearly gas price in each state, the maximum speed limit, seatbelt laws, the number of full-time law enforcement officers, and two specific drivers licensing measures—graduate licenses for younger drivers and administrative license suspensions for driving under the influence (DUI violations). Rudisill et al. applied a generalized Poisson mixed regression and found that UHB equaled an overall 10% reduction in the number of non-DUI fatalities and up to 13% fewer fatalities regardless of age or gender. With respect to the driver's age, the study found distraction from mobile devices decreased as age increased. Furthermore, the study showed that UTB laws did not significantly reduce driver fatalities. Rudisill et al. could not identify why UHB reduced accident fatalities, yet UTB did not.

French and Gumus (2018) studied the effect of UTB and UHB on motorcycle fatalities using 11 years of data from the Fatality Analysis Reporting System (FARS). Overall, the study found there were fewer motorcycle fatalities in states with strong (11% less) and moderate (7.7% less) UHB and UTB than those with weak or no UHB and UTB. The research defined strong bans as those applying to all drivers and prohibiting any mobile device use, while moderate bans prohibited either texting or all cell phone use for all drivers; in order to be either strong or moderate, the violation must be a *primary offense*, or stand-alone probable cause for law enforcement to stop a motor vehicle. One limitation noted by the researchers involved the length of the study, suggesting future

longitudinal studies use more than just 11 years of data. Interestingly, the study did not include single-vehicle motorcycle fatalities or non-fatal injury accidents, indicating a potential research gap.

Lim and Chi (2013) researched the efficacy of cell phone or texting bans toward reducing the number of motor vehicle fatalities among young drivers through a longitudinal study spanning from 1996-2010. The researchers looked at driving laws in the 48 contiguous states while controlling for mandatory seatbelt laws, graduated driver licensing, speed limits, enforcement of zero tolerance for impaired driving, income, gas prices, unemployment rates, population densities, and annual precipitation levels. After breaking the study into three time periods (1996-2010, 1998-2010, and 2000-2010) based on cell phone popularity, they applied a conditional negative binominal regression analysis and discovered about 8% fewer young driver fatalities in states with cell phone prohibition laws versus those without, and more than 10% fewer involvements in the final time period. The study found little reductions in fatalities among drivers aged 15-20 when a UTB or UHB only applied to novice drivers, but when the law applied to all drivers, 12%–14% less fatalities occurred among the same age group; basically, total cell phone bans saved lives when not limited to only young drivers. Lim and Chi posited greater ease of enforcement when officers did not need to discriminate driver age for the differences in results. Furthermore, the study emphasized the benefit of education and public safety announcements to educate on the dangers of distracted driving as a suggestion for greater compliance with cell phone bans.

Cellphone Ownership and Motor Vehicle Accidents

The literature review identified one study that refuted the above findings. White et al. (2018) found there was no correlation between the total number of motor vehicle accidents and the number of cellphone customers and prevalence of texting as a dominant means of communication. Utilizing the Moral Panic theory, the study used frequency and percentages coupled with binary regression to test the independent variables of the number of cellphone contracts in Kentucky, the year, and the number of motor vehicle accidents involving driving while distracted. According to the findings, the total number of motor vehicle accidents remained longitudinally consistent when compared to the number of cellphone contracts, with no significant increases in wrecks. Another point of interest in the study concluded that cellphone-related crashes accounted for less than 1% of all crashes, citing a disproportionate emphasis on cellphone use while driving as a cause of accidents. White et al. noted the study might not be generalizable, pertinent only to Kentucky, but should gain note for the lack of correlation between cellphones and motor vehicle accidents.

Driver Demographic and Rural/Urban Driving

Two studies used the 2008-2013 National Occupant Protection Use Survey data source. Each study confirmed that UHB laws helped reduce phone use while driving. Interestingly, the studies found that females are more likely to obey UHB than males, though neither study explains why. A study by Rudisill and Zhu (2017) used the same dataset to determine whether age, race, gender, and locality played a role with respect to UHB compliance. The study looked at the odds of a driver making a hand-held phone call

while driving in states with UHB laws. The observers stood on the side of the road counting individuals engaged in hand-held phone conversations in violation of UHB. Their logistic regression analysis found females complied with UHB more than males, as did drivers in Western states over drivers in the Northeast and Southern United States. According to the analysis, the odds of females having phone conversations was .034 versus 0.47 for males, and 0.31 for those in the West against 0.47 for Northeastern states and 0.50 in the South. Rudisill and Zhu found little difference in the behaviors of drivers in the Northeast compared to drivers in the Southern United States.

Using the same survey data, Zhu et al. (2016) analyzed the longitudinal effects of UHBs among drivers under the age of 25 using logistic regression. Zhu et al. found that the longer a state had a UHB law in effect, the less likely drivers under the age of 25 would engage in the prohibited behavior. Law compliance was 46% in states with UHB laws in place for less than one year, 55% compliance if the law was in effect from one to two years, and 63% compliance for states with laws at or older than two years as compared to states without UHB. Another interesting finding was that the amount of the fine influenced compliance. According to the study, 4.1% of drivers engaged in handheld phone use when the fine was less than $100. In contrast, 3.1% used their phones when the fine was equal to or greater than $100. Zhu et al. noted that they did not use data before UHB and recommended that future studies use earlier data to make UHB comparisons.

Rudisill et al. (2018b) used the 2011-2014 Traffic Safety Culture Index Surveys to investigate the relationship between statewide cellphone law and cellphone use behaviors among 16- to 18-year-old drivers. They applied a multi-level Poisson

regression and found that areas with UHB had 55% less youth driving while talking on the phone overall, with females using their phones less than males. Rudisill et al. looked at driver age, sex, race/ethnicity, rurality of primary residents, and both UTB and UHB, supporting previous study findings that rural drivers and males tend to talk on their phones more than any other drivers, even when prohibited by law. This study included information on texting bans (UTB), demonstrating no significant relationship between UTB and reduced texting. Rudisill et al. recommended implementation of UHB instead of UTB to reduce all types of phone use while driving.

UHB and UTB Enforcement

A study by Nevin et al. (2017) provided the first look at enforcement of distracted driving laws from the law enforcement officer perspective through a qualitative focus group discussion with Washington State law enforcement officers. Nevin et al. utilized thematic analyses to discover challenges to enforcement among the 26 police officers. They concluded the law itself presented difficulty for enforcement because it did not prohibit all use of a mobile device, only holding it up to the ear or texting. This ambiguity led to inconsistent prosecution and low conviction rates, making officers question why they should enforce the law. The officers also believed that traffic law enforcement is low priority compared to responding to calls for service; thus, there may be a need for dedicated traffic officers to enforce UHB. Interestingly, the study showed that most people appreciate the constant connectivity provided by mobile devices, indicating a need to remove this affinity before UHB compliance could be achieved. Furthermore, officers identified with the drivers, since they themselves must use multiple electronic devices

while operating their patrol unit, including computers. According to the officers, enforcing the law seemed hypocritical. Nevin et al. recommended increased public awareness campaigns on the dangers of distracted driving to stigmatize the behavior, as well as adherence to the recommendations of the NHTSA for a more enforceable law.

Rudisill and Zhu (2021) looked at enforcement issues related to UHB, specifically identifying the recipients of citations and the overall number of citations issued in each state. The study covered 14 states and the District of Columbia and measured the total population against the total number of licensed drivers, then checked these numbers against the total number of citations issued for UHB and UTB violations. Rudisill and Zhu used a cross-sectional descriptive design to test the independent variables of age, sex, day of week, season, and state of driver's licensure against the dependent variable of violation type. UHB proved the most frequently issued citation, with 18-24-year-old drivers receiving the most, garnering 96.9% of the citations issued, while 2.6% of UHB citations went to drivers older than 24 years, and less than 1% going to drivers aged 15-17. Like other studies, Rudisill and Zhu found males received more citations than females overall, though the gap closed some for UTB. Unsurprisingly, UHB citations accounted for less than 1% of all citations, and UTB tickets numbered even fewer; the study did not include the number of warnings issued by law enforcement for these violations. One important limitation of the study involved the lack of compulsory reporting among all law enforcement agencies, potentially skewing results. Overall, the study concluded low enforcement of UHB and UTB as compared to the total number of drivers and citations issued by law enforcement.

Perceived Risk of Distracted Driving

Factors Influencing Perceived Risk of Distracted Driving

Whereas the overall section deals with perceived risk of distracted driving, this section identifies individual factors affecting perceived risk assessments. The section begins with legal and moral norms influencing driver attitudes (Kim, 2018), then moves to personal and conversational characteristics of drivers engaging in distracted driving (Shi, Xiao, & Atchley 2016), and concludes with studies on the subjective norms and perceptions affecting perceived and actual self-reported distracted driving behaviors (Terry & Terry, 2016; Nguyen-Phuoc, Oviedo-Trespalacios, Su, De Gruyter, & Nguyen, 2020). This section informs the current study on the separate factors pertaining to distracted driving behaviors and how signs might or might not influence distracted driving decisions, and it also sets up for the following section on criminological theories to explain these decisions.

Kim (2018) conducted a study to determine the impact of legal and moral norms on attitudes, intentions, perceived risks, and frequency of texting while driving among college students in states with established, new, and no UTB. In measuring the concept of legal norms, Kim referred to the perception of law enforcement of the UTB to create an immediate sanction of the behavior, whereas the moral norm centered on the moral obligation to determine the rightness or wrongness of the behavior. The study looked at the history of law enforcement for UTB on moderating the attitude toward, behavioral intention of, the perceived risk of, and the frequency of texting while driving, as well as discerning the interaction of both legal and moral norms together on the attitude,

intention, perceived risk, and frequency of texting while driving. Researchers offered extra course credit for completion of an online survey, which resulted in a total participant group of 313 included respondents; 125 respondents from Wisconsin, with a UTB over 3 years old, 104 from Florida, with a UTB less than 6 months old, and South Carolina, with no UTB. The measured variables included perceived legal norm, perceived moral norm, perceived risk of texting while driving, and the frequency of texting while driving, and involved a general linear model analysis with state, perceived legal norm, and perceived moral norm as the predictor variables against the dependent variables of intent to text, attitude regarding texting while driving, the perceived risk of texting while driving, and the frequency of texting while driving to determine results.

The study found similar perceived risks of texting while driving and little effect of law enforcement on legal norms, meaning even with a UTB present, frequency of engaging in the behavior did not change much; South Carolina results indicated an increase in the frequency of texting while driving as the legal norm decreased. Respondents from all stated showed decreased frequency and intent of texting while driving as the perceived moral norm against it increased. In both Wisconsin and Florida, results revealed a positive association between the legal norm and frequency of and attitude toward texting while driving, with no impact in South Carolina. Overall, the study had a small sample size, increasing the risk of Type II error, suggesting a larger standard coefficient for future research. The study demonstrated a need for cultivation of a moral norm against texting while driving to achieve compliance with UTB.

Another survey-based study on perceived risk of distracted driving by Shi et al. (2016) measured the personal characteristics of drivers, the conversation types, and driving conditions, along with the perceived importance of the call, perceived risk of distracted driving, the emotionality of the conversation, and the frequency of phone use to determine engagement in the behavior. The survey included four parts: (1) demographics; (2) self-reported phone use while driving; (3) conversation types; and (4) driving mood condition or emotions. The application of structural equation modeling and chi squared measured four components along a seven-point Likert scale: (1) frequency of initiation of call or text; (2) perceived risk of different conversation types; (3) perceived importance of the communication; and (4) the emotionality of the communication. The analysis revealed that, even where laws prohibiting any use of mobile devices while driving (even hands-free) exist, 91.8% of respondents reported talking on the phone while driving at least sometimes, and 59.8% indicated texting while driving sometimes, with 78.3% of those reading texts.

It is important to note the lack of law enforcement resources in Beijing to enforce mobile device usage bans, leading to the exclusion of perceived risk of enforcement as a variable; this might account for the extraordinarily high rates of the phone usage, which coincides with the findings by Rudisill and Zhu (2016) (Shi et al., 2016). Contrary to previous studies, young drivers aged 18-25 were less likely than those aged 26-40 to engage in distracted driving overall, though the results did not include the specific difference measurements. Overall, males and married respondents demonstrated greater likelihood to use the phone, though most all participants indicated engaging in talking on

the phone while driving about three-to-four times per week, with a positive relationship between perceived importance of the communication and frequency of initiating it; in other words, even when the participants knew the law and the risks, they engaged in phone use based on the perceived importance of the communication.

Perceived risk and perceived importance of communication emerged as best predictors of phone use, with a negative relationship between perceived risk and a positive relationship between perceived importance (Shi et al., 2016). All respondents indicated a strong perceived risk of texting (reading, initiating, and responding) while driving, while most considered talking while driving as very small risk, leading to the result of increased perceived risk as the strongest predictor of decreased behavior. As in previous studies, increased education and income equated increased phone use. The study excluded non-internet users and involved a relatively small sampling frame, creating limitations of results.

Terry and Terry (2016) looked at perceived injunctive social norms and perceived accident risk from driving while under the influence of alcohol and four types of cellphone use while driving (CPWD) through self-report surveys received from 726 college students 18-years-old and older with both a driver's license and a cellphone. The survey integrated various Likert scales to rate frequency of five driver behaviors: 1) hands-free talking; 2) hand-held talking; 3) reading text messages; 4) sending text messages; and 5) driving with a Blood-Alcohol content (BAC) at or above 0.08 (DUI). A repeated measures analysis of variance (ANOVA) proved the respondents' estimates of risk differed significantly across the five categories of driving behaviors, with hands-free

talking reported as the safest driving option. Respondents perceived sending texts as dangerous as DUI, though 68.2% reported sending texts while driving against the 34.4% who reported driving while under the influence of alcohol. Terry and Terry noted a qualitative difference between CPWD and DUI, which could be attributed to the recency of CPWD laws against the age of DUI laws. Other limitations noted involved the non-uniform representation of participants, the exclusion of non-collegiate young adults, and the reliance on self-reporting. The study emphasized the need for education on the dangers of all forms of CPWD, as respondents reported peers as less likely to endorse laws excluding individual freedom restriction and an overall social acceptability of CPWD because of a lack of understanding of associated risks.

A study by Nguyen-Phuoc et al. (2020) used psychosocial construct conceptual framework in their study to determine the relationships between perceived risks, frequency, and attitudes and beliefs regarding CPWD and actual CPWD. A survey identified potential participants for an online and face-to-face surveys of 501 motorcyclists and 283 car drivers; the initial survey used various five- and ten-point Likert scales (rated from not true to extremely true) to determine frequency of, attitudes and beliefs toward, and perceived risk of CPWD among drivers. Demographic information included age, gender, marital status, occupation, education level, and monthly income. Nguyen-Phuoc et al. completed the data analysis in four stages: 1) analysis of demographics; 2) exploratory factor analysis; 3) evaluation of measurement model; and, 4) evaluation of structural equation model. The data revealed an increased perceived crash risk with CPWD in all drivers, while fewer car drivers than motorcyclists

believed in decreased safety with CPWD; all drivers reported moderate to high usage of mobile devices while driving. The study indicated a positive correlation between positive attitudes and beliefs toward CPWD and frequency of self-reported phone use and problematic phone use, and people who engaged in CPWD more often had a less problematic view of CPWD, identifying is as less of a safety risk. Furthermore, those with higher perceived risk identified through negative attitudes and beliefs about CPWD and reported less frequency of the behavior demonstrated an increased perceived crash risk and fear of fines from law enforcement. The study noted the reliance on self-reporting and limited number of constructs as limitations, and the authors recommended increased enforcement of CPWD laws and greater education on actual risks related to CPWD.

Simulation-Tested Crash Risk Among Distracted Drivers

More recently, Choudhary et al. (2020), used a longitudinal study to investigate distracted driving. Using a Structural Equation Modelling (SEM) to quantify deteriorated driving performance across 90 drivers, they found there was a greater risk of an accident among drivers distracted by texting and music player use while operating a driving simulator. The simulator involved multiple screens, a steering wheel, gas, brake, and clutch pedals, as well as sound effects to simulate operating a car on a four-lane divided highway; the simulation included interacting with ambient traffic for greater realism. Researchers engaged in scripted conversations with the subject to simulate phone conversations to create cognitive distraction, while text message exchanges provided a visual distraction; the music player combined both cognitive and visual distractions. The

drivers chose their distractions in the simulation and allowed familiarization prior to testing, with only 70 drivers choosing texting tasks and 78 choosing music player operations, though 87% reported receiving calls and 41% reading texts while driving, according to self-reports. Choudhary et al. discovered no correlations between driver demographics and crash risk, attributing the 89% increase in crash risk variance to engaging in distractions, with texting as the greatest risk, followed by operating the music player, and concluding with conversation tasks; the crash risks involved in the study included deviations in speed, lane positioning, and steering wheel angle. One limitation of the study involved the exclusion of older drivers, nor did they define the ages for such a designation, and they did not assign tasks evenly across the sample, which could skew results.

Li et al. (2019) also studied the risk of an accident when distracted via a car-following simulator scenario that focused on only cognitive distractions. Li et al. studied 37 drivers to determine the relationships between driver characteristics (gender and driving experience), mobile device use, and collision risk, measuring mobile device use at three stages: no phone, hands-free, and hand-held. The study used logit regression and cluster analysis to determine collision avoidance performances and collision risk, including speed, following distance, brake reaction time and force, time to collision, and collision risk as measured by collision, near miss, and no risk. The repeated-measures ANOVA revealed increasing collision risk in progression from no phone to hand-held phone usage, with a significant effect only on brake reaction time, while the cluster analysis demonstrated significant differences in brake force, maximum brake force, and

minimum time to collision (TTC) among those using a hand-held mobile device, with the high-risk category more likely to be involved in a collision. Female and non-professional drivers (taxi drivers) were more likely to be in the high-risk group than males or professional drivers. Li et al. found drivers engaged in hand-held mobile device use at greatest risk for collision. The greatest limitation present in the research involved the artificiality of the mobile device tasks in the simulation; in essence, the phone conversations during the simulation lacked the emotionality of a real-life phone conversation, and engagement in dialing, answering, and other handling of the phone did not occur.

In another simulator test, Sanbonmatsu et al. (2016) conducted a study to determine why drivers use cellphones while driving yet support UHB and UTB. The study utilized 249 undergraduate student participants in Utah, a state with UTB but no UHB. Participants responded to questions about their cellphone use while driving, perceived safety of the behavior, support of UTB and UHB law, general attitudes about cellphone use while driving, including benefits and risks, and perceived risks of drinking and driving. The participants also participated in an automated operation span task (OSPAN) assessment to determine multitasking abilities and measure actual ability to drive safely while using a cellphone. Sanbonmatsu et al. found that most participants admitted using a cellphone while driving, with only 22.5% saying they never or rarely engaged in the activity, and 77.5% supported law prohibiting cellphone use while driving. Additionally, participants who felt positively about their cellphone use while driving did not feel the same about others' doing the same, indicating increased support

for law as their opinion of other drivers' ability to safely drive distracted decreased. More than half of the subjects believed they could safely operate both a vehicle and a cellphone at the same time, contradictory to the OSPAN assessment; in other words, most participants greatly overestimated their ability to safely drive and operate a cellphone simultaneously. Sanbonmatsu et al. noted the participants admitted the safety issues with cellphone use and driving, but rated drinking and driving as a greater threat with worse consequences and believed the benefits of distracted driving outweighed the associative risks. In short, the study subjects supported UTB and UHB law for other drivers, but not themselves.

Another simulator test by Merrikhpour and Donmez (2017) sought to understand the effectiveness of incorporating parent feedback mitigate teen driver distraction using post-drive feedback with normative information (social norms), post-drive feedback without normative feedback, real-time feedback, and no feedback against self-reported distracted driving behaviors of both parents and teens and view on social norms. Incorporating the Theory of Normative Conduct, the study looked at 40 parent-teen dyads recruited through online advertisement and flyers in local businesses in Quebec, Canada. The study found social norms proved the strongest influence on improved driving performance, while real-time feedback reduced distracted driving behaviors, tested by measuring timing secondary display glances. Braking times provided information on the effect of distractedness on driving behaviors, measuring time between stimulus (front vehicle brake light engagement) and removal of accelerator pedal (ART), time from gas

release to brake contact (BTT), and time from braking stimulus to contact with the brake pedal (ART + BTT) (BRT).

As the teens progressed through the five driving simulations, all braking times decreased with social norm feedback, followed by real-time feedback, with a one-millisecond average decrease (Merrikhpour & Donmez, 2017); however, no feedback provided the fastest accelerator pedal release time versus post-drive and real-time feedback. The greatest difference during the simulation proved the deceleration time, with social norms feedback and real-time feedback lowering the maximum deceleration the most. The questionnaires used to determine self-reported distracted driving behaviors and social norms views produced data commensurate with expectations, with teenage males reporting higher frequencies of distracted driving compared to their female counterparts, but no differences in parent driving behaviors based on gender. Interestingly, mothers' approvals of distracted driving influenced teen self-reported driving behaviors especially among female teen drivers, with teen distracted driving positively correlated with the perception among same-gender parent distraction engagement, but not in opposite-gender parents. While the study supported earlier findings related to self-reported distracted driving behaviors, the small sample size proved a limitation toward generalizability, but underscored the importance of social norms in reducing distracted driving among teen drivers.

Predicting Distracted Driving Intentions

Predictions based on the Theory of Planned Behavior. The Theory of Planned Behavior (TPB) states that an individual's attitudes, norms, and self-efficacy determine

their actions, allowing a prediction of behavior (Wang, 2016). The inclusion of articles using TPB to forecast behaviors related to distracted driving informs the current study by identifying what influences driver attitudes, informs driver norms, and impacts driver concept of personal driving abilities for or against distracted driving to predict who signs might influence.

Wang (2016) studied college student attitudes regarding distracted driving to determine the likelihood of engaging in the behavior through an internet-based survey of 555 undergraduate students at a single, unnamed university. The internet-based survey asked respondents questions about car ownership, driving conditions, and commute information before delving into attitude-based questions to predict driving behaviors related to mobile device usage while driving. The attitude functions measured involved risk-related functions, entertainment and information-related functions, value-expressive functions, self-esteem maintenance functions, as well as injunctive norms and efficacy; all used a seven-point Likert scale of measurement. After implementing a two-step structural equation, the study found the theory of planned behavior related to attitudes as measured in functions and efficacy explained 63% of intent to text while driving in the future. Injunctive nor descriptive norms demonstrated an impact on texting while driving behaviors and could not provide a predictive function in the data. Overall, respondents chose texting while driving to underscore feelings of popularity and to manage time more effectively.

According to a study by Gauld et al. (2017), TPB also provided positive predictors of distracted driving behaviors among college students. Gauld et al. created an

online survey to measure 17-25-year-old drivers' intent to initiate, monitor, and respond to social interactive technology, not merely texting or cellphone conversing, while operating a motor vehicle, using snowball sampling and university email lists to elicit responses. The study found those with a positive attitude toward initiating, monitoring, and responding to social interactive devices reflected believed acceptance of the behaviors by people they found important in the respondent's life. Furthermore, the study observed that those who felt they could still drive well while using social interactive devices indicated greater likelihood of engaging in the activities while driving. In other words, respondents whose social norms and personal belief systems aligned with the use of social interactive devices while driving revealed themselves as more likely to do so, in accordance with TBP. The secondary part of the study sought to find the influence of moral norms and anticipated regret on driving while using social interactive devices, demonstrating a direct correlation between perception of believing interacting with a social interactive device while driving as immoral and reduced intentions to do so. Gauld et al. found greater regret among respondents for not participating in the behavior than for doing so, with monitoring communications deemed a less risky behavior, therefore resulting in low regret for engaging in it. All told, the study indicated a strong correlation between perceived social and moral norms of participants and the likelihood to engage with social interactive devices while driving.

Another study by Stavrinos, McManus, and Beck (2020) sought to identify predictors of distracted driving behaviors through surveys grounded in TBP, this time among adolescents. Like the Gauld et al. (2017) study, Stavrinos et al. (2020) included

social media interactions, but also included texting and talking, like the study by Wang (2016). The study utilized surveys received from 379 high schoolers enrolled in a non-mandatory Driver's Education course and used a factor analysis to reveal four factors related to distracted driving beliefs. The surveys adhered to a TBP framework to determine acceptance of distracted driving, the threat thereof, the importance of phone monitoring, sensation seeking behaviors, and demographic information. Stavrinos et al. used multiple linear regression among seven variables (age, gender, licensure status, months since obtaining permit, average number of days driven per week, Brief Sensation Seeking Scale (BSSS) total score, and self-rated importance of checking cellphone after notification receipt) to predict the likelihood of engaging in distracted driving. The study found 82% of respondents believed hands-free conversations are acceptable and 40% felt hand-held talking is not necessarily safe, but it is tolerable. Most respondents (29.7%) indicated that talking on a cellphone is not a threat to personal safety, but other cellphone interactions (texting, emailing, social media interactions, and taking selfies) were, with results ranging from 77.23% to 85.30%.

Their findings indicated certain drivers, specifically males, drivers with more driving experience, and respondents with higher sensation seeking scores, felt less threatened by themselves or others practicing distracted driving than other respondents (Stavrinos et al., 2020). The research also noted the respondents who placed higher value in checking phone notifications held lower scores about the danger of distracted driving. One factor of particular interest in the study was that self-acceptance of distracted driving behaviors did not significantly correlate with overall distracted driving beliefs; in other

words, just because a driver drove distracted did not equate approval in others doing the same. The limitation of using only students enrolled in a non-mandatory Driver's Education course could affect outcomes and explain discrepancies in extant literature, such as males less likely than females to believe peer acceptance of distracted driving, a direct disagreement with a study by Carter Bingham, Zakrajsek, Shope, and Sayer (2014), even though it allowed the opportunity to ascertain responses from a large group of juveniles at a similar point in time (Stavrinos et al., 2020). The study underscored the idea of using TBP to predict distracted driving behaviors among drivers by bearing out a correlation between perceptions and likelihood of engaging in distracted driving.

Predictions Based on Identified Characteristics. This section deals with a study related to predicting distracted driving based on certain driver demographics, specifically age, gender, education level, and vehicle type driven. Again, the inclusion of information related to who might engage in distracted driving can inform the current research by identifying which drivers could notice signs and change behavior based on these inputs.

According to a study by Kim et al. (2019), states with UHB demonstrated less CPWD behaviors than those with only a UTB, a more than one percentage point difference (10.53% versus 9.49%) (Kim et al., 2019). However, 51.5% of drivers from UHB states continued to use phones while driving, with those holding college degrees reporting more use than others; the study did not specify whether a degree increased recklessness or if it simply meant greater candor about behaviors. The study included univariate, bivariate, and multivariate logistic regression to predict which drivers would engage in distracted driving through a self-report survey device from 321 respondents

combined with annual observation studies in Hawaii and vehicle miles of travel (VMT) data; the study utilized email and social media coupled with snowballing to obtain the 337 survey participants. Researchers evaluated age, gender, education level, and vehicle type driven against handheld device use while driving (including phone, GPS, gaming console, tablet, and handsfree speakers), the perception of safety of CPWD, likelihood of citations, and whether the driver had been in a CPWD accident or received a citation for CPWD; the study classified respondents by state of residence and type of handheld device use laws in that state.

Compared to the National Highway Travel Safety (NHTS), the mean age of respondents proved close at 48 years old, though the levels of education proved higher in this study, with 95.7% reporting some college attendance (Kim et al., 2019). Drivers in this study drove mostly cars (51.7%), followed by sport utility vehicles (SUVs) at 25.1%, then trucks at 15.9%, vans at 4.3%, other vehicle types at just over 2%, and less than 1% driving motorcycles; this study demonstrated more trucks and SUVs than the NHTS. Overall, 63% of respondents indicated handheld device use while driving, with 85% of those stating they answered phone calls, 75% dialing the phone to make calls, 75% using navigation, 55% texting, 43% listening to music, 30% checking emails, and 13% reading web-based content (Kim et al., 2019). Just over half of respondents indicated distracted driving was either unsafe or very unsafe, and 77% desired increased enforcement of CPWD (Kim et al., 2019); around 15% of participants had a wreck within the last three years and just over 5% received a citation for a UHB or UTB violation (Kim et al., 2019). Among Hawaii residents, observed cellphone use varied from 4.69% (2006) to 1.56% in

2017, though self-reported use held at 60% (Kim et al., 2019); the authors specifically noted that not all trips made by an individual reporting CPWD involved cellphone use (Kim et al., 2019). The study admitted the results probably underestimated the problem of CPWD and encouraged education on the hazards of CPWD (Kim et al., 2019).

Risk Management and Distracted Driving Engagement

The idea of risk management – mitigating negative behaviors based on contextual information – pertains to distracted driving as a way to predict not only when a driver might use a cellphone, but also to explain the context of the use, including what might override their beliefs and cause them to behave uncharacteristically. Moreover, risk management allows an evaluation of ancillary benefits produced by mitigations, including reductions in insurance claims after UTB and UHB installation. This section reviews the literature related to risk management framework, intervention technologies, and insurance claim information as they relate to distracted driving. This section bears on the current study as it provides insight into various factors supporting and negating UTB and UHB, similar to the use of signage to warn drivers not only about the UHB but also the dangers of distracted driving.

Parnell et al. (2018) conducted a qualitative study using the risk management framework to determine driver likelihood of engaging with various technological tasks across different road types. Thirty-minute-long semi-structured interviews conducted by the same primary researcher provided the data for analysis to determine self-reported reasons for engaging with technology while driving and the influencing factors determining CPWD behavior (Parnell et al., 2018). Researchers coded initial, descriptive,

and subthemes as multiple individual concepts, then refined them into 18 semantic themes from the 168 descriptive themes, arranged into four main categories of driver, infrastructure, task, and context (Parnell et al., 2018). After analysis, the researchers concluded the drivers adapted to the driving demands and road conditions by not engaging with technology during in more challenging driving environments, but drivers tended to engage with a device because of attention competition, regardless of driving demand (Parnell et al., 2018). Other statistically significant factors included journey type and length, familiarity with the road, and the complexity of the task (texting, talking, etc.), with drivers willing to engage in less complex tasks more often (Parnell et al., 2018).

Reagan and Cicchino (2020) conducted a study on the influence of cellphone blockers on distracted driving behaviors. The research included a telephone survey of 800 drivers who also own and use cellphones to determine the number that use cellphone blocker technology, specifically Apple's Do Not Disturb (DND) application (Reagan & Cicchino, 2020). The study identified only 20.5% of respondents owning DND-compatible iPhones actually used the DND application as designed, or when the phone was linked to vehicle Bluetooth automatically (Reagan & Cicchino, 2020). Those with DND active in manual mode admitted to rarely turning it on and did so during about a quarter of their trips, negating the efficacy of the technology (Reagan & Cicchino, 2020). Moreover, of the 73.6% of participants who knew they could override DND, 28.7% stated they overrode it about half or more of the time they drove (Reagan & Cicchino, 2020). Most respondents (93%) agreed with DND technology, and around three of four

believed all cellphones should have some type of DND technology (Reagan & Cicchino, 2020). DND usage negatively correlated with overall cellphone engagement (Reagan & Cicchino, 2020); or, as DND usage increased, overall cellphone use while driving decreased. The reliance on surveys limited the available insight into motivations for DND usage, which could provide important information on decreasing CPWD behaviors, though the correlations found in the findings could prove advantageous for future policies (Reagan & Cicchino, 2020).

Karl and Nyce (2020) looked at the relationship between distracted driving laws and automobile liability insurance claims. Using a multivariate difference-in-differences study design allowed the researchers to determine whether distracted driving laws lead to reductions in automobile liability insurance claim frequency and cost by acquiring data from the Insurance Research Council (IRC) and comparing at the state level (Karl & Nyce, 2020). Karl and Nyce (2020) looked at distracted driving law enforceability (primary versus secondary enforcement), applicability (all driver versus novice driver application), and type (UHB versus UTB); a strong ban equaled a primary enforcement UHB applied to all drivers, and a weak ban constituted a UTB for novice drivers enforced as a secondary offense (meaning law enforcement officers could not stop drivers for this offense alone) (Karl & Nyce, 2020). Research revealed that strong bans equated around 4,400 fewer claims resulting in roughly $33 million dollars savings (Karl & Nyce, 2020). Moderate and weak bans also showed savings, with a 7% reduction with moderate bans and 6% fewer claims where weak bans existed (Karl & Nyce, 2020). Overall, UHB bans produced significantly fewer and less serious insurance claims post-implementation

longitudinally, and all bans caused fewer and less severe losses among insurance claims, though the research did not account for improved safety features in motor vehicles as a correlation (Karl & Nyce, 2020).

Signage and Human Behaviors

Dynamic Message Signage (DMS)

This section includes research on the influence of dynamic signs (electronic signs with changing messages) and driver responses. The first study measured dynamic sign comprehension when engaged in distracted driving, while the second tested driver response to sign messages. This section directly related to the current study, which includes measurement of fatal accidents within a two-mile radius of both dynamic and static signs, as they involve driver reaction to dynamic signs.

A study by Tejero and Roca (2021) researched distraction levels of drivers involved in hands-free cellphone conversations while reading DMS through driving performance indicators and heart rates using a driving simulator. Participants needed to distinguish between informative messages and warning messages while driving at or near the speed limit along a 28-kilometer route and talking on a phone hands-free (Tejero & Roca, 2021). Of the 18 participants, none showed significant loss of driving performance in speed or lane position, nor did heartrate changes emerge, when distraction presented during the simulation (Tejero & Roca, 2021); however, talking on the cellphone impeded drivers from correctly and quickly processing sign information, with answering questions creating the greatest difficulty in processing (Tejero & Roca, 2021). In short, while

driving did not appear influenced by hands-free talking, the ability to process DMS traffic messages proved negatively affected by it (Tejero & Roca, 2021).

A study by Kelarestaghi et al. (2020) researched the influence of DMS on driver behavior. The researchers used a multivariate ordered response structure to determine driver speed changes resulting from false or fictious messages on DMS; the survey used a five-point Likert scale (*extremely unlikely* to *extremely likely*) to answer whether the driver would (a) do nothing; (b) speed up; (c) slow down; or, (d) stop, in response to four different messages (road closure due to police activity, heavy traffic due to accident, read the news today, oh boy, and zombies ahead run). The data indicated those with greater trust in DMS and disabled drivers tended to comply with DMS messages, as they answered the survey questions advising they would reduce their speed or stop in accordance with message demand. Individuals with long commutes and Caucasian respondents mostly ignored the DMS, though most participants did not indicate increasing speed in any scenario. Females, DMS trusting drivers, and tech-friendly drivers noted a likelihood to slow down, and African-Americans, drivers with poor sense of direction, and careful drivers would probably stop for the message “road closure due to police activity”. Scenario three (*read the news today, oh boy*) results demonstrated white drivers, those with long commutes, and drivers familiar with DMS would mostly ignore the message, with most respondents choosing the slow down option. Young drivers (ages 25-34) showed a negative attitude to the *do-nothing* choice across scenarios, while the *slow down* and *speed up* choices had the lowest positive correlation among choices across scenarios. Most drivers indicated they would slow down in scenarios one and two, with

drivers indicating they would take photographs, check their radio, look around, and/or change their route based on the message, while several indicated they would take pictures, check the radio, or call/text with scenarios three and four. Females, African-Americans, disabled drivers, elderly, and those trusting DMS reported compliance by slowing down or stopping regardless of the messages versus those with longer weekly driving times ignoring the messages.

Road Signage Comprehension and Efficacy

A study by Moomen et al. (2019) tested whether downgrade warning signs prevented truck crashes. Downgrade warnings are notices to tractor trailers and other large vehicles about upcoming steep downhills that could cause brake failure or the driver to lose control of the vehicle, typically resulting in very serious accidents. The study applied a propensity score analysis and logistic regression to determine crash outcomes in locations of Wyoming with warning signs against those without, as propensity score analysis mimics a randomized experiment where a randomized experiment is not possible. The study found a 15% decrease in truck crashes on downgrades without warning signs versus those with advance warning signs at a 90% confidence interval. The researchers admitted possible bias through the exclusion of unmeasured covariates but denoted the impossibility of including all possible covariates. Incorporating intelligent transportation systems into existent warning systems could further improve crash prevention to automatically reduce truck speed approaching downgrades.

A study by Bortei-Doku et al. (2017) sought information on the influence of the number of road signs on comprehension of messages. Bortei-Doku et al. utilized a survey

with seven-point Likert scales (never to always) to rate specific maneuvers legality based on signage present, along with demographic data (age, gender, place of residence, income, driving frequency, professional experience, and field experience); the research used an anthropocentric perspective theory with Cronbach's Alpha and principal axis factoring for analysis of the 753 participant answers. Overall, males correctly identified a higher number of legal maneuvers than females, though females noted more conflicts between the original pictures and the corrections. Younger respondents reported less safety improvement in the comparative photographs, as did cyclists and pedestrians. Those reporting higher anxiety factor scores had higher estimations of the number of legal maneuvers with a lower perception of safety while more distracted drivers had lower safety perceptions but higher improvement perceptions. The research confirmed all hypotheses, indicating driver characteristics influenced perceived safety and ability to process sign messaging correctly.

Xie et al. (2019) conducted a study with similar goals as Bortei-Doku et al. (2017) to determine driving workload and performance based on sign information, with the added evaluation of road characteristics. The study utilized a driving simulator, and it applied an orthogonal design and Pearson correlation analysis among the 11 participants (10 males and one female; Xie et al., 2019). Four factors – radius, slope grade, traffic flow, and sign information – provided the test against driving workload and performance across 16 scenarios, with participants tested on driving performance (measured on driving speed and lane maintenance) and ability to recognized signs during driving. Road characteristics and sign information significantly influenced workload scores, while

traffic volume proved not a statistically significant affectation on workloads. Mean of lane deviation and the standard deviation of lane deviation showed positive correlations with sign information, as driving performance decreased (indicated by increased lane deviations) based on the amount of sign information for processing.

Yang et al. (2020) researched driver gaze behavior to determine the influence of highway traffic signs on driver performance toward accident prevention. As with the Xie et al. (2019) study, the researcher found that increased sign information increased cognitive needs of the driver to avoid accidents (Yang et al., 2020). The study utilized a simulator introducing visual stimuli while advancing through a scenario and measured eye movements with tracking technology. The study revealed that warning signs increased driver glance speeds against areas without warning signs, and areas with mixed signage (warning and informational) caused more glancing than those without signs, but not as much variation as areas with warning signs alone. The research suggested a reduction in road signs in locations demanding greater driving concentration, such as curves, to relieve stress on driver visual loads and increase driver safety.

Speed Reduction Signs and Driver Response

Research by Glendon et al. (2018) researched the influence of anti-speeding signs (designed to appeal to drivers to obey the posted speed limit) and driver behavior. The mixed-methods research involved an initial questionnaire ranking anti-speeding messages according to the six components of protection motivation theory (PMT), including possible reasons for their rankings (open-ended question responses), as well as group discussion. Furthermore, the 36 participants responded whether the anti-speeding

messages applied to themselves and/or other drivers more. According to the study, short, logically-presented, positive messages a driver could apply in their circumstances proved most effective for causing a driver not to speed for both drivers, riders, and self-as-driver.

Glendon and Prendergast (2019) also conducted a study on anti-speeding messages, this time utilizing only surveys to determine efficacy of this signage. A total of 81 participants in Australia responded to an online survey related to effectiveness of anti-speeding messages for themselves and drivers in general. Like the previous study, PMT provided the framework for the study and included self-as-driver responses, though this study also looked at gender to determine efficacy of signage and avoided qualitative measures. Results indicated messages emphasizing resulting harm for others more effective among self-as-driver responses, with penalty-focused messages more effective for drivers in general. When the researchers looked at male versus female responses, the results proved similar between the genders, with negligible variance. The study demonstrated the effectiveness of PMT in predicting appropriate anti-speeding messages, indicating needed expansion of PMT-driven research and application in the field.

Roadside Warning Sign Efficacy

A study by Meuleners et al. (2020) evaluated whether traditional painted warnings versus roadside signs proved more effective in reducing crashes at high-risk rural intersections. The research involved a total of 384 physical observations of 96 drivers between 18 and 80 years of age in a driving simulator with a two-way ANOVA test providing the results. Findings showed that the standard speed limit sign proved most effective at reducing speed than all other measures among all drivers. Intersections with

no signage demonstrated a speed greater than 20 km/h over the speed limit of 80 km/h, while intersections with the posted speed limit sign averaged a speed two km/h lower than the posted speed; painted *slow down* signs produced speeds above the posted speed limit, while roadside *slow down* signs had no measured effect. The study did not assess deceleration, reactions time, or mean speeds, but proved the roadside speed limit sign slowed all drivers with the greatest efficacy and efficiency.

Vignali et al. (2019) conducted an eye-tracking study to determine effectiveness of work zone signs. The study measured visual fixations of 29 participants to determine which signs worked best to gain driver compliance and reduce risks in work zones. The study found that drivers looked at road signs with only a 40% probability regardless of their permanency, with both temporary signs and permanent signs receiving similar attentions. Experienced drivers tended to drive faster through work zones than inexperienced drivers, but neither age nor gender influenced speed, fixation frequency, fixation length, or fixation distance. Older drivers and novice drivers reduced speed faster than all other drivers, but no other variance was presented in the study. The study could not measure visual periphery notice of signs, but the overall results demonstrated drivers tend to ignore more than half of all road signs.

Banares et al. (2018) conducted a study to measure the comprehension of redesigned road warning signs for Philippine roadways through questionnaires. The first questionnaire produced 21 of 40 of the original signs below the 85% comprehension threshold among the 90 respondents, while only six of the redesigned signs could not meet or exceed the 85% comprehension threshold; all the redesigned signs demonstrated

significant improvement in comprehension by the respondents. The original signs did not include any explanation of the warning associated with the sign, while the new signs incorporated an ergonomic sign with an explanation of the meaning to improve long-term comprehension. The study centered on warning signs only, excluding informational, guide, and regulatory road signs.

A study by Rahman and Kang (2020) looked at the effectiveness of a drowsy driving advisory system in Alabama. The drowsy driving advisory (DDA) system uses both roadside safety signs and road surface treatments to combat drowsy driving by encouraging drowsy drivers to rest at a safe location. The DDA includes a *gate post* sign, indicating an area known for drowsy driving, a warning sign section, and an advisory sign. The study evaluated total crashes and drowsy driving crashes (expanded definition drowsy driving (EDD), probable drowsy driving (PDD), and strict definition drowsy driving (SDD)) against crashes in DDA areas prior to installment of the warnings. The empirical bayes (EB) analysis revealed a total drop of 59.5% in area one and a total drop of 29.6% in area two in the three years after DDA implementation, with a reduction of 44.1% EDD crashes in area one and 15.8% in area two, 54.6% reduction of SDD crashes in area one and 25.0% in area two, and a drop of 39.1% PDD crashes in area one and 9.1% in area two. The data demonstrated the need for DDA and rest areas to reduce drowsy driving related crashes in rural areas.

Signage Efficacy in Changing Other Behaviors

Wu et al. (2018) researched the influence of waste disposal signage on waste disposal behaviors, specifically what information to include and how to present it. The

researchers used two simulation experiments, the first with 43 university students and the second with 20 university students and applied a 2 x 2 x 2 ANOVA for outcomes. The study revealed that signs with images only led to greater compliance with desired behaviors in experiment 1 verses signs with words, with standard picture signs yielding the fastest compliance. Experiment 2 demonstrated consistency in sign positions and receptacle location resulted in better outcomes than random positioning, and *yes* signs placed to the left and *no* signs to the right improved sorting efficiency though *yes* only signs produced significantly better results overall. Simple pictures, consistent placement, and reduced information proved the best signs for sorting efficiency and compliance with tasks. The influence of sign familiarity did not gain attention in this study.

A qualitative study by Issel et al. (2019) investigated whether tobacco-free parks ordinance signage reduced tobacco related litter. The researchers looked at 42 parks across Mecklenburg County, North Carolina, and they found tobacco-use evidence at about 80% of all parks. The study took a total of 972 photographs throughout the 42 parks, averaging 23 photographs per park taken in about 58 minutes. According to photographic data, 67% of walking trails, picnic areas, and parking lots had evidence of tobacco use, with limited evidence at athletic course (23%) and play areas (29%) across the parks even with 87% of parks having signage announcing the tobacco-free status; this indicated that signage alone did not influence tobacco use behaviors. The study found an average of 16.95 acres per sign, with a wide variety among parks. The signs present were small, pale-colored, and mostly located at the park entrances and entrances to walking

trails with only the words “tobacco-free park” on the sign. The results of this study align with the previous study regarding the message and placement of signs for efficacy.

Like the previous study, the research by Saunders et al. (2019) looked at signs in parks, though this study focused on safety messages in national parks in Australia. The study looked at four categories to determine best practice principles (BPP) for signage: 1) noticeability; 2) encoding; 3) comprehension; and, 4) compliance. Researchers conducted detailed reviews of the areas, including previous incidents at these sites, context, safety signage, and relevant infrastructure against the BPPs through semi-structured observations, assessments, on- and off-site analyses, and an internal audit by operational staff. The study used a *presence-or-absence of characteristics* methodology to establish efficacy of signage in relation to BPPs, finding most signs in compliance with BPP; the *presence-or-absence* demanded some subjectivity in assessment, with evaluators deferring to a *predominately achieved* status. While the majority of signs met BPPs, the research noted several groups of signs, which could overwhelm visitors and negate the four best practices for signs, and potential confusion related to color schemes, with the colors yellow and red used as corporate colors instead of indicative of warning. Overall, the signs present met expectations, and the research provided a tangible way to evaluate signage for efficacy.

Summary and Conclusions

This chapter covered an extensive look at the theoretical framework of the study, the dependent variable of the study (fatal motor vehicle crashes), and the independent variable of the study (signs). SCPT, the theoretical framework for the current study, helps

explain the linkage between signs and UHB compliance. Studies using SCPT have demonstrated that manipulating the environment prevents and deters crime. The installation of signs on Georgia's interstates can help remind drivers to avoid distracted driving to increase driver safety. This study filled a gap in the literature by determining whether UHB signs reduce motor vehicle fatalities on Georgia interstates.

Distracted driving contributes to motor vehicle crashes, resulting in injuries, fatalities, and property damage, and UTB and UHB work to discourage these behaviors to save lives (Chen & Lym, 2021; Ferdinand et al., 2019; French & Gummus, 2018; Gliklich et al., 2016; Lim & Chi, 2013; Rudisill et al., 2018a). Even with UTB and UHB, some drivers continue to engage in distracted driving despite UTB and UHB because they do not perceive distracted driving as risky behavior as evidenced by current enforcement levels (Rudisill et al., 2018b; Rudisill & Zhu, 2021; Rudisill & Zhu, 2017), or because they overestimate their driving abilities as proven by simulator testing (Choudhary et al., 2020; Li et al., 2019; Sanbonmatsu et al., 2016; Merrikhpour & Donmez, 2017). Furthermore, moral and legal norms help explain whether drivers consider distracted driving an acceptable behavior, influencing their participation in distracted driving (Kim, 2018; Nguyen-Phuoc et al., 2020; Shi et al., 2016; Terry & Terry, 2016), while the Theory of Planned Behavior helps predict which drivers might drive distracted (Wang, 2016; Gauld et al., 2017; Stavrinos et al., 2020). With the demonstrated deleteriousness of distracted driving, understanding why drivers engage in the behavior becomes more important. Therefore, investigating how risk management interventions help contextualize distracted driving behaviors – participation or avoidance

– allows scholars and researchers to determine why or why not a driver might drive distracted (Parnell et al., 2018; Reagan & Cicchino, 2020; Karl & Nyce, 2020). Even though the study by White et al. (2018) found no increase in wrecks with increased numbers of cellphone users, it did not investigate whether the damage caused by motor vehicle accidents increased, and they still advocated for UHB and UTB, understanding the dangers of distracted driving and need for interventions to prevent it, such as signs.

Signs work as informatory interventions to gain compliance with certain behaviors, including distracted driving mitigation. Both dynamic and static signage influence driver behaviors to varying degrees (Banares et al., 2018; Bortei-Doku et al., 2017; Glendon et al., 2018; Glendon & Prendergast, 2019; Kelarestaghi et al., 2020; Meuleners et al., 2020; Moomen et al., 2019; Rahman & Kang, 2020; Tejero & Roca, 2021; Vignali et al., 2019; Xie et al., 2019; Yang et al., 2020). The reminders and instructions provided by signs tell people what they should do, why they should do it, or how they should do it (Wu et al., 2018; Issel et al., 2019; Saunders et al., 2019). The inclusion of signs to instruct individuals helps dictate behaviors, working as an environmental intervention to deter or encourage specific behaviors.

Chapter 3 provides a detailed description of the proposed methodology for this study. This includes a presentation of the research question and hypotheses, as well as the study variables. Additionally, it contains a description of the nonexperimental quantitative design approach and its justification while identifying the target population, sampling strategy, and sampling procedures. The chapter also covers the statistical

testing, data analysis plan, and potential validity threats, and concludes with a summary of the research design.

Chapter 3: Research Method

In Chapter 1, I introduced Clarke's SCPT as a method to inform policymakers on the efficacy of signage for encouraging compliance with distracted driving laws. The purpose of this study was to discover a possible relationship between signage and the number of motor vehicle accidents in the state of Georgia after UHB implementation. This study used the number of signs present before and after legislation implementation to determine whether motor vehicle fatalities on Georgia interstates increased, decreased, or remained the same. This chapter provides an overview of the study's nonexperimental quantitative research design using secondary data to examine motor vehicle crash data to determine efficacy in reducing motor vehicle fatality accidents post-legislation change.

Findings from this study can be used to demonstrate whether states with UHB should increase the number of signs related to legislation to help decrease the number of motor vehicle fatality accidents. Chapter 1 established the background of the study, the purpose and problem statements, as well as the research question for the study. The literature review in Chapter 2 provided a rationale for this study. This chapter includes the identification of the independent variable, the dependent variable, the research question and hypotheses, a description of the population, sampling size and procedures, data collection plans and access, verification of validity of the sources, the data analysis plan, and the threats to validity of the study to help explain the rationale of the study, as well as implementation.

Research Design and Rationale

Independent and Dependent Variables

The independent variable for this research is the number of state-installed signs on Georgia interstate rights-of-way. The dependent variable is motor vehicle fatality accidents on Georgia interstates, an interval variable. Accidents occurring from July 1, 2016, through June 30, 2018, create the first or control group, while the accidents from July 1, 2018, through June 30, 2020, populate the second or treatment group. The independent treatment variable—signage—is dichotomous, with zero ($n = 0$) representing the lack of distracted driving law signs 2 years before the implementation of the law on July 1, 2018, and one ($n = 1$) signs in the 2 years after the law went into effect through June 30, 2020. These variables proved straightforward for analysis. The study does not include any control variables or additional variables.

Table 1

Variables, Type, and Entity Providing Data

Variable	Type	Data source
Dependent – Motor vehicle fatalities	Interval	NHTSA FIRST Database
Independent – Presence or absence of signs on Georgia interstate rights-of-way	Dichotomous	Georgia Department of Transportation

Note. NHTSA FIRST = National Highway Traffic Safety Administration Fatality and Injury Reporting System Tool.

Research Design and Connection to the Research Question

This study employed a nonexperimental quantitative research design involving secondary data (see Bachman & Schutt, 2019). A quantitative analysis of the dependent

variable (motor vehicle accident fatality numbers) against the independent variable (number of signs) provides a longitudinal evaluation of the phenomena. Multiple studies involving signs and driving have used surveys or simulators to discover sign effectiveness, though none used secondary data (Banares et al., 2018; Bortei-Doku et al., 2017; Glendon & Prendergast, 2019; Glendon et al., 2018; Kelarestaghi et al., 2020; Meuleners et al., 2020; Moomen et al., 2019; Rahman & Kang, 2020; Tejero & Roca, 2021; Vignali et al., 2019; Xie et al., 2019; Yang et al., 2020). Few studies in the literature review relating to the variables employed secondary data, and all of them focused on driver demographics, enforcement issues, or urbanicity of driving (Rudisill et al., 2018b; Rudisill & Zhu, 2017, 2021; Zhu et al., 2016). One of the studies included in the literature review related to SCPT used secondary data to determine the efficacy of intervention on criminality (Lynch et al., 2018), making this a logical deployment for this study. Since I did not use surveys in this study and focused on only the number of incidents of motor vehicle fatalities as compared to the number of signs on the road pre- and post-legislation to answer the research question, it was logical to apply a nonexperimental quantitative research design using secondary data.

Time and Resource Constraints

The data used for this study included crash data from the NHTSA and the Georgia GOHS and information provided by the organization responsible for sign installation on Georgia rights-of-way. The data for the dependent variable in the study came from NHTSA's Fatality and Injury Reporting System Tool (FIRST), which can be confirmed through GOHS databases; all of this information is publicly available. The organization

in charge of sign installation on Georgia interstate rights-of-way is the source for the independent variable of signs, though the presence or absence of signs is the variable, no data must be collected from this agency; should a person desire traveling every interstate in Georgia to determine sign locations, they could do so. An Open Records Act request could also provide the data on sign locations, but it was not necessary for this study. This allowed for few time constraints in obtaining the data, since anyone can conduct the search of the NHTSA and GOHS websites to collect the necessary information related to motor vehicle fatalities, and anyone can file an Open Records request from the partner organization to receive information related to the number of signs on Georgia interstate rights-of-way. According to Open Records laws, a responding agency must return the requested information within three business days (Open Records Act, 2012).

Consistency of Research Design

After the data were gathered for evaluation, the use of a longitudinal nonexperimental quantitative research design permitted a straightforward evaluation of the efficacy of the signs in reducing the number of motor vehicle fatalities. Multiple studies explored driver demographics and other characteristics to determine propensity to commit the offense of distracted driving (Choudhary et al., 2020; Li et al., 2019; Merrikhpour & Donmez, 2017; Rudisill et al., 2018b; Rudisill & Zhu, 2017, 2021; Sanbonmatsu et al., 2016), while others examined the influence of signage on individual behaviors, including driving (Banares et al., 2018; Bortei-Doku et al., 2017; Glendon & Prendergast, 2019; Glendon et al., 2018; Issel et al., 2019; Kelarestaghi et al., 2020; Meuleners et al., 2020; Moomen et al., 2019; Rahman & Kang, 2020; Saunders et al.,

2019; Tejero & Roca, 2021; Vignali et al., 2019; Wu et al., 2018; Xie et al., 2019; Yang et al., 2020). The application of SCPT as a theoretical framework to identify a correlation, if any, between signs related to distracted driving and the number of motor vehicle fatalities allowed a blend of the two categories of previous research without concern of researcher bias. Secondary data collection combined with the application of a paired-sample, two-tailed *t* test helped advance knowledge in the discipline by demonstrating the effectiveness of manipulating environments with signs to stop criminal activity.

Methodology

Population

The population of the study is the entirety of all fatal motor vehicle accidents occurring on interstates in Georgia from July 1, 2016, through June 30, 2020. A total of 15 active interstate systems exists in Georgia, accounting for 1,247 miles of roadway out of the state's 104,474 miles of public roadways, or 1.2% of Georgia's public roads (Georgia Department of Transportation, 2022, 2022a). According to the NHTSA FIRST database, a total of 792 fatality motor vehicle crashes occurred on Georgia interstates from July 1, 2016, through June 30, 2020. The number of motor vehicle fatality accidents on Georgia interstates, broken down by month, provided the information for analysis. The data retrieved from the NHTSA FIRST allowed the breakdown. The numbers indicate only the number of accidents, not the number of fatalities per accident, since multiple factors can increase the number of deaths per accident.

Sampling and Sampling Procedures

G*Power software for determining minimum sample sizes indicated a minimum sample size of 15 for each group where each month represents a potential sample, and the groups pertained to the 2 years before the signage installation versus the 2 years after the signage installation. Samples for the study will be selected randomly by the SPSS software through the randomization tool. Thanks to the use of secondary interval data for each variable, the entire population was included for sampling, as no distinguishable reasons posed to exclude any member of the population of either variable. Each group contains a total population of 24. The designated alpha for the study was 0.05, with a 95% confidence interval to prevent a Type I error and erroneously reject the null hypothesis. Since both groups contained an equal number of months, the ratio for the analysis equaled 1. G*Power indicated a noncentrality parameter of 4.000 to produce a calculated degree of freedom as 15 and alpha of 0.05, which provided a critical *t* value output for this study as 2.1314495 at an actual power of 0.9618851, or 96.2%. The standard deviation for the study to determine the sample size was assumed 1 for both groups, since there was no discernable reason to believe the populations would have any difference.

Use of Archival Data

The study used secondary data retrieved from various sources. NHTSA FIRST provided a breakdown of accidents per month during the time span indicated. GOHS data can be used to verify the NHTSA data. Both NHTSA and GOHS data allow open access to all interested parties via the Internet; the NHTSA tool permits the manipulation of

information to obtain specific data for interpretation. Anyone can download the GOHS data present on the internet pertaining to accident information, but the data cannot be manipulated to provide specific information; however, the GOHS data can confirm the NHTSA data and vice versa. If necessary, Georgia Department of Public Safety records could confirm the NHTSA and GOHS data through Open Records Act requests. The organization in charge of sign installation on Georgia interstate rights-of-way provided the data related to signs on Georgia interstate rights-of-way, obtained through internet searches; this information could be confirmed by any person wanting to drive these roads and count signs and through Open Records Act requests. All secondary data have independent confirmation available to confirm veracity.

Prior to any gathering of information, I obtained Walden University Institutional Review Board (IRB) approval of the research. After submission of Form A, Walden University IRB returned confirmation of approval for the study on August 17, 2023. The IRB approval number is 08-17-23-0550166.

Data Analysis Plan

The data were entered into SPSS for evaluation using a paired-sample, two-tailed *t* test to compare the mean of the populations (see O'Sullivan et al., 2017). A comparison of means *t* test allowed an assessment of the two groups of the dependent variable, divided by date, with Group 1 containing the number of motor vehicle fatalities occurring on Georgia interstates between July 1, 2016, through June 30, 2018, entered by month, and the Group 2 including the motor vehicle fatalities on Georgia interstates from July 1,

2018, through June 30, 2020, entered by month. The separation point between the groups is the independent variable of number of distracted driving law signs present.

Data Cleaning and Screening

Since the data are secondary and contain no identifying information, the data presented few issues with cleaning and screening. Since the data came from the NHTSA FIRST database, running multiple tests to determine the veracity of the results provided the only screening process necessary. A check of additional sources through GOHS can confirm the data, working as a cleaning procedure and additional screening process. Using a third party to verify the numbers are correctly input would also prevent any cleaning or screening issues. There were no other cleaning or screening procedures necessary for this dataset.

Analysis Plan

The research question and hypotheses for the research were as follows:

- RQ: What is the impact of roadway signage on the number of fatality motor vehicle accidents on Georgia interstates?
- H_0: Roadway signage has no influence on the number of vehicle accidents with fatalities on Georgia interstates as measured by a comparison of means *t* test.
- H_1: There is a negative correlation between roadway signage and the number of fatal vehicle accidents on Georgia interstates as measured by a comparison of means *t* test.

The data for the study involved only secondary data retrieved from the NHTSA FIRST online database, filtered by date (July 2016 through June 2020), state (Georgia), and road type (interstate). Reports from GOHS confirmed the NHTSA data. No data were required from the organization in charge of sign installation on Georgia interstate rights-of-way, though a request for the number of road signs present on interstate rights-of-way in 2016, 2017, 2018, 2019, and 2020 could have been obtained from the masked entity if required.

The NHTSA data were entered into SPSS, with Group 1 containing the accidents per month on Georgia interstates from July 2016 through June 2018, and Group 2 containing the accidents per month on Georgia interstates from July 2018 through June 2020. The statistical test for use to test the data was a paired-sample, two-tailed *t* test, since both groups have the same number of samples per group. The statistical formula for a paired-sample, two-tailed *t* test is

$$t = \frac{\bar{x}_{diff}}{(s_{diff}/\sqrt{n})} \text{ or } t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\left[\frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1+n_2-2}\right]\left[\frac{n_1+n_2}{n_1 n_2}\right]}}$$

where $\bar{x}$ is the sample mean, $\bar{x}_{\text{diff}}$ equals the sample mean of the differences, *s* is the sample standard deviation, s_{diff} equals the difference in sample standard deviations, s_1^2 as the variance for Group 1 and s_2^2 as the variance for Group 2, and *n* equals the sample size, or number of pairs, with n_1 representing the population of Group 1 and n_2 for the population of Group 2 (Salkind & Frey, 2021); each group has a population of 24.

Additionally, a computation of the effect size, using the formula

$$ES = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{\sigma_1^2 + \sigma_2^2}{2}}}.$$

Where ES is the effect size, $\bar{x}_1$represents the mean of Group 1, $\bar{x}_2$ represents the mean for Group 2, and $\sqrt{\frac{\sigma_1^2 + \sigma_2^2}{2}}$ is the pooled or averaged standard deviation (σ) from either group, with σ_1^2 equaling the variance of Group 1 and σ_2^2 representing the variance of Group 2 (Salkind & Frey, 2021). The result of the paired-sample *t* test and effect size test will determine whether to reject or accept the null hypothesis with a confidence interval of 95% and α = 0.05, with a rejection of the null hypothesis equating no significance in changing the outcome of fatality accidents with the presence of road signs about the distracted driving law when $p < .05$ (Salkind & Frey, 2021).

Threats to Validity

Since the application of statistical tests results in data for interpretation, it is important to understand that the research is actually measuring what it says it measures (Salkind & Frey, 2021). The test must also work well to provide answers for the research question in the way it intends (Salkind & Frey, 2021). For this study, an evaluation of external validity, internal validity, and construct validity was completed to determine whether the statistical tests were appropriate to measure the influence of distracted driving law signs on motor vehicle fatalities on Georgia interstates according to SCPT directions.

External Validity

External validity is the initial type of validity to be addressed. The idea of external validity refers to the extent to which a study's results can be generalized from the

population of the study to the entirety of all similar populations (see Bachman & Schutt, 2023). In this study anything that threatens the ability to apply the results to multiple states or multiple roadway types would be considered a threat to external validity.

Some external threats to validity presented in the study. The first threat to external validity related to a focus only on Georgia interstates. Since the data involved only fatality accidents on Georgia interstates, the potential to generalize the data to all states or all roadways may not exist. One way to combat this involved including multiple years' data in the study; by using a total of four years' data, broken into two groups, the ability to generalize the information increases, as larger populations apply more easily to more groups. Additionally, the isolation of Georgia interstates increases validity, since the road composition of interstates is federally regulated, making increasing similarity across the country. On the other hand, the exclusion of any other type of roadway beyond interstates could be a threat, as all interstates have a minimum of four lanes of travel, two for each direction; this would prevent the application of this study to two-lane roads. Furthermore, the weather patterns in Georgia also work to threaten external validity, since Georgia weather differs from other parts of the country, making generalization of data less likely. Lastly, the use of only fatality motor vehicle crashes also mitigates generalizability, since multiple factors influence whether individuals die in motor vehicle accidents, including the vehicles involved, weather patterns, and various driver factors. While several external validity threats exist, the information from this study can be applied to other states and roadways with similar characteristics and legislation.

Internal Validity

Just as the study must consider external validity, it must also look at internal validity. Internal validity, also known as causal validity, looks to ensure that an assertion truly causes the result (see Bachman & Schutt, 2023). While nonexperimental design research tends not to control for internal validity threats because it cannot help but demonstrate the presence or absence of change in a group after an intervention (Rassel et al, 2016), this study must still consider the possibilities. In this study, the question becomes whether signs influence the number of motor vehicle fatalities, with signs being the assertion and motor vehicle fatalities the outcome. Only one internal validity threat emerged in the study, specifically the exclusion of control variables to explicate any difference that might emerge. Individual driving habits vary over time, making the use of a longitudinal study a way to diminish these influences a positive choice. Limiting the study testing to a comparison of means *t*-test permitted a focus on the variables without clouding the issue. The longitudinal aspect without control variables permits the study to correctly test the influence of the independent variable on the dependent variable.

Construct Validity

While the internal validity issue might influence the outcome, construct validity must be addressed. Construct validity is defined as the ability of a test to appropriately measure what it intends to measure (Babbie, 2016). The construct validity question related to the lack of a survey could mitigate the full measure of the interaction of variables. By excluding a survey answered by drivers on Georgia interstates to determine the influence of signage on driver behavior, the study may not correctly reflect the full

impact of signage on motor vehicle fatalities on Georgia interstates. Another threat to construct validity is the installation of the signs with coverings prior to the law effective date; the use of longitudinal data should mitigate this issue, which would cover at most a two-month timeframe. In this study, a *t*-test provided the pathway to determine whether the signs influenced the number of motor vehicle fatality accidents. By including two years' data in each group and including the number of state-installed signs for each month gave a direct comparison mode for analysis. As noted in both the external and internal validity sections, driver habits and weather influence the number of motor vehicle fatalities, making the longitudinal nature of the study a way to mitigate these problems.

Ethical Procedures

While some threats to validity were presented in the study, ethical procedures did not cause concern. The use of secondary data reduced ethical questions for this study. By using publicly available data from NHTSA which could be confirmed through publicly available data from GOHS and data from a partner organization, identified as such in the IRB documentation, mitigates most ethical questions. The independence of the organizations from one another and the use of publicly available data minimized the ethical question. The use of NHTSA data, data independent of Georgia sources yet confirmable through Georgia sources, and use of masking to prevent identification of the organization in charge of sign installation on Georgia interstate rights-of-way proved the ethically smart move. The use of NHTSA data confirmed by GOHS data will remove the ethical question of using one set of data versus the other and allow for independent

verification of the data from unrelated and unaffiliated data. Additionally, masking the identity of the partner organization circumvented potential appearance of duplicity or obfuscation.

The presentation of accountability and transparency provided by the articulation of the agencies elevated the idea of ethical behavior in the study. Using only the number of motor vehicle accidents without any indicators or information about the individuals involved reduced ethical questions related to identity of individuals. Since the data only included the actual number of motor vehicle accidents, not the number of individuals who died pursuant to those accidents, further prevented any ethical questions about the identity of people involved in the accidents, as there is no way to identify those involved. The lack of involvement of individuals in the study prohibited ethical issues. The handling of information did not demand any special treatment to ensure anonymity or confidentiality, since the number of accidents had no attachment to names.

Summary

To answer the research question, a comparison of means paired-sample, two-tailed *t*-test allowed the research to retain focus on the independent variable of signage against the dependent variable of motor vehicle fatality accidents on Georgia interstates. All data for the study comes from publicly available sources which can be verified through alternative and unrelated entities. The design choice combines the methodologies used in prior research yet fills a gap through the application of SCPT to determine the effectiveness of signs in reducing motor vehicle fatalities, especially those related to distracted driving.

The target populations of signs and motor vehicle fatality accidents counted by month in the two years before the legislative change and two years post-legislation give a population of 48, as the interval data will be entered by month, and each group contains 24 months. G*Power software indicated a sample size of seven for each group with a designated *p* value or alpha of .05, with a 95% confidence interval to prevent a Type I error and demonstrate significance of results. The nonexperimental quantitative study will use archival data which requires no cleaning or screening, and, according to Georgia law, must be available within three business days of an Open Records request (Open Records Act, 2012). Once data were collected, the information was entered into SPSS by month, and a paired-sample, two-tailed *t*-test was performed to compare the mean of Group 1, or the number of motor vehicle fatality accidents before sign installation, against the mean of Group 2, or the number of motor vehicle fatality accidents after sign installation. An effect size computation determined the level of significance of the results.

Though the data is limited to a single state and roadway type, a longitudinal approach improved the likelihood that the study adequately tested the premise of the study while increasing the generalizability of the results. Transparency of data through multiple sources and the use of secondary data removed most ethical concerns for the study; the information involved only numbers, eliminating questions of anonymity and confidentiality. This study filled the gap in determining the influence of SCPT on distracted driving legislation compliance through the comparison of means.

In Chapter 4, I discuss the data collection process and a description of all tests done on the data. The chapter also contains a discussion of the results of the study,

including the exact statistical tests applied, the confidence intervals, and effect sizes. Tables and figures were included to help explain the data and results. Finally, the chapter concludes with a distinct and direct answer to the research question and confirms one of the hypotheses of the study.

Chapter 4: Results

The purpose of this quantitative, nonexperimental longitudinal study was to determine the efficacy of signs on distracted driving law compliance as measured by a comparison of means *t* test. The problem with distracted driving is well researched, but the efficacy of signs in relation to distracted driving law compliance is not, and the application of SCPT to distracted driving compliance is not known until now; this study sought to fill the gap in the literature regarding SCPT and distracted driving law compliance. The research question and hypotheses for this study were as follows:

- RQ: What is the impact of roadway signage on the number of fatality motor vehicle accidents on Georgia interstates?
- H_0: Roadway signage has no influence on the number of vehicle accidents with fatalities on Georgia interstates as measured by a comparison of means *t* test.
- H_1: There is a negative correlation between roadway signage and the number of fatal vehicle accidents on Georgia interstates as measured by a comparison of means *t* test.

This chapter contains the data collection procedure for the research, explains the descriptive statistics characterizing the sample, and describes the statistical assumptions appropriate for this study. Additionally, in this chapter, I report all findings, including statistical values and probability values, confidence intervals, and effect sizes. Tables and figures will be used to explain the findings.

Data Collection

As mentioned in previous chapters, the data came from the NHTSA FIRST analysis tool (https://cdan.dot.gov/query). The time frames selected included 2016–2020, with data broken down by month (see Figure 1). Data collection occurred on the same day as requested, since the data are publicly available. No discrepancies presented in data collection from the plan listed in Chapter 3. The numerical data presented is a ratio variable, since a natural zero exists for the data (see Babbie, 2016). The independent variable of signs was dichotomous since the signs were either present or not. As the groups were divided by time, with Group 1 containing all fatal motor vehicle accidents from July 1, 2016, through June 30, 2018, and Group 2 containing all fatal motor vehicle accidents from July 1, 2018, through June 30, 2020, the independent variable was not entered into SPSS. Table 2 contains the data from Groups 1 and 2. Table 3 contains the data from the sample Group 1 and Group 2 generated by the Random Sampling Without Replacement tool in SPSS. The sample size of 15 from a population of 24 in each group (30 of 48 for entire dataset) used 62.5% of the population, giving a proportionate sampling of the data. The average number of fatal accidents for the full populations were 16 and 17.42 respectively, while the average of the sample groups were 16.27 and 18.27 (see Figure 2), demonstrating a difference of less than one accident in the sample versus the population of both groups, confirming external validity.

Figure 1

NHTSA FIRST Data Query Results

National Highway Traffic Safety Administration (NHTSA) Motor Vehicle Crash Data Querying and Reporting
Fatal Motor Vehicle Crashes
Filter Selected: Interstate: Interstate
State: Georgia
Years: 2016-2020

Fatal Motor Vehicle Crashes [1]

Crash Date (Year)	Crash Date (Month)												
	January	February	March	April	May	June	July	August	September	October	November	December	Total
2016	10	16	15	18	16	16	15	21	19	14	13	13	186
2017	15	9	17	9	25	17	24	16	23	14	26	11	206
2018	13	12	17	9	20	12	15	9	17	20	28	19	191
2019	19	13	19	16	29	15	16	14	22	15	13	18	209
2020	12	9	26	15	13	16	17	17	23	17	14	10	189
Total	69	59	94	67	103	76	87	77	104	80	94	71	981

Table 2

Groups 1 and 2 – All Fatal Motor Vehicle Accidents

Fatal motor vehicle accident numbers	Group 1	Group 2
July, Year 1	15	17
August, Year 1	21	20
September, Year 1	19	28
October, Year 1	14	19
November, Year 1	13	19
December, Year 1	13	13
January, Year 1	15	19
February, Year 1	9	16
March, Year 1	17	29
April, Year 1	9	15
May, Year 1	25	16
June, Year 1	17	14
July, Year 2	24	22
August, Year 2	16	15
September, Year 2	23	13
October, Year 2	14	18
November, Year 2	26	12
December, Year 2	11	9
January, Year 2	13	26
February, Year 2	12	15
March, Year 2	17	13
April, Year 2	9	16
May, Year 2	20	17
June, Year 2	12	17

Table 3

Random Sampling Without Replacement Results

Sample result	Group 1	Group 2
Sample 1	21	20
Sample 2	19	28
Sample 3	13	19
Sample 4	13	13
Sample 5	15	19
Sample 6	9	16
Sample 7	17	29
Sample 8	25	16
Sample 9	17	14
Sample 10	24	22
Sample 11	26	12
Sample 12	11	9
Sample 13	13	26
Sample 14	12	15
Sample 15	9	16

Study Results

A comparison of means *t* test continued to present as the most appropriate statistical test for the data. The total sample included the number of motor vehicle fatality accidents in the 24 months preceding Georgia's legislative change against the 24 months after the change, where the preceding 24 months had no signage and the following 24 months had signs present. The lowest number of fatal motor vehicle accidents reported (nine accidents) occurred in February 2017, April 2017, April 2018, and December 2019, and the highest number of reported fatal motor vehicle accidents occurred in March 2019, with a reported 29 fatal accidents. The average number of accidents for the entire dataset equaled 16.71 fatal motor vehicle accidents over the 48-month period.

Figure 2

Descriptive Statistics

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Fatality Accidents Before Law	16.27	15	5.650	1.459
	Fatality Accidents After Law	18.27	15	5.885	1.520

I conducted a single paired-sample *t* test using SPSS (Version 27). The results (see Figure 2) demonstrated a standard deviation 5.650 for Group 1 and 5.885 for Group 2, giving them very close results and confirming use of a paired-samples *t* test with assumed equal variances. The mean of Group 1, as indicated earlier, was 16.27, and 18.27 for Group 2, denoting a difference of 2, with Group 2 results higher than Group 1. The standard error of the was 1.459 for Group 1 and 1.520 for Group 2. The correlations results (see Figure 2) indicated positive but not significant correlation between the two groups (r = .155) with a significance of 0.582; a positive correlation contradicts the alternate hypothesis for the study. The paired samples test (see Figure 3) indicated a p value of 0.319, which exceeded the level of significance of $p < .05$. On average, there were two more accidents during the time after sign installation than prior to installation (95% CI [-6.155, 2.155]), and there was no significance in the results, $t_{(14)} = -1.032$, p = .319. The null hypothesis was accepted.

Figure 3

Paired Samples Test All Fatality Accidents

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Fatality Accidents Before Law - Fatality Accidents After Law	-2.000	7.502	1.937	-6.155	2.155	-1.032	14	.319

I conducted an additional test using data from the NHTSA FIRST database filtering for accidents where distracted driving was listed as a cause (see Table 4). The results demonstrated a negative and strongly significant correlation between signs and fatal motor vehicle accidents, with the difference of means at 0.33, with the mean of the fatal accidents at 1.20 against the mean after the sign installation at 0.87 and a Pearson correlation of -0.156 with a significance of 0.578 (see Figure 4). However, the paired samples *t* test demonstrated no significant difference, with a *p* value of 0.475, well above the designated $p < .05$ (see Figure 5). Regardless of the inclusion of distracted driving causation of the accidents, the signs did not significantly reduce the number of motor vehicle fatalities. This set of accident numbers only indicated fatality accidents where officers could directly identify distracted driving as a causation; not all accidents involving distracted driving can be proved as such, hence the reason the study included all fatality motor vehicle accidents. Considering the total number of fatal motor vehicle accidents in the study in Group 1 was 384 versus only 27 where distracted driving was attributed as a cause, and Group 2 had 418 versus 17, the utilization of all accidents

provided a clearer picture of the problem of distracted driving on Georgia interstates, since it removed the causations.

Table 4

Groups 1 and 2 Distracted Driving Causation Motor Vehicle Fatalities

Fatal motor vehicle accident numbers	Group 1	Group 2
July, Year 1	1	1
August, Year 1	2	0
September, Year 1	0	1
October, Year 1	1	1
November, Year 1	1	1
December, Year 1	1	3
January, Year 1	0	1
February, Year 1	0	1
March, Year 1	0	0
April, Year 1	0	1
May, Year 1	2	1
June, Year 1	3	0
July, Year 2	2	0
August, Year 2	3	0
September, Year 2	5	1
October, Year 2	0	0
November, Year 2	0	2
December, Year 2	2	0
January, Year 2	0	1
February, Year 2	2	0
March, Year 2	1	1
April, Year 2	0	1
May, Year 2	1	0
June, Year 2	0	0

Figure 4

Pearson Correlation Distracted Driving Caused Accidents

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	DISTDRVPRELAW & DISTDRVPOSTLAW	15	-.156	.578

Figure 5

Paired Samples Test Distracted Driving Only

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	DISTDRVPRELAW - DISTDRVPOSTLAW	.333	1.759	.454	-.641	1.308	.734	14	.475

Summary

This chapter started with a restatement of the purpose of this research and the research question and commensurate hypotheses. The purpose of this study was to determine the efficacy of signage in decreasing the number of motor vehicle fatalities by increasing awareness of distracted driving legislation. I used a nonexperimental quantitative research design for this study. After gathering the secondary data from the NTHSA FIRST database, I conducted a comparison of means two-tailed paired sample *t* test to answer the research question: What is the impact of roadway signage on the number of fatality motor vehicle accidents on Georgia interstates? According to the results, signs had no impact on the number of fatal motor vehicle accidents on Georgia interstates, as evidenced by the increase in the average number of motor vehicle fatalities in the years after the legislative change as compared to the 2 years prior.

In Chapter 5, I discuss the results in further detail, as well as the conclusions from the research and its limitations. Chapter 5 also contains the recommendations for future research based on the current study. Lastly, I cover information related to the social change impacts of the research findings and provide a conclusion of the study.

Chapter 5: Discussion, Conclusions, and Recommendations

Distracted driving is a growing problem, demanding that policymakers find effective ways to decrease individual proclivity for the act. Georgia implemented legislation to officially criminalize the act of using a mobile device while driving, then installed signs to deter individuals from committing the crime. This nonexperimental quantitative study looked at the effectiveness of signs in deterring distracted driving on Georgia interstates using a comparison of means *t* test. The secondary data used as the dependent variable for the study came from the publicly available NHTSA FIRST database; all data could be verified through secondary sources, including Georgia Department of Public Safety and GOHS searches. The independent variable was the dichotomous variable of presence or absence of signage on Georgia interstates. The statistical test revealed that the mean number of motor vehicle fatality accidents actually increased after the sign installation, demonstrating the ineffectiveness of the signs toward increasing distracted driving law compliance, contrary to SCPT.

Interpretation of the Findings

This quantitative study demonstrated no significant change in the number of fatal motor vehicle accidents on Georgia interstates before versus after sign installation to educate drivers on the legislative change. This study extended knowledge of the field as it filled a gap in the literature by demonstrating the influence, or lack thereof, of signs in reducing distracted driving. Prior research demonstrated that people tend to overestimate their ability to multitask, further complicating the problem (Choudhary et al., 2020; Li et al., 2019; Merrikhpour & Donmez, 2017; Sanbonmatsu et al., 2016). Other studies have

shown that signs help influence individual behavior while driving (Banares et al., 2018; Bortei-Doku et al., 2017; Glendon et al., 2018; Glendon & Prendergast, 2019; Kelarestaghi et al., 2020; Meuleners et al., 2020; Moomen et al., 2019; Rahman & Kang, 2020; Tejero & Roca, 2021; Vignali et al., 2019; Xie et al., 2019; Yang et al., 2020), so the results of this study seem to contradict the previous research. Nevin et al. (2017) and Rudisill and Zhu (2021) studied the enforcement of distracted driving laws and determined that enforcement was difficult, and educating drivers would be more effective. It is important to note that with both enforcement and educational programs, unsafe driving behaviors like speeding and driving while intoxicated (DUI) continue to happen (Bogstrand et al., 2015); just because people know a behavior is dangerous to self and others does not mean they will stop doing it. Even though people understand the dangers of distracted driving, they continue to do it (Li et al., 2018; Lipovac et al., 2017; Telemaque & Madueke, 2015). The combination of overestimation of abilities and the desire for continuous connectivity (Nevin et al., 2017) might also help explain the research findings.

The study was based on Clarke's (1980) SCPT. Clarke (1980) postulated that manipulation of an environment reduced crime occurrences. Introducing signs into the environment, creating real, physical reminders, presented as a possible way to reduce the incidents of distracted driving on Georgia interstates. The structural change provided by the signs should increase not only awareness of the criminality, but fear of getting caught, thereby reducing the offense (see Clarke 1980, 1995). The findings contradict this theory, demonstrating an increase in motor vehicle fatalities on Georgia interstates after the

installation of the signs. Even when looking at accidents where distracted driving was listed as a contributing factor, it was not a statistically significant intervention, as the *p* value was 0.475, well above the necessary $p < .05$ at a confidence interval of 95%. The original statistical test result including all motor vehicle fatality accidents resulted in $p = .319$, again, well above $p < .05$ at a 95% confidence interval. In light of SCPT, the environmental manipulation was not great or significant enough to intervene in the criminal activity of distracted driving.

Limitations of the Study

Several limitations presented in this study. The first was the use of secondary data to determine the findings. While reducing bias, the use of secondary data through a focus on the number of motor vehicle accidents could not provide information relating to driver knowledge of the signs or whether they understood the signs' meaning. A second limitation of the study was the exclusion of roadways other than interstates. By concentrating only on interstates, the number of accidents are limited; this was a necessary limitation, as only interstates had the signs utilized in the study overhead or on the rights-of-way. Another limitation of the study was not including census data on the number of individuals living in Georgia and its possible correlations with the number of motor vehicle fatalities. The use of interstates helps mitigate this limitation, since individuals cannot build homes along interstates. It is also important to understand that population fluctuation does not necessarily affect the number of individuals using Georgia interstates, since, by their very nature, interstate roadways are designed for travel between states.

The use of secondary data and the exclusion of various roadways were not the only limitations. The exclusion of covariates provided another limitation, though limited in scope. Understanding that myriad factors contribute to fatal motor vehicle accidents provided the impetus for this exclusion, diminishing the limitation. The final limitation in the study was not using only accidents with distracted driving listed as a contributing factor. As mentioned earlier in the study, the reason for this limitation is the difficulty among law enforcement to positively identify distracted driving as a causation (Nevill et al., 2017; Rudesill & Zhu, 2021).

Each of the limitations, while few, required attention. Almost all secondary studies contain certain limitations, specifically the exclusion of survey data and lack of experimental setup. The ability to externally verify all data abates the few limitations as it related to the results. All limitations for this study were appropriately and effectively addressed in the study, allowing for the confirmation of the null hypothesis.

Recommendations

After gathering the data and conducting a quantitative analysis, I verified the null hypothesis: Roadway signage has no influence on the number of vehicle accidents with fatalities on Georgia interstates as measured by a comparison of means *t* test. The results gave a clear idea that either greater environmental manipulations must exist for statistically significant results or other pathways must be investigated for distracted driving law compliance. Both the research outcome and the limitations informed several recommendations for future research.

The first recommendation involves the use of primary research and inclusion of a qualitative aspect. It is my recommendation that future researchers distribute surveys among drivers on Georgia interstates to determine if they notice the signs and if those signs influence their driving habits. Additionally, the researchers could ascertain whether static or dynamic signs provide greater impact on their knowledge of the law, as well as the level of sway both types of signs have on whether drivers use their mobile devices while driving. This primary data collection could answer the research question more fully, with greater insight into driver behaviors and influences. It would also permit better interpretation of the hypothesis by providing context that secondary data cannot give. A word of caution for future researchers choosing this research method involves the need to ensure the respondents operate a vehicle on Georgia interstates; this would not necessarily mean the participants be Georgia residents, making data gathering somewhat difficult, a threat to the validity of the research.

Giving rise to the idea of primary data, and in light of the research question, a strictly qualitative methodology could provide more information about what causes people to comply with or ignore signs related to distracted driving. Researchers have studied the influence of signs on driver behaviors (Banares et al., 2018; Bortei-Doku et al., 2017; Glendon et al., 2018; Glendon & Prendergast, 2019; Kelarestaghi et al., 2020; Meuleners et al., 2020; Moomen et al., 2019; Rahman & Kang, 2020; Tejero & Roca, 2021; Vignali et al., 2019; Xie et al., 2019; Yang et al., 2020), but I could not find any literature related to distracted driving signage and driver behavior. Conducting qualitative

research would fill this gap in the research while delivering information related to the influence of signs on distracted driving.

While a recommendation for primary data, as informed by the limitations, makes sense, the use of secondary data also gives rise to a recommendation. Using accident numbers from surrounding states with similar laws and signage could provide more information on the efficacy of signs. Tennessee also has a UHB in effect, so determining whether they use signs to inform drivers could allow for additional information, plus provide comparative analysis for discussion. On the theme of comparisons, using accident information from various states with UHBs and signs, both in the same or other regions of the country, could permit comparisons in effectiveness of signs to establish similarities and differences between the different drivers, thereby providing greater insight to help inform intervention strategies.

An expansion of the use of secondary data also gives rise to the idea of expanding the research to include more years' data for comparison. By looking at additional years of fatal accidents, a clearer picture could emerge related to the longitudinal nature of the impact of signs. This could answer the research question using the same statistical testing methodology. Disaggregating the data by year would also inform driver changes over time to establish patterns. To add another level, researchers could include census data to explain potential correlations between population and fatal accidents. Including information from the number of vehicles traveling Georgia interstates, if available, could also help explain the results more fully.

Including covariates is the final recommendation for future research. Even though many factors can influence whether a wreck occurs as well as the severity of it, information like visibility, weather, and driver experience can inform the research. One study demonstrated lowered ability to process sign information among older and newer drivers (Bortei-Doku et al., 2017), so that could impact the results of this study. Lack of visibility caused by intense fog or rain could also speak to a driver's ability to read the signs and operate the vehicle. Including covariates could provide greater understanding of the depth and breadth of the issue of signs and motor vehicle fatalities.

Implications

Implications of the research findings, theory, and methodology exist from the individual, familial, and societal/policy perspectives. At the individual level, there are several implications for consideration. As a driver, the knowledge that signs had no impact on the number of motor vehicle fatality accidents does nothing to give comfort; however, I doubt this would affect the driving habits of individuals travelling on Georgia interstates. For taxpayers, the findings may raise some questions about the use of funds to pay for the signs without demonstrated efficacy, which may seem wasteful.

The next level for consideration is the familial level. For parents, the dangers of driving become very real, so anything that would diminish the number of motor vehicle fatalities is greatly desired. The lack of effectiveness of signs in reducing fatal accidents is discouraging, demanding attention to alternative ways to reduce these deaths. The accident that killed the five nursing students in April 2016 and led to legislative change gave national attention to the issue of distracted driving and fueled every parent's

nightmare about their child driving. This research provided hope that signs could reduce these tragedies yet failed to come through. Parents must still worry about their child driving on Georgia interstates while people drive distracted.

Finally, some policy and societal changes emerge for attention. The idea that distracted driving continues to grow even in the presence of legislation demands policymakers find effective ways to gain compliance. On the other hand, taxpayers require effective use of funds provided to those policymakers. This research showed no influence of sings on distracted driving law compliance as measured by a comparison of means *t* test of fatal motor vehicle accidents. Policymakers must note the inefficacy of signs and direct the funding to other avenues. In light of the results, as well as the consideration of prior research, moving funding from signs to education and enforcement efforts seems a better utilization of resources. Also, directing officers to pursue more distracted driving enforcement and education opportunities could be a way to increase these initiatives without needing additional funds.

While considering policy implications, the application of SCPT clearly demonstrates the effectiveness of environmental manipulation on reducing crime. Therefore, the idea of installing more signs could positively impact the number of fatal motor vehicle accidents. While contrary to the prior recommendation of redirecting funding to enforcement or education, finding additional monies for more signs is recommended; with the suggested move to education and enforcement among existing law enforcement personnel without needing to move the funds, continuing to provide funds to signs would create an equitable balance. Justification of fund dispersal is a

consideration for policymakers; this is a difficult balancing act, since removing money from one area affects the individuals receiving the benefits thereof. If policymakers could install more signs and increase both education and enforcement without redirecting funding, all stakeholders would benefit.

Conclusion

This quantitative study provided brief findings and summaries of prior research and literature. I analyzed research related to the theoretical framework of SCPT, various articles related to distracted driving, and research about signage effectiveness associated with overall sign effectiveness and as it related to various driving behaviors. I explained and justified the methodology, including the sample size and statistical testing necessary to answer the research question. I then collected data from the secondary source of the NHTSA FIRST database and ran a comparison of means *t* test to determine the answer to the research question. The results confirmed the null hypothesis, that signs had no statistically significant influence on the number of motor vehicle fatality accidents on Georgia interstates.

After explicating the research findings, I discussed the limitations of the research and gave multiple recommendations for future research, including expansion of the initial data, distributing both quantitative and qualitative surveys, and the addition of covariates in the research. Finally, I discussed the implications of the research, specifically the need to increase the number of signs and educational and enforcement opportunities to successfully reduce lives lost to distracted driving; these are necessary changes to save lives and spend money judiciously and frugally.

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