

PEDESTRIAN CROSSING BEHAVIOR IN COLLEGE STUDENTS:  
EXPLORATION USING THE THEORY OF  
PLANNED BEHAVIOR

by

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## ABSTRACT

**Background.** In the United States, pedestrian fatalities make up a substantial proportion of total traffic fatalities. High use of mobile data and exposure to high-traffic environments place college students at increased risk. The present study aimed to utilize the theory of planned behavior (TPB) to examine college students' behavioral intention to cross the street on campus while using a mobile device. A secondary aim was to estimate the incidence of distracted mobile device use among street-crossing pedestrians at a large public southeastern university.

**Methods.** Questionnaire data were collected from undergraduate college students attending a Southeastern university. Questionnaire development involved a literature review, face and content validity by expert panel, readability and comprehensibility by pilot test, stability reliability by test-retest, and internal consistency using Cronbach's alpha. Construct validity of the TPB for predicting behavioral intention to cross the street on campus while using a mobile device was assessed using linear regression analyses. The second aim involved performing observations to estimate the incidence of distracted mobile device use among street-crossing pedestrians.

**Results.** The TPB constructs of attitude toward the behavior ( $B = .395, p < .001$ ), subjective norm ( $B = .328, p < .001$ ), and perceived behavioral control ( $B = .158, p < .001$ ) were significant predictors of behavioral intention and explained 48.4% of the variance. Observations yielded 4,878 crossing instances (33.9% male and 66.1% female). Overall, 1,201 (24.6%) cases involved device use with 16.8% of male crossings and 28.6% of female crossings involving

distraction. A significant difference in device use while crossing was found between some observation locations,  $\chi^2(3) = 8.866, p = .031$ .

Discussion. A questionnaire was developed to measure TPB constructs predictive of college students' behavioral intention to cross the street on campus while using a mobile device. Such a questionnaire can be used in the design and evaluation of TPB-based interventions to decrease distracted mobile device use while crossing the street among college students. Observation data provide an estimate of distracted mobile device use while crossing the street. Future research should focus on improving understanding of the problem and evaluation of interventions to influence behavioral intention.

## DEDICATION

This dissertation is dedicated to my late father, Joseph C. Piazza (1944 – 2016), my mother, Elizabeth A. Piazza, and my brother, Joseph D. Piazza. Thank you all for your support over the decades.

## LIST OF ABBREVIATIONS AND SYMBOLS

ANOVA	Analysis of Variance
NHTSA	National Highway Traffic Safety Administration
FARS	Fatality Analysis Reporting System
TPB	Theory of Planned Behavior
TRA	Theory of Reasoned Action
ACEP	American College of Emergency Physicians
PDA	Personal digital assistant
NOPUS	National Occupant Protection Use Survey
TACT	Target, action, context, time
fps	Frames per second
%	Percent
$\alpha$	Cronbach's index of internal consistency
$B$	Beta weight: indicator of relationship strength between variables
$\beta$	Regression slope coefficient: the predicted change in the dependent variable for every one unit change in the independent variable
$\eta^2$	Eta squared
$\pi$	Proportion
$\mu$	Mean
$df$	Degrees of freedom: number of values free to vary after certain restrictions have been placed on the data
$F$	Fisher's $F$ ratio: A ratio of two variances

$H$	Kruskall-Wallis test statistic
$M$	Mean
$Mdn$	Median
$Mrank$	Mean rank
$SD$	Standard deviation
$p$	Probability associated with the occurrence under the null hypothesis of a value as extreme as or more extreme than the observed value
$r$	Pearson product-moment correlation
$R_s$	Spearman rank correlation
$t$	Computed value of $t$ test
$<$	Less than
$\leq$	Less than or equal to
$>$	Greater than
$\geq$	Greater than or equal to
$=$	Equal to

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## CHAPTER 1

### INTRODUCTION

#### **Background and Rationale**

In the United States, unintentional injury is the fourth leading cause of death overall and is the leading cause of death for individuals between 1 to 44 years of age (Heron, 2016).

Regarding death from unintentional injury, motor vehicle traffic crashes are the leading cause of death for persons aged 5 through 24 years (National Center for Injury Prevention and Control, 2017a). In addition to motor vehicle traffic crashes between two or more vehicles or between a motor vehicle and inanimate objects, collisions between motor vehicles and pedestrians fall under the category of motor vehicle traffic crashes. The National Highway Traffic Safety Administration (NHTSA) has defined pedestrians as, “any person on foot, walking, running, jogging, hiking, sitting, or lying down...” (National Center for Statistics and Analysis, 2016b, p. 1). Motor vehicle traffic crashes are defined as, “an incident that involved one or more motor vehicles where at least one vehicle was in transport and the crash originated on a public traffic way, such as a road or highway” (National Center for Statistics and Analysis, 2016b, p. 1).

Since 2009, the overall number of traffic-related pedestrian fatalities has steadily increased (National Center for Statistics and Analysis, 2016b). According to NHTSA, 4,884 pedestrians were killed as a result of traffic crashes in 2014; the highest number in eight years. For the same year, an estimated 65,000 pedestrians were injured in motor vehicle traffic crashes (National Center for Statistics and Analysis, 2016b). The economic cost of pedestrian fatalities in 2010 is estimated to be over \$4.85 billion U.S. (National Center for Injury Prevention and

Control, 2017c). In 2010, nonfatal pedestrian injuries of those hospitalized and those treated and released from the emergency department are estimated to have cost \$6.75 billion and \$1.06 billion (National Center for Injury Prevention and Control, 2017c).

Another trend is illustrated by the percentage of pedestrian deaths expressed as a percentage of total traffic fatalities. In 2007, pedestrian fatalities in traffic crashes (4,699) made up 11% of the total 41,259 traffic fatalities. Since 2008, the number of pedestrian fatalities from traffic crashes has increased and, in 2014, made up 15% of the 32,675 total motor vehicle traffic fatalities (National Center for Statistics and Analysis, 2016b).

Despite mixed evidence across some pedestrian observation studies, a greater proportion of studies found that with distractions, including mobile device use, there was an increase in unsafe crossing behaviors and gait abnormalities. The authors of these studies posit that walking while distracted increases the risk of pedestrian injury or death (Bungum, Day, & Henry, 2005; Hatfield & Murphy, 2007; Lamberg & Muratori, 2012; Lin, Goldman, Price, Sears, & Jacko, 2007; Schabrun, van den Hoorn, Moorcroft, Greenland, & Hodges, 2014; Thompson, Rivara, Ayyagari, & Ebel, 2013).

College students frequenting campus may be at risk of distracted walking injury due to regular street-crossing on campus (Pucher, Buehler, Merom, & Bauman, 2011), high regard for text-based messaging (texting) as socially acceptable means of communication (Rainie & Zickuhr, 2015), and heavy use of mobile communication technology among the traditional college student age group (Lenhart, 2010; Pettijohn, Frazier, Rieser, Vaughn, & Hupp-Wilds, 2015). The heavy vehicular and pedestrian traffic inherent of many campus environments leads to numerous instances of vehicle-pedestrian interaction and thus provides abundant opportunities for conflict (Balsas, 2003; Loukaitou-Sideris et al., 2014). Further, Americans belonging to the

age categories of 15 and 19 years and 20 and 24 years have the highest rates of injury (37 and 31 per 100,000 population, respectively) (National Center for Statistics and Analysis, 2016b).

As distracted walking becomes recognized as a threat to public health ("Amended and reinstated ordinances," 2016; American Academy of Orthopaedic Surgeons, 2015a; Cortez, 2012; Davidson, 2012; Interbrand North America, 2015; National Highway Traffic Safety Administration, 2014; Safe Kids Worldwide, 2013; San Francisco Municipal Transportation Agency, 2016), pedestrian injury prevention initiatives have taken shape (U.S. Department of Health and Human Services, 2016a). Such prevention initiatives take the form of policy ("Amended and reinstated ordinances," 2016; Ngak, 2012), awareness campaigns (American Academy of Orthopaedic Surgeons, 2015a; Cortez, 2012; Interbrand North America, 2015; Safe Kids Worldwide, 2013; San Francisco Municipal Transportation Agency, 2016), safety tips (National Highway Traffic Safety Administration, 2014; San Francisco Municipal Transportation Agency, 2016), and position statements by professional organizations (American College of Emergency Physicians, 2014).

To date, there exists a very small body of literature investigating the behavior of distracted walking (Barton, Kologi, & Siron, 2016; Lennon, Oviedo-Trespalacios, & Matthews, 2017). The increased incidence of pedestrian injuries in college-age persons (National Center for Statistics and Analysis, 2016b), the explosion in mobile data consumption (CTIA-The Wireless Association, 2016), and the increased risk to which college students are exposed (Balsas, 2003) necessitate further study in this area. The present study served to add to the dearth of literature regarding predictors of behavioral intention to cross the street while using a mobile device with emphasis on the process of questionnaire development. A secondary aim of the present study

was to estimate the incidence of distracted mobile device use among street-crossing pedestrians at the University of Alabama (Tuscaloosa).

### **Theoretical Framework**

Kerlinger and Lee (2000, p. 8) define theory as, “a set of interrelated concepts, definitions, and predispositions that present a systematic view of events or situations by specifying relations among variables to explain and predict the events or situations.” Given the value of being able to accurately predict behaviors in health education and health promotion, using theory in health behavior research has become standard practice (Sharma, 2017).

Appropriately applied health behavior theory provides a framework by which health practitioners can articulate assumptions and hypotheses about a strategy or target of intervention (National Cancer Institute, 2005).

### **Theory of Planned Behavior**

The theory of planned behavior (TPB) is a health behavior theory developed by Martin Fishbein and Icek Ajzen to improve understanding of the relationships between attitude toward the behavior, subjective norm, perceived behavioral control, behavioral intention, and behavior (Glanz, Rimer, & Viswanath, 2008). The theory posits that a person’s behavioral intention to engage in a behavior is the immediate psychological antecedent to the actual behavior. Thus, the ability to predict behavioral intention is useful in determining whether one is likely to engage in a given behavior (Ajzen, 1991). According to the TPB, behavioral intention is predicted by attitude toward the behavior, subjective norm, and perceived behavioral control. Attitude toward the behavior is the degree to which performance of the behavior is positively or negatively valued (Ajzen, 2017). Subjective norm represents an individual’s perceived social pressure to engage or not to engage in a given behavior (Ajzen, 2017). Perceived behavioral control involves

a person's perceptions of their ability to perform a given behavior (Ajzen, 2017). Therefore, the TPB as employed in the present study posits that a person's attitude toward the behavior, subjective norm, and perceived behavioral control will predict behavioral intention, which, in turn, predicts behavior. The TPB has been used extensively in health behavior research to predict condom use (Albarracin, Fishbein, & Middlestadt, 1998), healthy eating (Conner, Norman, & Bell, 2002), clinical treatment adherence (Manning & Bettencourt, 2011), organ donation (Bresnahan et al., 2007), smoking (Gantt, 2001), and vaccinations (Askelson et al., 2010).

In addition to being useful predictors of a given behavior, the TPB constructs of attitude toward the behavior, subjective norm, and perceived behavioral control are often modifiable. Eliciting change in one or more of the theory's constructs is posited to bring about change in behavioral intention and subsequent behavior (Fishbein & Ajzen, 2010). Given limited resources and varying difficulty in influencing certain TPB constructs related to a given behavior, Fishbein and Ajzen (2010) advise that planners prioritize intervention activities based on TPB construct data collected from the target population. Information gleaned from a well-designed TPB questionnaire gives intervention planners an idea of the relative importance of each construct as a target of change. Additionally, a well-designed questionnaire based on the TPB provides a tool by which to evaluate intervention activities (Fishbein & Ajzen, 2010).

The TPB has also been used to investigate pedestrian behaviors (Barton et al., 2016; Díaz, 2002; Evans & Norman, 1998, 2003; Holland & Hill, 2007; Lennon et al., 2017; Xu, Li, & Zhang, 2013; Zhou & Horrey, 2010; Zhou, Horrey, & Yu, 2009). Successful use of the TPB in distracted pedestrian research and utility of the TPB in planning and evaluating interventions justifies use of the TPB in the present study. Figure 1.1 depicts a graphical representation of the TPB as used in the present study.

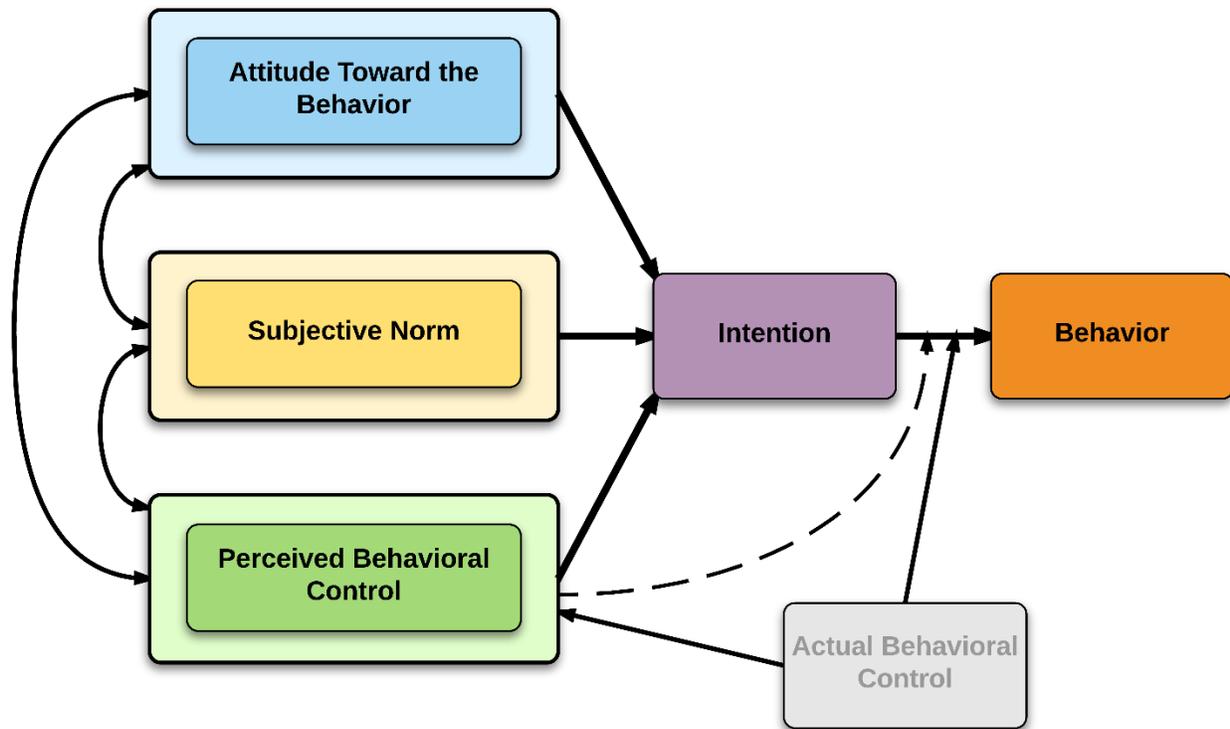


Figure 1.1. Graphic illustration of the theory of planned behavior. Graphic adapted from Model adapted from Ajzen (2013). Theory of planned behaviour questionnaire. *Measurement instrument database for the social science*. Retrieved from <http://www.midss.org/content/theory-planned-behaviour-questionnaire>.

### Study Purpose

The primary aim of this study was to utilize the theory of planned behavior (TPB) to examine college students' behavioral intention to engage in the behavior of crossing the street on campus while using a mobile device. A secondary aim of the study was to estimate the incidence of distracted mobile device use on campus among street-crossing college student pedestrians at the University of Alabama (Tuscaloosa).

## Research Questions

The current investigation explored seven research questions. Research questions 1 through 4 (RQ1 – RQ4) pertained to relationships between TPB constructs and behavioral intention to cross the street on campus while using a mobile device in the next week. Research question 5 (RQ5) sought to assess differences in behavioral intention between select demographic subgroups. Research question 6 (RQ6) sought to estimate the incidence of distracted mobile device use among street-crossing pedestrians. Research question 7 (RQ7) pertained to differences in incidence between observation locations and gender. The research questions were as follows:

1. To what extent does attitude toward the behavior predict behavioral intention to cross the street on campus while using a mobile device in the next week?
2. To what extent does subjective norm predict behavioral intention to cross the street on campus while using a mobile device in the next week?
3. To what extent does perceived behavioral control predict behavioral intention to cross the street on campus while using a mobile device in the next week?
4. To what extent do attitude toward the behavior, subjective norm, and perceived behavioral control, when combined, predict behavioral intention to cross the street on campus while using a mobile device in the next week?
5. Does behavioral intention to cross the street on campus while using a mobile device in the next week differ between typical daily mobile device use, past device use while crossing, past injury exposure, and gender?
6. What is the incidence of distracted mobile device use among street-crossing pedestrians on campus?

7. Does the incidence of distracted mobile device use among street-crossing pedestrians on campus differ between observation locations and gender?

### **Hypotheses and Analyses**

An *a priori* significance level of  $p < 0.05$  was set for rejecting null hypotheses. Based on the aforementioned research questions, four sets of hypotheses were conceptualized. RQ6 did not involve inferential statistics and, therefore, is not associated with a hypothesis. The hypothesis sets are detailed next.

#### **Hypothesis set one: Tests for univariate predictive relationships between theory of planned behavior constructs and behavioral intention to cross the street on campus while using a mobile device in the next week**

The first hypothesis set related to RQ1 through RQ3 and aimed to separately test for predictive relationships between the individual TPB constructs of attitude toward the behavior, subjective norm, and perceived behavioral control and behavioral intention to cross the street on campus while using a mobile device in the next week. To test the null hypotheses in the first hypothesis set, each TPB construct was regressed individually on behavioral intention. The remainder of this section lists the hypotheses comprising hypothesis set one.

- **H<sub>0</sub> 1:** There will be no predictive relationship between attitude toward the behavior and behavioral intention to cross the street on campus while using a mobile device in the next week.

$$H_0 1: \beta = 0$$

**H<sub>A</sub> 1:** There will be a predictive relationship between attitude toward the behavior and behavioral intention to cross the street on campus while using a mobile device in the next week.

$$H_A 1: \beta \neq 0$$

- **H<sub>0</sub> 2:** There will be no predictive relationship between subjective norm and behavioral intention to cross the street on campus while using a mobile device in the next week.

$$H_0 2: \beta = 0$$

**H<sub>A</sub> 2:** There will be a predictive relationship between subjective norm and behavioral intention to cross the street on campus while using a mobile device in the next week.

$$H_A 2: \beta \neq 0$$

- **H<sub>0</sub> 3:** There will be no predictive relationship between perceived behavioral control and behavioral intention to cross the street on campus while using a mobile device in the next week.

$$H_0 3: \beta = 0$$

**H<sub>A</sub> 3:** There will be a predictive relationship between perceived behavioral control and behavioral intention to cross the street on campus while using a mobile device in the next week.

$$H_A 3: \beta \neq 0$$

**Hypothesis set two: Test for a multivariate predictive relationship between theory of planned behavior constructs and behavioral intention to cross the street on campus while using a mobile device in the next week**

The second hypothesis set related to RQ4 and aimed to test the utility of combined TPB constructs of attitude toward the behavior, subjective norm, and perceived behavioral control in predicting behavioral intention to cross the street on campus while using a mobile device in the next week. To test the null hypothesis in the second hypothesis set, attitude toward the behavior, subjective norm, and perceived behavioral control were regressed on behavioral intention using a

multiple regression procedure. The remainder of this section lists the hypotheses comprising hypothesis set two.

- **H<sub>0</sub> 4:** There will be no predictive relationship between attitude toward the behavior ( $\beta_1$ ), subjective norm ( $\beta_2$ ), and perceived behavioral control ( $\beta_3$ ) and behavioral intention to cross the street on campus while using a mobile device in the next week ( $Y$ ).

$$H_0 4: \beta_1 = \beta_2 = \beta_3 = 0$$

**H<sub>A</sub> 4:** There will be a predictive relationship between attitude toward the behavior ( $\beta_1$ ), subjective norm ( $\beta_2$ ), and perceived behavioral control ( $\beta_3$ ) and behavioral intention to cross the street on campus while using a mobile device in the next week ( $Y$ ).

$$H_A 4: \text{At least one } \beta_j \text{ is } \neq 0$$

**Hypothesis set three: Tests for differences in behavioral intention to cross the street on campus while using a mobile device in the next week between typical daily mobile device use, past device use while crossing, past injury exposure, and gender**

The third hypothesis set relates to RQ5 and aimed to test for differences in behavioral intention to cross the street on campus while using a mobile device in the next week between participants grouped by typical daily mobile device use, past device use while crossing, past injury exposure, and gender. To test the null hypotheses in the third hypothesis set, a series of one-way analysis of variance (ANOVA) tests were performed. Based on k-means clustering analyses, the variable of typical daily mobile device use was reduced from 11 to 3 categories and the variable of past device use while crossing was reduced from 6 to 3 categories. The remainder of this section lists the hypotheses comprising hypothesis set three.

- **H<sub>0</sub> 5:** There will be no difference in group means of behavioral intention to cross the street on campus while using a mobile device in the next week between participants

grouped by typical daily mobile device use (between 1 minute and 2 hours and 59 minutes; between 3 hours and 5 hours and 59 minutes; and 6 or more hours per day).

$$H_0 5: \mu_{0:01-2:59} = \mu_{3:00-5:59} = \mu_{\geq 6:00}$$

**H<sub>A</sub> 5:** There will be a difference in group means of behavioral intention to cross the street on campus while using a mobile device in the next week between participants grouped by typical daily mobile device use (between 1 minute and 2 hours and 59 minutes; between 3 hours and 5 hours and 59 minutes; and 6 or more hours per day).

$$H_A 5: \text{At least one } \mu_j \text{ is different}$$

- **H<sub>0</sub> 6:** There will be no difference in group means of behavioral intention to cross the street on campus while using a mobile device in the next week between participants grouped by past device use while crossing (never or almost never; less than half or about half; more than half but not all or nearly every time).

$$H_0 6: \mu_{\text{never/almost never}} = \mu_{<\text{half or half}} = \mu_{\geq\text{half but not all/nearly every time}}$$

**H<sub>A</sub> 6:** There will be a difference in group means of behavioral intention to cross the street on campus while using a mobile device in the next week between participants grouped by past device use while crossing (never or almost never; less than half or about half; more than half but not all or nearly every time).

$$H_A 6: \text{At least one } \mu_j \text{ is different}$$

- **H<sub>0</sub> 7:** There will be no difference in group means of behavioral intention to cross the street on campus while using a mobile device in the next week between participants with previous injury exposure and those without.

$$H_0 7: \mu_{\text{previous exposure}} = \mu_{\text{no previous exposure}}$$

**H<sub>A</sub> 7:** There will be a difference in group means of behavioral intention to cross the street on campus while using a mobile device in the next week between participants with previous injury exposure and those without.

$$H_A 7: \mu_{\text{previous exposure}} \neq \mu_{\text{no previous exposure}}$$

- **H<sub>0</sub> 8:** There will be no difference in group means of behavioral intention to cross the street on campus while using a mobile device in the next week between males and females.

$$H_0 8: \mu_{\text{male}} = \mu_{\text{female}}$$

**H<sub>A</sub> 8:** There will be a difference in group means of behavioral intention to cross the street on campus while using a mobile device in the next week between males and females.

$$H_A 8: \mu_{\text{male}} \neq \mu_{\text{female}}$$

**Hypothesis set four: Tests for differences between observation locations and gender on observed incidence of crossing the street on campus while using a mobile device**

The fourth hypothesis set relates to RQ7 and aimed to test for differences in observed street-crossing on campus while using a mobile device between observation locations and gender. To test the null hypotheses in the fourth hypothesis set, Chi-square and binary logistic regression analyses were performed on the independent variables of gender and observation location, respectively. The dependent variable for analyses in hypothesis set four was use of a mobile device while crossing the street (based on observational data). The remainder of this section lists the hypotheses comprising hypothesis set four.

- **H<sub>0</sub> 9:** There will be no difference in the proportion of those observed street-crossing on campus while using a mobile device between males and females.

$$H_0 9: \pi_{\text{male, use}} = \pi_{\text{female, use}}$$

$$\pi_{\text{male, no use}} = \pi_{\text{female, no use}}$$

**H<sub>A</sub> 9:** There will be a difference in the proportion of those observed street-crossing on campus while using a mobile device between males and females.

*H<sub>A</sub> 9:* At least one  $\pi_j$  is different

- **H<sub>0</sub> 10:** There will be no relationship between those observed street-crossing on campus while using a mobile device and observation locations.

$$H_0 10: \beta_{\text{location 1}} = \beta_{\text{location 2}} = \beta_{\text{location 3}} = \beta_{\text{location 4}} = 0$$

**H<sub>A</sub> 10:** There will be a relationship between those observed street-crossing on campus while using a mobile device and observation locations.

*H<sub>A</sub> 10:* At least one  $\beta_j$  is  $\neq 0$

## **Descriptive Statistics**

In addition to inferential statistical analyses related to the aforementioned hypotheses, descriptive analyses of the sample were performed and are reported. Descriptive statistics reported are the total number of participants in the study as well as frequencies and percentages of typical daily mobile device use, past device use while crossing, previous injury exposure, age, gender, race, year in school, and whether participants live on or off campus. Descriptive statistics on the TPB constructs of attitude toward the behavior, subjective norm, perceived behavioral control, and behavioral intention to cross the street on campus while using a mobile device in the next week are also reported and include the possible range of scores, observed range of scores, mean scores, and standard deviations.

## **Delimitations**

When performing research utilizing the TPB, Francis et al. (2004) emphasize the importance of carefully defining the behavior of interest in terms of Target, Action, Context, and Time (TACT). For the purpose of this study, the target was defined as college students between 18 and 24 years of age. The action was defined as crossing the street while using a mobile device. Use of a mobile device was defined as using a mobile device to: (1) send or view text messages or email messages, (2) view content from the internet (such as a web page or email attachment), (3) view content using mobile apps including but not limited to Blackboard, Snapchat, Facebook, Instagram, Twitter, or Yik Yak, or (4) engage in a phone or video call (whether to the ear or through headphones/Bluetooth/speakerphone). Context was defined as while on campus. Time was defined as in the next week.

The aforementioned TACT principles gave rise to the study delimitations that follow. Participation in this study was delimited to undergraduate college students at the University of Alabama who were between 18 and 24 years of age, who used a mobile phone (as described in the preceding paragraph), who visited campus at least once per week and crossed the street at least once when visiting. Participants were enrolled in classes during the fall 2016 and spring 2017 semesters as undergraduate students at the University of Alabama.

Further delimitations were set to ensure that the investigation was carried out in a deliberate and focused manner. Though many documented pedestrian incidents take place outside of crosswalks, this investigation did not explore those crossing the street outside of crosswalks. While several victims of documented fatal and nonfatal pedestrian injuries may be under the influence of alcohol at the time of their injury, questionnaire items did not ask about situations where respondents were under the influence of alcohol. It was assumed that those

questioned and those observed were not under the influence of alcohol. Observations in the present study were delimited to daylight hours.

### **Limitations**

Due to the limitations inherent of any investigation, results from this study must be considered while remaining cognizant of several important limitations. Due to the aforementioned delimitations, the findings of this study are not explicitly generalizable beyond the study participants at the University of Alabama. Generalizability of findings to intoxicated pedestrians, night-time pedestrians, as well as those crossing outside of crosswalks is also limited. Participants were only asked about crossing while on campus. It is possible that responses to TPB constructs would have been different with inquiry in the context of off-campus crossing locations. Despite the limitation this imposes on generalizability, the scope of the present study and the requirement that TPB questionnaires explicitly define the behavior in terms of TACT principles supported a narrowed definition of the behavior. Another limitation to generalizability is inherent in the use of the convenience sampling employed in the present study. Given that not every member of the population had an equal chance of being selected, findings cannot be generalized beyond the participants sampled.

Questionnaire responses involved self-reporting of information while participants were in close proximity to each other and the researcher. Thus, it was possible that some participants felt inclined to respond in a way that was perceived to be socially acceptable instead of providing authentic information. To reduce the potential for social desirability bias, participants were asked to not write their name on the questionnaire and to not share their answers. The researcher also assured participants that their responses would be kept confidential. Another limitation lies in the possibility that participants misinterpreted questionnaire items. Given that one purpose of this

investigation was to create a novel questionnaire, the researcher employed a pilot test of the questionnaire before full-scale implementation. Pilot test participants were asked to provide feedback on clarity of instructions, clarity and readability of items, and questionnaire layout. Another limitation is borne out of the cross-sectional design of the present study. Since such a design is limited to conclusions based on data collected from a single point in time, it was impossible to infer causation between variables.

The observation portion of the present study presents limitations. The cross-sectional nature of the observations made it difficult to determine whether a behavior exhibited by an observed participant was a behavior in which they engaged frequently or rarely. This introduced the possibility of a phenomenon known as *regression toward the mean*. For example, a person observed engaging in use of a mobile phone while crossing could have engaged in this behavior infrequently and could have had weak behavioral intention while another person observed crossing while not using a mobile phone could have engaged in this behavior very frequently and could have had strong behavioral intention. Despite this potential limitation, it was expected that any such extreme cases exerted relatively little influence given their dispersion amongst the large number of observed cases. Given that analyses of observational data in the present study relied on the researcher's judgement of whether participants appeared to be engaging in distracted mobile device use, there was a possibility of misclassification of pedestrian behavior in the present study. To address this limitation, both rater-interrater and intra-rater reliability analyses were performed to provide an indicator of protocol reliability. Although the observation locations differed by traffic control devices and traffic flow, the small sample of observation locations made it difficult to determine whether any differences between locations were due to these characteristics or whether other factors were at play.

## **Outline of the Study**

The seven aforementioned research questions are represented in Figure 1.2 in the context of how they drove the methodology and are indicated by “RQ1 - RQ3,” “RQ4,” “RQ5,” and “RQ6 & RQ7.” Consistent with the primary aim of the present study, a TPB questionnaire served to collect data on the TPB constructs of attitude toward the behavior, subjective norm, perceived behavioral control, and behavioral intention to cross the street on campus while using a mobile device in the next week. The timeframe of one week was chosen based on recommendations from an expert panel and aligns with TACT framework as discussed by Francis et al. (2004). Data on attitude toward the behavior, subjective norm, and perceived behavioral control served two purposes: (1) to predict, using univariate analyses, behavioral intention consistent with RQ1 through RQ3 and (2) to predict, using multivariate analyses, behavioral intention consistent with RQ4. Differences in behavioral intention to cross the street on campus while using a mobile device in the next week between typical daily mobile device use, past distracted mobile device use while crossing the street, past injury exposure, and gender were the focus of RQ5. To meet the secondary aim of the present study, simultaneous observations took place to estimate the incidence of distracted mobile device use among street-crossing pedestrians at the University of Alabama and were consistent with RQ6 and RQ7.

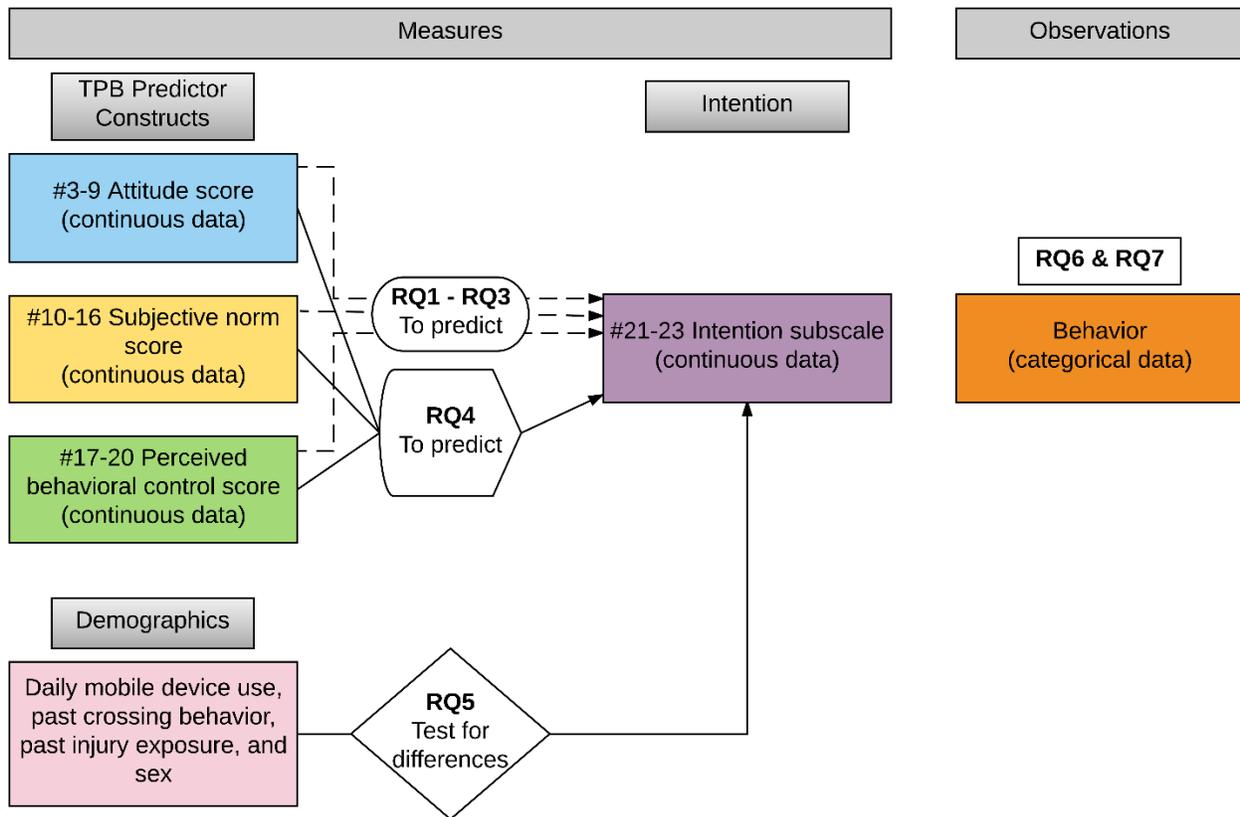


Figure 1.2. Diagrammatic overview of the present study. The numbers that precede each subscale description correspond to the items on the questionnaire addressing the same.

### Definition of Terms

The following are operationalized definitions of select terms used in this study.

*Attitude toward the behavior:* an individual’s overall feeling of like or dislike toward using a mobile device while crossing the street on campus in the next week.

*Behavioral intention:* refers to a person’s readiness to engage in the behavior of using a mobile device while crossing the street on campus in the next week.

*College-age:* individuals between the ages of 18 and 24 years of age.

*Mobile device use:* doing any of the following on a mobile device (such as an iPod, iPhone, Android Phone, MP3 player, or a basic “flip phone”): (1) sending or viewing text messages or email messages, (2) viewing content from the internet (such as a web page or email

attachment), (3) viewing content using mobile apps including but not limited to Blackboard, Snapchat, Facebook, Instagram, Twitter, or Yik Yak, or (4) being on a phone or video call (whether to the ear or through headphones/Bluetooth/speakerphone).

*Mobile device:* a device (such as an iPod, iPhone, Android Phone, MP3 player, or a basic “flip phone”) that allows a user to do at least one of the following: (1) send or receive text messages or email messages, (2) display content from the internet (such as a web page or email attachment), (3) access content using mobile apps including but not limited to Blackboard, Snapchat, Facebook, Instagram, Twitter, or Yik Yak, or (4) place or receive voice or video calls (whether to the ear or through headphones/Bluetooth/speakerphone).

*Motor vehicle traffic crash:* an incident that involved one or more motor vehicles where at least one vehicle was in transport and the crash originated on a public traffic way, such as a road or highway.

*Pedestrian:* any person on foot, walking, running, jogging, hiking, sitting, or lying down.

*Subjective norm:* a participants’ general belief that others important to them think they should or should not use a mobile device while crossing the street on campus in the next week.

*Perceived behavioral control:* the degree to which participants believe they control whether or not they use a mobile device while crossing the street on campus in the next four weeks.

## CHAPTER 2

### REVIEW OF LITERATURE

#### **Pedestrian Injuries**

In the U.S., unintentional injury is the fourth leading cause of death overall and is the leading cause for persons aged 1-44 years (Heron, 2016). Regarding death from unintentional injury, motor vehicle traffic crashes are the leading cause of death for persons aged 5 through 24 years (National Center for Injury Prevention and Control, 2017a). In addition to motor vehicle traffic crashes between two or more vehicles or between a motor vehicle and inanimate objects, incidents between motor vehicles and pedestrians fall under the category of motor vehicle traffic crashes. The National Highway Traffic Safety Administration (NHTSA) has defined pedestrians as, “any person on foot, walking, running, jogging, hiking, sitting, or lying down...” (National Center for Statistics and Analysis, 2016b, p. 1). Motor vehicle traffic crashes are defined as, “an incident that involved one or more motor vehicles where at least one vehicle was in transport and the crash originated on a public traffic way, such as a road or highway” (National Center for Statistics and Analysis, 2016b, p. 1).

Apart from the year 2013, recent data show that pedestrian fatalities have steadily increased every year since 2009 (National Center for Statistics and Analysis, 2016b). According to NHTSA, 4,884 pedestrians were killed in motor vehicle traffic crashes in 2014 (National Center for Statistics and Analysis, 2016b); the highest number in eight years. For the same year, an estimated 65,000 pedestrians were injured in motor vehicle traffic crashes (National Center for Statistics and Analysis, 2016b).

The economic cost of pedestrian fatalities in 2010 is estimated to be over \$4.85 billion (National Center for Injury Prevention and Control, 2017a). In 2010, nonfatal pedestrian injuries of those hospitalized and those treated and released from the emergency department are estimated to have cost \$6.75 billion and \$1.06 billion respectively (National Center for Injury Prevention and Control, 2017a).

Another trend can be illustrated by the percentage of pedestrian deaths expressed as a percentage of total traffic fatalities. In 2007, pedestrian fatalities in traffic crashes (4,699) made up 11% of the total 41,259 traffic fatalities. Since 2008, the number of pedestrian fatalities in traffic crashes has increased and, in 2014, makes up 15% of the 32,675 total motor vehicle traffic fatalities (National Center for Statistics and Analysis, 2016b).

While the frequency statistics are substantially alarming, trends in pedestrian injuries and fatalities is important to consider in the context of the amount of walking that occurs in a population. For example, with all else being equal, it might be expected that a population engaging in more pedestrian activity will experience a higher frequency of pedestrian fatalities than a population engaging in less pedestrian activity. In an attempt to measure national travel characteristics, the National Household Travel Survey (NHTS) collects travel data from a nationally representative sample of Americans through the use of self-report travel diaries (Pucher et al., 2011). Along with other modes of transportation, the NHTS allows for estimation of rates of pedestrian activity during a survey period. Pucher et al. (2011) analyzed data from consecutive NHTS surveys (2001 and 2009) to investigate trends in walking among Americans. Their analyses suggest that there was an increase in the share of trips by walking in 2009 to 10.5% from 8.6% in 2001 (Pucher et al., 2011). Additionally, over the time period from 2001 to 2009, there were small but statistically significant increases in the number, duration, and length

of walking trips. Pucher et al. (2011) report that in 2009 the average American made 17 more walking trips and spent about five more hours walking, which lead to a nine-mile increase in walking distance traveled when compared with data from 2001.

While the aforementioned data suggest a recent small but statistically significant upward trend in the amount of pedestrian travel, which could partially explain the frequency of pedestrian motor vehicle crash fatalities, it is important to note that the most recent data on walking trips in the U.S. originate from the 2009 National Household Travel Survey. More recent data are needed to adequately compare trends in pedestrian traffic crash fatalities with the amount of pedestrian activity in the U.S. Data collection for the 2016 National Household Travel Survey is scheduled to be completed in April 2017 and more time will be needed to adequately analyze the data in search of trends.

More recent data from the National Survey of Bicyclist and Pedestrian Attitudes and Behaviors (NSBPAB) conducted in 2012 by the NHTSA indicate a 14% increase in the number of respondents reporting walking in the past 30 days and walking more often than they had a year earlier (U.S Department of Transportation, 2016). While not a strong indicator of overall walking rates, the NSBPAB results provide corroborating evidence for increased pedestrian activity among Americans. Given the limited data on pedestrian activity, the U.S. Department of Transportation has highlighted the need to improve data in order to work toward an understanding of pedestrian safety problems (U.S. Department of Transportation, 2016a). Nonetheless, the relatively static frequency of pedestrian traffic crash fatalities over the years in the midst of declining total motor vehicle traffic crash fatalities remains an important public health concern.

## **Distraction**

### **Distracted Drivers**

The NHTSA estimates that in 2014, 3,179 people were killed in 2,955 crashes where distracted driving was a factor. Of the fatal crashes, 13% (385) of the crashes were reported to have involved the use of cell phones and other electronics. A total of 404 fatalities occurred in crashes that involved the use of cell phones or other activities related to cell phone use (National Center for Statistics and Analysis, 2016a).

Of the estimated 2,338,000 people non-fatally injured in motor vehicle traffic crashes in 2014, 18% (431,000) are estimated to have been injured in crashes associated with driver distraction. Of the distraction-related crashes in 2014, about 8% (33,000) were associated with cell phone distraction (National Center for Statistics and Analysis, 2016a).

**National distracted driving prevention efforts.** Given the increase in crashes involving distracted drivers President Barack Obama issued an executive order in 2009 which aimed to ban text messaging when driving a government vehicle, while driving a private vehicle on official government business, or while using electronic equipment supplied by the government (The White House, 2009). In 2012, the Federal Motor Carrier Safety Regulations (FMCSRs) and Hazardous Materials Regulations (HMRs) were amended to restrict the use of handheld mobile telephones by drivers of commercial vehicles ("Drivers of CMVs: Restricting the use of cellular phones. 76 Federal Register," 2011).

Currently, 46 U.S. states, D.C., Puerto Rico, Guam, and the U.S. Virgin Islands have text message laws aimed at all drivers (U.S. Department of Transportation, 2016c). Two of the remaining four states ban texting and driving by “novice” drivers; usually determined by driver age (U.S. Department of Transportation, 2016c). In Arizona, the texting and driving ban only

affects school bus drivers while Montana currently has no bans on distracted driving (U.S. Department of Transportation, 2016c).

Additionally, the U.S. Department of Transportation (DOT) maintains the official U.S. government website for distracted driving at [www.distraction.gov](http://www.distraction.gov). This website is part of the DOT's effort to stop texting and cell phone use while driving and includes the general public in their target audience (U.S. Department of Transportation, 2016b). Some major cell phone service providers have united behind an advertising campaign titled "It Can Wait" (AT&T, 2016a). Hosted at [www.itcanwait.com](http://www.itcanwait.com), this campaign offers tools and smartphone applications that people can use to raise awareness of the dangers of texting and driving; including the ability to make a pledge to "keep your eyes on the road, not your phone" (AT&T, 2016b). While there has been a much greater focus on distracted automobile drivers, there has been much less research, and therefore much less intervention efforts, on distracted pedestrians. The following section will serve to summarize relevant distracted pedestrian observation literature.

## **Distracted Pedestrian Research**

### **Naturalistic Observations**

Naturalistic observations follow a non-experimental research design where data are gathered from direct scoring of pedestrian behavior in real-world settings. Coding of pedestrian behaviors can take place in real-time or through review of captured video (Scopatz & Zhou, 2016).

Utilizing real-time observational data, Bungum et al. (2005) investigated the effect of multitasking on pedestrian attentiveness and display of cautionary behaviors. It was hypothesized that multitasking pedestrians would display more inattentiveness and thus fail to perform cautionary behaviors such as looking left and right, crossing in accordance with the pedestrian

signal, and keeping within the bounds of the crosswalk. For the purposes of the investigation, multitasking was defined as, “talking on a mobile phone, wearing headphones, speaking with another walker, or drinking, eating or smoking while they crossed the street” (Bungum et al., 2005, p. 273). In total, 867 individuals were observed crossing an intersection near a large university in Las Vegas, Nevada. The crossing spanned seven lanes and featured a marked crosswalk with a signal for pedestrians (signalized).

Bungum et al. (2005) found that 20.1% of pedestrians observed were distracted as they crossed the street with 5.7% being users of headphones or a cellphone. Analysis of the observational data revealed that significantly fewer cautionary behaviors were exhibited by distracted pedestrians when compared to non-distracted pedestrians. While distraction was a significant predictor of demonstration of cautionary behaviors in this study, the authors report that only 1.6% of the variance was explained by distraction. Bungum et al. (2005) posit that their findings support an increased risk associated with crossing the street while distracted.

Hatfield and Murphy (2007) utilized real-time observations at signalized and non-signalized intersections in Sydney, Australia to (1) establish rates of mobile phone use while crossing the road and (2) compare crossing behaviors of pedestrians crossing while using a mobile phone versus those not using a mobile phone. Variables collected on mobile phone use were using a handheld phone, using a hands-free phone, text messaging, and not using a phone. Data were collected using a case-control design where each case (a pedestrian using a mobile phone) was matched to both a time-matched control (the first pedestrian to cross the same point while not using a mobile phone) and an approximate age-and-gender-matched control (a pedestrian appearing to be the same age and gender as the case).

Hatfield and Murphy (2007) found that female pedestrians who used a mobile phone while crossing were less likely to look at traffic before crossing than those not using a mobile phone at both signalized and non-signalized crossings. At non-signalized crossings, females were less likely to wait for traffic to stop before crossing while males walked slower when compared to those crossing without using a mobile phone. At signalized crossings, females walked slower and were less likely to look at traffic while crossing. Another noteworthy finding is that females using a mobile phone were more likely to wait for traffic to stop before beginning to cross at signalized crossings. Hatfield and Murphy (2007) suggest that mobile phone use is associated with cognitive distraction that can negatively impact pedestrian safety.

Two studies conducted by Nasar, Hecht, and Wener (2008) aimed to explore the effects of cell phone distraction on pedestrians. The first study sought to determine if cell phone distraction hampered a pedestrian's situational awareness. Sixty randomly-selected pedestrians walking near the entrance to a large university were recruited for study participation and were assigned equally to one of two conditions. Condition one involved participants walking on a prescribed route while talking to a researcher on a cell phone. Condition two involved participants walking the same prescribed route while holding a cell phone waiting on a potential call that never came. Thus, participants assigned to condition one were distracted by a cell phone conversation and participants in the other condition served as non-distracted controls. Before the study, researchers placed several "out of place" items along the route. After the prescribed walk, participants in both groups were interviewed to see how many items they remembered seeing. The results indicated that participants in the non-distracted group noticed significantly more objects than those in the distracted group.

Given the impairment of situational awareness found in the first study, the aim of the second study by Nasar et al. (2008) was to explore the impact of cell phone or iPod use on pedestrian crossing behavior. Three researchers were trained to conduct observations of pedestrians approaching a crosswalk who might be involved in a conflict with a vehicle. In total, 127 pedestrians were included in the analysis. Analysis revealed that the percentage of those observed exhibiting unsafe crossing behavior for the cell phone group, iPod group, and neither group was 48.0%, 16.1%, and 25.3% respectively; thus suggesting that pedestrians using cell phones exhibit more unsafe crossing behaviors.

Over two studies, Hyman, Boss, Wise, McKenzie, and Caggiano (2010) examined the effects of distraction while walking. In the first study, 196 individuals were observed as they walked through the central plaza of a university. All participants were chosen by one of the following criteria: listening to a music player, using a cell phone, walking in pairs, or walking alone with no electronics. Outcome variables recorded for each participant were crossing time, number of direction changes, weaving, tripping or stumbling, near-collisions or collisions, and acknowledgment of other pedestrians (indicated by waving, nodding, or talking). Analysis revealed that participants distracted by cell phones took 82.53 seconds to cross the plaza compared to non-distracted lone participants who took 74.81 seconds to cross; indicating that pedestrians distracted by a cell phone walk slower than those who are not distracted. Cell phone users were also reported to change direction more, weave more, and acknowledge people less than non-distracted walkers.

In their second study, Hyman et al. (2010) assessed whether inattention blindness was associated with pedestrian cell phone use. Hyman et al. (2010) described inattention blindness as a phenomenon where people are less likely to notice new and distinctive stimuli in their

environment. The stimulus used for this study was a brightly-colored clown on a unicycle in the middle of the same central plaza of a university. Participants meeting the same criteria as the first study (listening to a music player, using a cell phone, walking in pairs, or walking alone with no electronics) were observed as they passed the clown in the plaza. Researchers then attempted to interview all observed participants as they exited the plaza to ask if they noticed the clown. Of the individuals interviewed, only 25% of cell phone users reported noticing the clown. By contrast, over half of those in the other conditions reported seeing the clown. These results suggest that people who use cell phones while walking are less aware of their surroundings.

Walker, Lanthier, Risko, and Kingstone (2012) conducted a study to examine the effect of personal music devices on cautionary behavior exhibited by pedestrians crossing the street. Conducted in Vancouver, Canada, this study collected data from observations of 264 pedestrians. Participants were coded to reflect participant gender, presence of a music device, presence of other distractions, presence of an approaching vehicle, and cautionary behavior in the form of number of head movements before crossing and whether participants stopped or slowed before entering the crosswalk. The presence of a music device was operationalized by the presence of headphones in participants' ears (Scopatz & Zhou, 2016). Tests for differences between music device use and non-use as well as tests for differences between gender found no statistically significant difference between any of the groups. Results from this study suggest that the use of music devices does not significantly affect cautionary behavior.

Thompson et al. (2013) examined distracting behaviors in pedestrians crossing the street. A total of 1,102 pedestrians were observed crossing busy intersections in Seattle, Washington. Demographic data was in the form of gender and estimated age as categorical variables. Participants were coded according to whether they were walking alone, in a group, or in a group

talking to another person. Coded behaviors were direction of travel, whether the pedestrian crossed within the crosswalk, whether the pedestrian looked left and right, and whether the crossing signal was obeyed. Device use while crossing was coded as either cell phone (a voice call with the phone to the ear or use of an earpiece), music player with earphones, or texting (manually using the device). Music player use was described as a pedestrian carrying a device capable of playing music with headphones in the ears. The time it took observed pedestrians to cross was also recorded. Of the sample population, 30% exhibited a distracting activities which included listening to music (11.2%), text messaging (7.3%) and using a handheld phone (6.2%). Analysis revealed that distracted pedestrians, with the exception of those listening to music, took significantly longer to cross the intersections than those not distracted. Handheld and hands-free cell phone use increased crossing time by 0.75 and 1.29 seconds, respectively. Text-messaging pedestrians took an extra 0.55 seconds to cross each lane of the intersection, increasing total crossing time by 18%. Perhaps unexpectedly, pedestrians listening to music crossed the intersections 0.16 seconds faster when compared to those who were not distracted. Regarding unsafe crossing behavior, text messaging and gender were significantly associated with increased unsafe behavior such that pedestrians distracted by text messaging were 3.9 times more likely to exhibit at least one unsafe crossing behavior compared to those not distracted. Text-messaging pedestrians were also four times more likely to cross the street without looking both ways than those not distracted; with listening to music, talking with others, and “other distractions” causing a smaller but statistically significant increase in likelihood of failing to look left and right before crossing. A comparison of male and female texters revealed that females were twice as likely to exhibit at least one unsafe crossing behavior.

**Summary.** The general aim of naturalistic studies is to view pedestrian behaviors as they occur in the natural environment without researcher interaction with those observed. Though the strength of evidence from these studies is mixed, a greater proportion of these studies found that with distractions (including mobile device use) came an increase in unsafe crossing behaviors posited to increase the risk of pedestrian injury or death (Bungum et al., 2005; Hatfield & Murphy, 2007; Thompson et al., 2013). Two studies focusing on inattention blindness found that use of cell phones resulted in failure to notice “out-of-place” objects in one study (Nasar et al., 2008) and failure to notice a brightly-colored clown in another (Hyman et al., 2010). Thompson et al. (2013) found that text messaging was associated with slower crossing speeds as well as a four-fold increase in the likelihood of crossing the street without looking both ways. One study investigating the use of personal music devices only, found that use of a personal music device resulted in increased *cautionary* behaviors among males with no difference among females (Walker et al., 2012). While existing studies provide evidence that mobile-device-associated injury risk exists it is not clear how much of the variation in conclusions is due to widely varying methodological designs (Scopatz & Zhou, 2016).

### **Simulation Observations**

To address limitations of observational research, there have been experimental studies that involve the observation of street-crossing behavior in a virtual reality environment. A virtual environment allows researchers to place participants in certain artificial situations that would be ethically impossible in a physical environment. A simulated environment allows researchers to control certain variables within the environment that would be very difficult to control in the natural environment. The simulated environment also allows for increased ease and accuracy in the collection of pedestrian behavior data. Measures of pedestrian behavior obtained through

virtual environments have been shown to be valid measures of real-world pedestrian behavior (Schwebel, Gaines, & Severson, 2008).

Neider, McCarley, Crowell, Kaczmarski, and Kramer (2010) investigated the effects of distraction on the crossing behavior of college students. Participants were placed into three conditions: (1) no distraction, (2) listening to music, and (3) using a hands-free device to talk on a cell phone. Behaviors of interest included crossing success rate, collision rate, time-out rate, time to initiate, crossing duration, and number of head turns. Results indicated that while cell phone conversation did not increase the number of times participants were hit, it did result in a reduced percentage of participants crossing the street within a 30-second time limit (time-out). Participants engaging in cell phone conversation took significantly longer to cross than those listening to music or those not distracted. Similarly, cell phone conversation was associated with a longer crossing initiation time.

One series of studies to use a virtual reality crosswalk environment investigated the effects of cellphone distractions on college students' crossing behavior (Stavrinos, Byington, & Schwebel, 2011). In the first of two studies, Stavrinos et al. (2011) asked participants to cross a simulated street environment twelve times (six times distracted and six times not distracted). Distraction was defined as having a naturalistic voice conversation via cell-phone. Easily answerable questions such as, "what is your college major," were asked. Video of the simulated crossings was recorded to facilitate data coding. Behaviors coded were average time left to spare (the time left after crossing before another vehicle passed), missed opportunities (times when a participant could have crossed safely but did not), attention to traffic, and hits and close calls. Results indicate that, when distracted by a cell-phone conversation, participants crossed with less time left to spare, missed more opportunities, and experienced more hits and close calls.

In the second study, Stavrinou et al. (2011) introduced distraction by engaging participants in telephone conversations believed to target different cognitive domains. Three groups of participants were engaged in different types of cellphone conversations which were naturalistic conversation consisting of several easily-answerable questions with no right or wrong answer, a spatial conversation where participants describe their living quarters, and a conversation requiring mental arithmetic. As in the initial study, behaviors coded were average time left to spare, missed opportunities, attention to traffic, and hits and close calls. Results revealed that each condition of distraction had equally negative effects on participants' safe crossing behavior.

In another simulation study on college students' crossing behavior, Schwebel et al. (2012) placed participants into four groups: (1) listening to music, (2) talking on a phone, (3) texting on a phone, and (4) no distraction. Behaviors coded were time left to spare, looking left and right, looking away, hits, and missed opportunities to cross. The investigators found that, when compared to the non-distracted group, all distracted conditions produced more looks away from the crossing environment, with the texting group exhibiting the most dramatic increase. More hits occurred in the music and texting groups when compared to the non-distracted group.

**Summary.** Though not without limitations of their own, simulation studies attempt to solve important limitations inherent of naturalistic studies by taking advantage of the ability to ethically place participants in certain high-risk situations that are considered ethically impossible in a real-world setting. Existing simulation studies suggest that cell phone conversation or texting while crossing the street adversely affect pedestrian safety in a simulated environment.

## **Laboratory Observations**

Laboratory settings have also been used to study the effects of distraction on pedestrians. The laboratory setting allows for precise analysis of characteristics such as gait pattern and walking speed. While simulated traffic environments with an emphasis on realism are not usually a component of laboratory studies, they can, perhaps, facilitate an understanding of the distracted pedestrian problem.

Using an indoor laboratory, Lin et al. (2007) placed college student study participants into three groups: (1) seated, (2) treadmill walking, and (3) walking through an obstacle course. Distraction was introduced by asking participants to manipulate a personal digital assistant device (PDA) using a stylus. Data were collected pertaining to participants' performance during different PDA-specific tasks and were target selection time, error rate, total task completion time, and workload (utilizing measures of mental demand, physical demand, temporal demand, performance, effort, and frustration). Of all three participant groups, walking through an obstacle course was associated with the largest PDA-specific performance decrement.

In a laboratory setting, Lamberg and Muratori (2012) conducted analyses of gait pattern across different groups of distracted pedestrians. Participants were placed into three groups: (1) non-distracted walking, (2) walking while talking on a cell phone, and (3) walking while texting on a cell phone. Gait analysis took place while participants wore a vision-obstructing hood. All participants underwent a baseline gait analysis one week prior to being assigned to one of the three distraction groups. The researchers observed gait disturbances associated with walking while texting or talking on a cell phone in a laboratory setting. Compared to baseline testing, walking speed decreased by 33% in the texting group and by 16% in the talking group. The

texting group also exhibited a 61% increase in lateral deviation and a 13% increase in linear distance traveled.

Another laboratory study utilized a simulated street setting to collect data on the effects of mobile phone use on gait (Schabrun et al., 2014). Gait data were collected from participants in three groups: (1) walking (non-distracted), (2) walking while scrolling through and reading text on a mobile phone, and (3) walking while typing on a mobile phone. Variables of interest included walking speed, path deviation, and the position of various anatomical structures. Results indicate that pedestrians reading and typing on a mobile phone walked slower than those without a mobile phone. Further, typing on a mobile phone resulted in slower walking when compared to reading on a mobile phone. Mobile phone use was associated with other gait abnormalities including a lack of straight-line walking with the largest deviations in straight-line walking found among the typing group.

**Summary.** Laboratory studies attempt to examine naturalistic behavior in a relatively safe environment. Similar to simulator studies, laboratory researchers have the ability to control key aspects of the environment in which participants are observed. Like the reviewed simulator studies, results from the laboratory studies reviewed provide evidence that walking while using a mobile device degrades performance, likely resulting in an increased risk of pedestrian injury.

### **Risk Factors for Pedestrian Injury**

In addition to the aforementioned risk of pedestrian injury introduced by the use of electronic devices, general risk factors will be discussed in the following paragraphs. In 2014, most pedestrian fatalities occurred in urban areas (78%), at non-intersection locations (71%), and at night (72%). Of the total pedestrian fatalities, 50% occurred between the hours of 6:00 PM to 11:59 PM (National Center for Statistics and Analysis, 2016b).

In 2014, the highest percentage (10%) of adult pedestrian fatalities was made up of those between the ages of 60 and 64 years. Analyses of fatality rates indicate that adults 80 years of age and older have the highest rate at 2.54 per 100,000 population. Of total pedestrian *injuries*, children between the ages of five and fourteen years made up the largest percentage (10%) while the highest rates were among those of traditional college age (18 to 24 years). Americans between the ages of 15 and 19 years had the highest injury rate (37 per 100,000 population) with those between the ages of 20 and 24 years having the next highest injury rate (31 per 100,000 population) (National Center for Statistics and Analysis, 2016b).

In 2014, most pedestrian fatalities (70%) were among males. In the same year, the injury rate among males was more than double the rate among females, at 2.17 per 100,000 and 0.91 per 100,000 population respectively. Regarding *injuries*, males and females possessed rates of 22 and 19 respectively. An interesting fact is revealed when injury rates among males and females are examined according to age group. The injury rate among females aged between 15 and 19 years was 49 per 100,000 population, while the injury rate for males of the same age group was substantially lower at 26 per 100,000 population. The same analyses on the female and male age groups of 20 through 24 years shows a similar disparity at 34 per 100,000 population for females and 28 per 100,000 population for males (National Center for Statistics and Analysis, 2016b).

In 2014, nearly half (48%) of all traffic crashes resulting in pedestrian fatalities involved alcohol. For this statistic, alcohol involvement is defined as “whether alcohol was consumed by the driver and/or the pedestrian prior to the crash,” not necessarily whether or not alcohol was the cause of the crash. About one third (34%) of fatal pedestrian crashes involved a pedestrian with a blood alcohol concentration (BAC) of .08 grams per deciliter (g/dL) or higher. Drivers

with BACs of .08 g/dL or greater were involved in 14% of fatal pedestrian crashes (National Center for Statistics and Analysis, 2016b).

### **Rationale for College Pedestrians as a Priority Population**

Along with an increase in pedestrian activity among the general U.S. population between 2001 and 2009, pedestrian activity among college-age individuals has also increased. According to data from the NHTS, the percentage of Americans between the ages of 16 and 24 years who reported making five or more walking trips a week increased from 31% to 33% over the time period from 2001 to 2009 (Pucher et al., 2011). As previously stated, Americans between the ages of 15 and 19 years and 20 and 24 years have the highest rates of injury (37 and 31 per 100,000 population, respectively) (National Center for Statistics and Analysis, 2016b).

Rainie and Zickuhr (2015) report results from a survey that measured opinions of proper cell phone etiquette among U.S. adults age 18 to 29 years. Of eight scenarios, 77% of respondents overall felt that cell phone use “while walking down the street” was “generally OK.” Cell phone use while walking down the street garnered approval from the highest percentage of adults who indicated that the behavior was generally OK. When analyzed by age group, 78% of respondents aged 18 to 29 years indicated that cell phone use while walking down the street was generally OK. Results from this survey suggest a large degree of social acceptability of the behavior of cell phone use in public places, including while walking down the street. Table 2.1 shows overall results from all eight scenarios presented. Table 2.2 shows results broken down by age category.

Table 2.1

*Opinion of U.S. Adults on Proper Cell Phone Etiquette.*

Context	% generally OK	% generally not OK
While walking down the street	77	23
On public transportation	75	25
While waiting in line	74	26
At a restaurant	38	62
At a family dinner	12	88
During a meeting	5	94
At movie theater or other usually quiet place	5	95
At church or other worship service	4	96

*Note.* Table adapted from Rainie, L., & Zickuhr, K. (2015). Americans' views on mobile etiquette. *Pew Research Center*. Retrieved from [http://www.pewinternet.org/files/2015/08/2015-08-26\\_mobile-etiquette\\_FINAL.pdf](http://www.pewinternet.org/files/2015/08/2015-08-26_mobile-etiquette_FINAL.pdf)

Table 2.2

*Opinion of U.S. Adults on Proper Cell Phone Etiquette by Age Group.*

Context by age group in years	% generally OK
On public transportation	
18-29	90
30-49	79
50-64	71
65+	54
While waiting in line	
18-29	86
30-49	77
50-64	70
65+	59
When walking down the street	
18-29	78
30-49	82
50-64	77
65+	66
At a restaurant	
18-29	50
30-49	40
50-64	33
65+	26
At a family dinner	
18-29	16
30-49	10
50-64	11
65+	12
At movie theater or other usually quiet place	
18-29	11
30-49	4
50-64	4
65+	3
During a meeting	
18-29	10
30-49	6
50-64	3
65+	2
At church or other worship service	
18-29	9
30-49	3
50-64	1
65+	1

*Note.* Table adapted from Rainie, L., & Zickuhr, K. (2015). Americans' views on mobile etiquette. *Pew Research Center*. Retrieved from [http://www.pewinternet.org/files/2015/08/2015-08-26\\_mobile-etiquette\\_FINAL.pdf](http://www.pewinternet.org/files/2015/08/2015-08-26_mobile-etiquette_FINAL.pdf)

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There is further evidence to suggest that younger Americans differ from older adults in their views of social etiquette regarding cell phone use. Using a survey, Forgays, Hyman, and Schreiber (2014) investigated gender and age differences in views of social etiquette related to cell phone use. An inverse relationship was found between age and social acceptability of texting as means of communication such that as age increased, social acceptability of texting decreased. This finding is also important to consider within the context of findings from a Pew Research Center study that younger Americans send and receive five times more text messages per day than a typical adult (Lenhart, 2010). The findings that younger Americans favor texting over other forms of communication and corroborating evidence of increased mobile communication among members of this group provide rationale for the inclusion of this demographic in the present investigation.

A recent survey of 2,008 U.S. adults conducted on behalf of the American Academy of Orthopaedic Surgeons (AAOS) revealed that 70% of respondents aged 18 to 34 years believe that distracted walking is a serious issue compared to 81% of individuals 35 years and older. Younger adults were more likely to report engaging in common distracted walking behaviors and half consider distracted walking to be “embarrassing--in a funny way.” The survey also uncovered an interesting “it’s not me, it’s you” effect described as respondents feeling that distracted walking is a common problem, but not one in which they, themselves, engage. Ninety percent of respondents said they see pedestrians on the phone while only 37% admit engaging in the behavior of phone use themselves. This disparate trend is seen across a range of potentially distracting walking behaviors including listening to music and using a smartphone (American Academy of Orthopaedic Surgeons, 2015b).

With the advent of independent messaging applications that serve as alternatives to traditional text messages that are sent and received through a cellular service provider, it is also important to acknowledge the increased use of such alternate means of communication. Mobile applications like WhatsApp, Apple iMessage, and Google Hangouts allow users to send and receive messages via an internet connection while bypassing a cell phone service provider's proprietary channel of communication. Research indicates that the use of alternative messaging applications has grown over the past few years and, like traditional texting, is most prevalent in younger age groups (Duggan, 2015).

Further, mobile device use in areas other than sending and receiving messages has grown significantly in the recent past. A Pew Research Center report reports a usage increase in almost all major social media platforms that the center tracks (Duggan, 2015). Some social media platforms, like Pinterest and Instagram, have seen traffic more than double from 2012 to 2015 (Duggan, 2015). The large increase in activity other than mobile messaging correlate with an increase in wireless traffic data reported by CTIA-The Wireless Foundation. Since 2012, wireless traffic has increased from 1.47 trillion megabytes (MBs) to 9.65 trillion MBs with the largest increase occurring between the year 2014 and 2015. From 2014 to 2015, wireless traffic more than doubled to 9.65 trillion MBs from 4.06 trillion MBs (CTIA-The Wireless Association, 2016).

Of Americans who text, Lenhart (2010) reports that 29% of teenagers aged 12 to 17 years send or receive text messages in excess of 100 per day while only 8% of adults 18 or older report sending greater than 100 text messages in a day. Further, the median and mean number of text messages sent or received per day for teenagers (50 and 112.4, respectively) is higher than the median and mean in adults 18 or older (10 and 39.1 respectively) (Lenhart, 2010). By the time of

this writing, the teenage participants surveyed by Lenhart (2010) have now entered into the age group that is considered, for the purposes of this study, to be ‘traditional college students’ age 18 to 24 years.

A recent study by Pettijohn et al. (2015) surveyed 235 college students to assess their use of texting in the classroom. Results indicated that 36.9% of those who owned cell phones reported sending between 1 and 50 texts per day, 13.3% reported sending between 51 and 75, 20.6% reported sending between 76 and 100, 20.2% reported sending between 100 and 300, and 6.8% reported sending more than 300. Overall, 58.5% of students reported texting during class. Of the students who text during class, some reported reasons were boredom (38.9%), work (35.6%), and emergencies (13.4%) (Pettijohn et al., 2015).

Regarding cell phone ownership, Pettijohn et al. (2015) found that of the 235 college students surveyed, 99.6% reported owning a cell phone. These findings match findings that 98% of the U.S. adult population between the ages of 18 and 29 reported owning a cell phone in 2015 (Anderson, 2015).

Certain environmental risk factors for pedestrian injury are inherent to the college campus environment. A depiction of the college campus environment by Balsas (2003) describes a large number of people operating on an irregular schedule and moving around campus throughout the day. This high level of activity typical of a college campus results in a multimodal (many transportation means at once) environment that increases the likelihood of conflicts. With many institutions dis-incentivizing automobile travel on campus, high volumes of people moving through alternative means is common. Features of high-risk to pedestrians found on nearly all college campuses include intersections and crosswalks (Balsas, 2003), where pedestrians are perhaps the most likely to encounter a conflict (Loukaitou-Sideris et al., 2014).

An investigation of three college campuses in California revealed that significantly higher numbers of crashes occurred during the late fall and winter. The majority of campus crashes also happened in the morning and afternoon; the crash rate seemingly a function of the number of people present (Loukaitou-Sideris et al., 2014).

### **Rationale Summary**

Nearly all college students own a cell phone and have the potential to own other mobile devices capable of producing conditions of distraction. Large numbers of college students use mobile devices while walking, a behavior seen by many as socially acceptable. Texting and other forms of nonverbal mobile communication have become the preferred methods, particularly among younger Americans. The increased social acceptance and large volume of such communication among this demographic is suggestive of a looming shift toward increased acceptance overall as this group ages. Analysis of recent wireless data traffic indicates near exponential growth. This increase can be partially explained by increases in texting and other mobile communication, but also suggests the use of mobile devices for activities other than communication.

Unique features of the college campus environment likely exacerbate the problem of walking while distracted. In a large study of three college campuses by Loukaitou-Sideris et al. (2014), intersections, crosswalks, and other features associated with large volumes of pedestrian activity were found to be areas of high risk. Though large numbers of people moving around campus on an irregular schedule is one inherent driver of risk, the risk is compounded when the behavioral factor of inattention is introduced. The demonstration of risky pedestrian behaviors and environmental risk factors associated with college campuses justifies the selection of college students as the priority population in the present study.

## **Other Potential Pedestrian Injuries**

While traffic-related incidents have been a primary focus of distracted pedestrian research, it is important to consider the potential impact of other injuries that can occur because of distracted walking. Though not within the scope of the current investigation, cognizance of other potential injuries that could result from distracted walking further substantiate the importance of research in this area. Through secondary analysis of U.S. emergency department data obtained from the National Electronic Injury Surveillance System (NEISS), Nasar and Troyer (2013) estimated that 1,506 nonfatal injuries occurred in 2010 due to mobile phone use among pedestrians in public places; an estimate which includes traffic-related and non-traffic-related events (e.g., a pedestrian collides with a tree). Nasar and Troyer (2013) discovered that the frequency of such injuries increased with statistical significance between 2004 and 2010. Injuries included concussions, seizures, fractures, contusions, lacerations, dislocations, abrasions, sprains, strains, and pain in various parts of the body. Overall, more injuries related to talking than texting with talking accounting for 69.5% of injuries and texting accounting for 9.1%. Pedestrian injuries more frequently involved people under the age of 31 (54.7%) and more men (52.9%) than women.

Though the estimated frequencies for nonfatal, non-traffic, distraction-related incidents might seem relatively low, Nasar and Troyer (2013) argue that such incidents are underreported for a variety of reasons including some injury victims visiting a primary care doctor or other provider, not seeking treatment, not reporting a cell phone as the cause, or dying. To illustrate the plausibility of underreporting, Nasar and Troyer (2013) contrast their 2008 estimate of 1,099 nonfatal driver injuries to an NHTSA estimate of 515,000 injuries and 5,870 fatalities related to some form of distraction for the same year.

While the study by Nasar and Troyer (2013) focused on injuries occurring in public spaces, a comparable study by Smith, Schreiber, Saltos, Lichenstein, and Lichenstein (2013) expanded their case selection criteria to include injuries in all settings. Based on the modified criteria, an additional 280 estimated telephone-related cases were revealed in the year 2010. For the year 2011, Smith et al. (2013) reported an increase to an estimated 2,197 cases while also acknowledging a likely underreporting of cases. Like Nasar and Troyer (2013), Smith et al. (2013) report a statistically significant upward trend in estimated cases during the study period.

In addition to the need for further research, improved data collection is needed to move toward an understanding of the problem of distracted walking (Mwakalonge, Siuhi, & White, 2015). Regarding distracted pedestrians, formal data collection on the national level does not occur. At the state level, there is a lack of uniformity among reporting systems which makes in-depth analysis difficult (U.S. Office of Compliance, 2010).

### **Prevention Efforts**

Prevention efforts described in this section take the form of policy, education, awareness-raising, and position statements from professional organizations. Research on the effectiveness of prevention efforts remains scarce. Evaluation of interventions is hindered, in part, by the lack of high resolution data on distracted pedestrian injuries (Mwakalonge et al., 2015) and limitations in the general understanding of the distracted pedestrian problem inherent in any emerging field of study (Scopatz & Zhou, 2016).

### **HealthyPeople 2020**

HealthyPeople 2020, a set of national health-related goals and objectives, addresses many health topics that include injury and violence prevention (U.S. Department of Health and Human Services, 2016a). With the overarching goal to, “prevent unintentional injuries and violence, and

reduce their consequences,” the Injury and Violence Prevention section of HealthyPeople 2020 contains two pedestrian-related objectives. Objective IPV-18, “reduce pedestrian deaths on public roads,” and objective IPV-19, “reduce nonfatal pedestrian injuries on public roads,” place national emphasis on the importance of increasing pedestrian safety and bolsters rationale for the present study (U.S. Department of Health and Human Services, 2016b).

### **Legislation**

There are currently no widespread laws aimed at distracted pedestrians. Some municipalities have been reported to enforce bans against texting and walking (Ngak, 2012). An ordinance passed by the Utah Transit Authority (UTA) states that, “no distracted pedestrian shall enter a Railroad Grade Crossing” (“Amended and reinstated ordinances,” 2016, p. 14). The ordinance, punishable by a fine up to \$100 for repeat offenders, is claimed to have had a positive effect according to UTA (Davidson, 2012).

### **Municipal Awareness Campaigns**

Reports of municipalities conducting awareness campaigns have surfaced in recent years (Cortez, 2012). In Delaware, safety officials have used sidewalk decals at busy intersections in an attempt to get the attention of pedestrians who may be looking down at their mobile devices. Such decals read, “Look up. Drivers aren’t always looking out for you.” In Philadelphia, as part of a safety campaign disguised as an April Fool’s Day joke, an “e-lane” was created for the exclusive use of distracted pedestrians on a sidewalk. Some residents who thought the lane was permanent were reported to have been upset upon learning that it was only an April Fool’s Day joke. A campaign in San Francisco was launched in response to a series of adverse events related to distracted walking. The campaign included outdoor, radio, and television ads that aimed to raise awareness of the dangers of using a mobile device while walking. An example outdoor ad

shows a woman wearing headphones while crossing the street. The text of the ad reads, “Stop. Look. Listen. Do you want Beethoven to be the last thing you hear?” As part of this campaign, transit drivers were also provided training on how to avoid incidents with distracted pedestrians. Safety advice to the public also appears in the San Francisco Municipal Railway Rider’s Guide and reads, “Avoid using your cell phone, texting or other multitasking while walking” (San Francisco Municipal Transportation Agency, 2016). An awareness-raising prank in New York City involved the use of people wearing orange safety vests with the words “Seeing Eye Person” written on them. The intent of the prank was to make it appear as if the New York DOT had set up a service that allowed distracted pedestrians to be guided by a human in order to safely text and walk (Improv Everywhere, 2013).

## **Social Media**

A number of social media awareness campaigns relating to distracted walking have been launched in the recent past. Social media campaigns often utilize “hashtags” represented by the # symbol to deliver a message. Twitter Incorporated (2016), a popular social media platform, describes a hashtag as follows: “A hashtag—written with a # symbol—is used to index keywords or topics on Twitter. This function was created on Twitter, and allows people to easily follow topics they are interested in.” Hashtags are also used on popular competing social media platforms such as Facebook and Instagram. Social media users use the hashtag symbol within the context of a personal post to promote the post within the context of a larger grouping of posts on the same topic (Twitter Incorporated, 2016). Current social media awareness campaigns include #devicedown and #walksafely (Safe Kids Worldwide, 2013), #eyesup (Interbrand North America, 2015), and #digitaldeadwalker (American Academy of Orthopaedic Surgeons, 2015a).

### **American College of Emergency Physicians**

In 2014, the American College of Emergency Physicians (ACEP) formally addressed the issue of distracted pedestrians by releasing an official position statement. The position statement recognizes the dangers of walking while using a mobile device and discourages use among moving pedestrians. The statement also advocates for research to further understand the magnitude of the problem, as well as public education about the associated dangers of distracted walking (American College of Emergency Physicians, 2014).

### **American Academy of Orthopaedic Surgeons**

The American Academy of Orthopaedic Surgeons (AAOS) specifically addresses distracted walking by leading an awareness campaign aimed at the public. Radio and television public service announcements which aired in 2015 and 2016 followed a humorous “digital deadwalkers” theme to raise awareness of the dangers of distracted walking. As a form of education, safety tips are provided that discourage distracted walking (American Academy of Orthopaedic Surgeons, 2015a). The AAOS has also sponsored research (American Academy of Orthopaedic Surgeons, 2015b) aiming to increase understanding of the problem; results of which were discussed earlier in this chapter.

### **National Highway Traffic Safety Administration (NHTSA)**

The NHTSA offers several “safety reminders” to reduce the risk of pedestrian injuries and fatalities. One such reminder explicitly addresses distracted walking is stated as, “stay alert; don’t be distracted by electronic devices, including smart phones, MP3 players, and other devices that take your eyes (and ears) off the road” (National Center for Statistics and Analysis, 2016b, p. 10). A second NHTSA recommendation also implies that remaining aware of your surroundings can protect pedestrians from traffic fatalities and reads, “Be cautious night and day

when sharing the road with vehicles. Never assume a driver sees you (he or she could be distracted, under the influence of alcohol and/or drugs, or just not see you). Make eye contact with drivers as they approach” (National Center for Statistics and Analysis, 2016b, p. 10).

### **Theoretical Framework**

Kerlinger and Lee (2000, p. 8) define theory as, “a set of interrelated concepts, definitions, and predispositions that present a systematic view of events or situations by specifying relations among variables to explain and predict the events or situations.” Given the value of being able to accurately predict behaviors in health education and health promotion, using theory in health behavior research has become standard practice (Sharma, 2017).

Appropriately applied health behavior theory provides a framework by which health practitioners can articulate assumptions and hypotheses about a strategy or target of intervention (National Cancer Institute, 2005).

### **Theory of Planned Behavior**

The beginnings of the theory of planned behavior (TPB) can be traced back to development of the theory of reasoned action (TRA). TRA was initially developed by Martin Fishbein and Icek Ajzen to improve understanding of the relationships between attitude toward the behavior, subjective norm, behavioral intention, and behavior (Fishbein, 1967). Early studies using TRA consistently demonstrated a strong relationship between behavioral and normative beliefs, intention to perform the behavior, and the actual behavior. The theory posits that a person’s intention to engage in a behavior is the direct antecedent to the actual behavior. Thus, the ability to predict behavioral intention is useful in determining whether one will engage in the behavior (Ajzen, 1991). According to TRA, behavioral intention is predicted by attitude toward the behavior and subjective norm. Attitude toward the behavior is the degree to which

performance of the behavior is positively or negatively valued (Ajzen, 2017). Subjective norm is an individual's perceived social pressure to engage or not to engage in a behavior (Ajzen, 2017).

The TPB was borne out of the idea that the TRA constructs of attitude toward the behavior and subjective norm might not sufficiently predict behaviors that are further from volitional control. Thus, the TPB is an extension of the TRA and adds the construct of perceived behavioral control to account for factors outside of one's individual control that might influence behavior (Glanz et al., 2008). Perceived behavioral control involves a person's perceptions of their ability to perform a given behavior (Ajzen, 2017). Therefore, the TPB as employed in the present study posits that a person's attitude toward the behavior, subjective norm, and perceived behavioral control will determine behavioral intention, which ultimately predict behavior. The TPB has been used extensively in health behavior research. Such uses include condom use, healthy eating, clinical treatment adherence, organ donation, smoking, and vaccinations (Ajzen, 2015; Sharma, 2017).

The TPB has also been used to investigate pedestrian behaviors (Barton et al., 2016; Díaz, 2002; Evans & Norman, 1998, 2003; Holland & Hill, 2007; Lennon et al., 2017; Xu et al., 2013; Zhou & Horrey, 2010; Zhou et al., 2009). These studies will be discussed now in the context of the present study. Early studies employing the TPB to investigate pedestrian behavior took place in a variety of locations outside of the U.S. such as Chile (Díaz, 2002), China (Xu et al., 2013; Zhou & Horrey, 2010; Zhou et al., 2009), and the United Kingdom (Evans & Norman, 1998, 2003; Holland & Hill, 2007). Perhaps because many of these studies were conducted before the steady and substantial increase in mobile device voice, message, and data traffic (CTIA-The Wireless Association, 2016), early studies focused on street-crossing violations or group conformity and did not focus on distraction. Only recently has investigation begun using

the TPB in relation to distracted walking within the U.S. (Barton et al., 2016). In a sample of 80 undergraduate college students, Barton et al. (2016) found that TPB constructs explained 61% of the variance in behavioral intention. Further, attitude toward the behavior and perceived behavioral control significantly predicted behavioral intention to cross the street while distracted with perceived behavioral control emerging as the strongest predictor of behavioral intention. A study of 362 adults conducted in Australia by Lennon et al. (2017) found that TPB constructs explained 55% of the variance in behavioral intention among participants aged 18 to 30 years. Attitude toward the behavior and subjective norm emerged as significant predictors with attitude toward the behavior being the strongest predictor.

In the earliest study known to use the TPB to examine pedestrian behavior (Evans & Norman, 1998), 210 adult participants completed a questionnaire about hazardous street-crossing scenarios. Perceived behavioral control was found to be the strongest predictor of behavioral intention, explaining 37% to 49% of the variance (across three scenarios) in behavioral intention to cross the street in a hazardous manner. Another study of 1,833 schoolchildren by Evans and Norman (2003) used a similar hazardous crossing scenario but focused on adolescents' intentions and found similarly high variance explained.

A study by Díaz (2002) surveyed 146 city residents about intention to engage in hazardous crossing behavior. Analysis revealed that all TPB constructs were significantly correlated with behavioral intention and behavioral intention significantly correlated with "behavior" as measured by another questionnaire administered during the study.

In another study designed to measure behavioral intention as they pertain to crossing in a hazardous manner, Holland and Hill (2007) measured the TPB constructs in 293 participants within the context of three scenarios pertaining to hazardous street-crossing. Across the

scenarios, a statistical model of TPB constructs accounted for 46% to 51% of the variance. The TPB construct of attitude toward the behavior emerged as the strongest predictor of behavioral intent.

Past studies have also used the TPB to investigate pedestrians' intentions to conform to the behaviors of other pedestrians in given street-crossing scenarios (Zhou & Horrey, 2010; Zhou et al., 2009). Zhou et al. (2009) recruited 426 adults to complete a questionnaire that aimed to measure behavioral intention across two different scenarios pertaining to conformity. The TPB was useful in predicting behavioral intention across the scenarios. Further, it was found that attitude toward the behavior was the strongest predictor in the non-conformity group and perceived behavioral control was the strongest predictor in the conformity group. A subsequent study by Zhou and Horrey (2010) aimed to perform a similar investigation using the TPB to predict intention related to conformity in a sample of 510 adolescents across two conformity scenarios. In the resulting statistical model, TPB variables helped explain from 30% to 40% of the variance in conformity intention.

Another recent study by Xu et al. (2013) examined pedestrian's intentions to illegally cross the street. A questionnaire administered to a sample of 323 adult participants revealed that the TPB constructs led to the explanation of 43% of the variance in behavioral intention to cross the street illegally.

Regarding the use of the TPB in predicting behavioral intention of college students, two of the reviewed studies involved undergraduate college students. One exclusively (Barton et al., 2016), and one as part of a mix of participants of other demographics (Xu et al., 2013). Given promising but scant research that is both theory-based and recent, the TPB was selected for the present study to further test the utility of the TPB in predicting college student pedestrian

intention to engage in distracted street-crossing. This results of this study will add to the small body of U.S.-based literature utilizing theory to investigate the problem of distracted walking (Barton et al., 2016).

Like any theory in health behavior research, the TPB has several limitations that are important to consider. Although the TPB has been useful in predicting intention to engage in a behavior, it assumes that behavioral intention is the direct antecedent to actual behavior (Fishbein & Ajzen, 2010). Since many behaviors are difficult or practically impossible to measure directly, it can be difficult to test the predictive ability of behavioral intention in some situations (Barton et al., 2016). While evidence exists to support the predictive power of the TPB (Ajzen, 2015; Sharma, 2017), the theory does not necessarily explain behavior change (Sharma, 2017). An incomplete explanation of behavior can serve as a hindrance to effective behavior modification. Further, the measurement of a person's perceived behavioral control may not be an accurate indicator of a person's actual behavioral control which can be affected by factors outside of an individual's perception (Sharma, 2017). Finally, the TPB assumes that all thoughts about a behavior are rational (Sharma, 2017). This assumption might lead to failure to consider irrational thoughts or fear. Despite these limitations, successful use of the theory in distracted pedestrian research and the need for more theory-based health behavior research justified use of the TPB in the present study.

## CHAPTER 3

### METHODS

The primary aim of this study was to examine intention to engage in the behavior of crossing the street on campus while using a mobile device in the next week. A secondary aim of the study was to estimate the incidence of distracted mobile device use among street-crossing pedestrians at the University of Alabama (Tuscaloosa). Chapter 3 describes the research methods and analyses that were used to meet the study purposes.

#### **Approval**

Prior to performing the procedures described herein, approval was obtained from the University of Alabama Institutional Review Board (IRB) on August 22, 2016 (see Appendix A). The researcher submitted questionnaire revisions and received subsequent approval on November 15, 2016 (see Appendix B). The temporary mounting of video recording equipment on university-owned property required additional approval from the University of Alabama Office of Facilities and Grounds. Permission to collect video data was obtained from the University of Alabama Office of Facilities and Grounds via an approved Application for Use of Campus Grounds (see Appendix C).

#### **Research Design and Population**

This study employed a non-experimental, cross-sectional design. The study involved data collection from a convenience sample of undergraduate students between the ages of 18 and 24 years enrolled in face-to-face courses at the University of Alabama. The study consisted of two phases conducted simultaneously. Phase one involved refinement and administration of a theory

of planned behavior (TPB) questionnaire. Phase two employed outdoor pedestrian observations to estimate the incidence of distracted mobile device use among street-crossing pedestrians on campus.

A power analysis was conducted with G\*Power Version 3.1.9.2 (Faul, Erdfelder, Buchner, & Lang, 2009) to calculate the sample size needed for analyses using bivariate normal model correlation with designated parameters (two tails; correlation = 0.20;  $\alpha$  = 0.05; power = 0.80). The calculation resulted in a sample size of  $n = 193$ . This number was rounded up and a minimum sample size goal of 200 was set for the collection of TPB questionnaire data in the present investigation.

### **Phase One**

Figure 3.1 illustrates the TPB questionnaire refinement and administration process. The study began with the creation of a TPB questionnaire designed to measure behavioral intention to engage in the behavior of crossing the street on campus while using a mobile device in the next week, followed by expert panel review, and subsequent pilot testing of a revised TPB questionnaire. Administration of the final TPB questionnaire followed and a test-retest procedure assessed stability reliability of the questionnaire. Simultaneous pedestrian observations took place to meet the secondary aim of the study. The observation process is also illustrated in Figure 3.1.

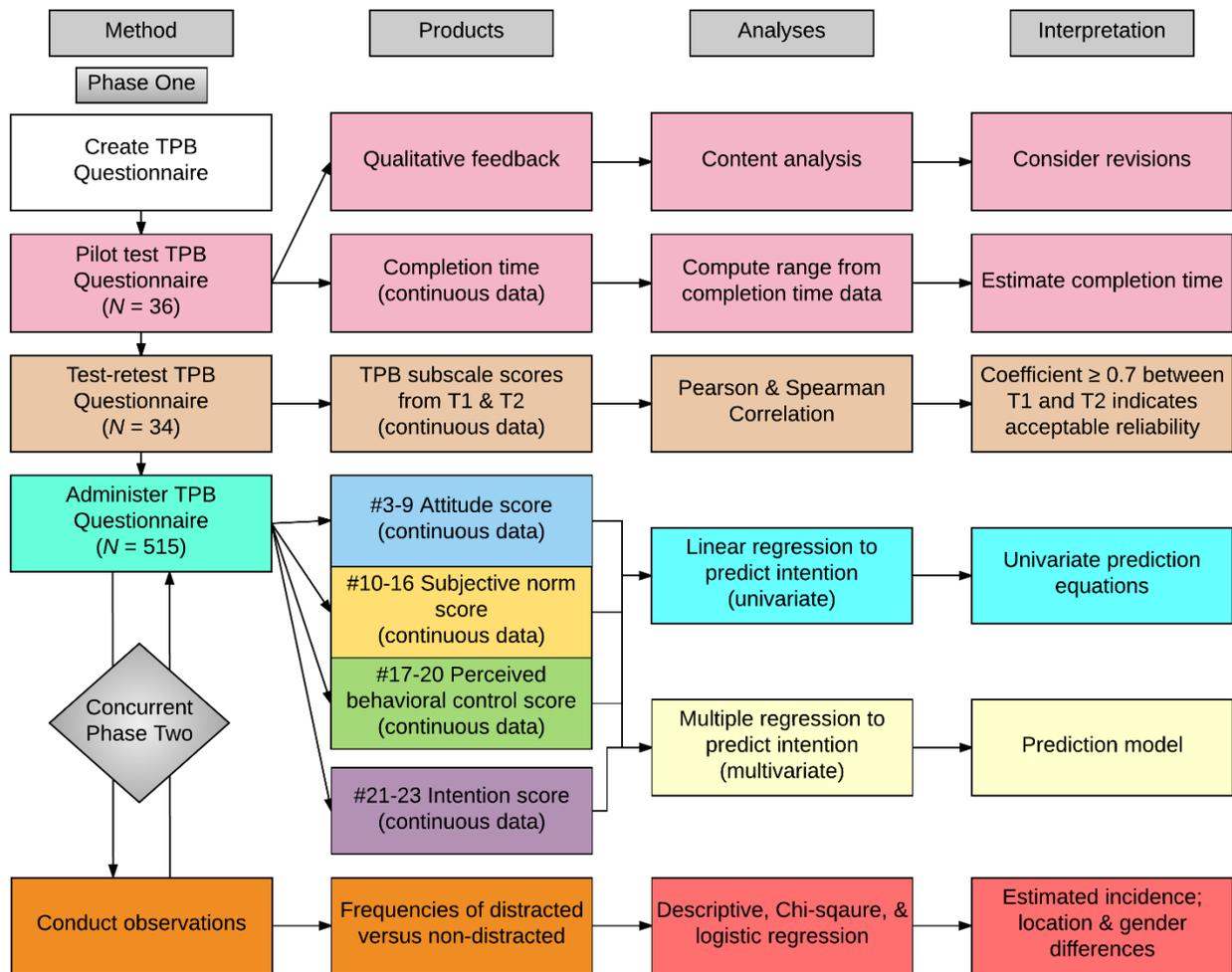


Figure 3.1. Diagram of study processes.

## Theory of Planned Behavior Questionnaire Creation and Refinement

**Theory of planned behavior questionnaire purpose.** The purpose of the TPB questionnaire was to measure the three TPB constructs of attitude toward the behavior, subjective norm, and perceived behavioral control and test the ability of those three constructs to predict behavioral intention to cross the street on campus while using a mobile device in the next week. Following the TACT framework (Francis et al., 2004), behavioral intention refers to college students between 18 and 24 years of age (target) intending to use a mobile device (action) while crossing the street on campus (context) in the next week (time).

**Panel of Experts.** After an initial draft was created, a four-member panel of experts assessed face validity, content validity, and readability of the questionnaire. Face validity is a measure of whether a questionnaire appears to measure the intended constructs as operationally defined. Content validity is a measure of whether each construct is adequately assessed within the universe of content as operationally defined (Sharma & Petosa, 2014). Panel members were identified based on expertise in at least one of the following areas: measurement and instrument development, the TPB, and/or college student populations (see Appendix D). All panel members were university faculty members. Panel members were recruited via an email message that included an explanation of the study purpose, a digital copy of the draft questionnaire, and an explanation of the type of feedback desired. Panel members provided written feedback via the “track changes” feature in Microsoft Word. Panel members were asked to return their feedback not more than 10 days from the date the request was sent. Several modifications were made to the questionnaire based on feedback from panel members and are summarized in Table 3.1. The resultant version of the questionnaire is detailed in the sections that follow.

Table 3.1

*Summary of Changes to Instrument as Recommended by Expert Panel Members.*

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<b>Questionnaire Modifications</b>
<ul style="list-style-type: none"><li>• The “time” component of target, action, context, time (TACT) was changed from “the next four weeks” to “the next week.”</li><li>• Instructions based on participants’ response to the screening questions were placed inside a shaded box to increase visibility.</li><li>• The word “extremely” was added before all attitude toward the behavior items (e.g., “extremely bad-extremely good”).</li><li>• For one perceived behavioral control item, the words “if I wanted to...” were changed to “I am confident that...”</li><li>• The attitude toward the behavior items were modified to contain a balance of instrumental and experiential items.</li><li>• The subjective norm items were modified to contain a balance of injunctive and descriptive items.</li><li>• The perceived behavioral control items were modified to contain a balance of autonomy and capacity items.</li><li>• For consistency, all scale endpoints except for those related to attitude toward the behavior items and one subjective norm item were changed to “strongly disagree-strongly agree.”</li><li>• For consistency, instructions for all multiple response items were changed to contain the words “choose all that apply.”</li><li>• An “other” response choice was added to the race demographic item.</li></ul>

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**Theory of planned behavior questionnaire inclusion criteria.** To ensure responses from participants who had the potential to engage in the behavior of interest, inclusion criteria stipulated that participants be undergraduate college students at the University of Alabama, visit the university campus at least once per week, and cross the street on foot or using an assistive device at least once during campus visits. To be eligible, participants also needed to report using a mobile device (such as an iPod, iPhone, Android Phone, MP3 player, or a basic “flip phone”) capable of allowing the user to engage in at least one of the following activities: (1) sending or viewing text messages or email messages, (2) viewing content from the internet (such as a web page or email attachment), (3) viewing content using mobile apps including but not limited to Blackboard, Snapchat, Facebook, Instagram, Twitter, or Yik Yak, or (4) engaging in a phone or video call (whether to the ear or through headphones/Bluetooth/speakerphone).

**Theory of planned behavior questionnaire overview.** Phase one data were collected using a 30-item paper TPB questionnaire. The first section of the questionnaire contained screening questions to ensure that participants met the inclusion criteria. Eligible participants were then instructed to complete the remainder of the questionnaire which contained items to measure the TPB constructs of attitude toward the behavior, subjective norm, perceived behavioral control, and behavioral intention. Demographic and descriptive information was also collected. Portions of the TPB questionnaire used in the present study originated from a previous questionnaire by Barton et al. (2016). Remaining portions of the questionnaire were informed by Fishbein and Ajzen (2010) and the four-member expert panel. Permission to utilize portions of the questionnaire by Barton et al. (2016) for the purposes of the present study was obtained from the study's lead author, Dr. Benjamin Barton (See Appendix E).

Consistent with previous TPB-based study (Barton et al., 2016) and recommendation from Ajzen (2013) and Francis et al. (2004), TPB items were operationalized using 7-point semantic differential scales. Scoring of the scales involved calculating the mean of the item scores for each TPB construct. Items assessing demographic characteristics were used to characterize the sample and test for differences and are described in the following section. The TPB questionnaire scoring guide is contained in Appendix F.

**Questionnaire components.** Participants completed a 30-item questionnaire designed to measure the TPB constructs as well as demographic characteristics. Except for two demographic items measuring past behaviors, all demographic items were placed at the end of the questionnaire. Items measuring past behaviors were placed at the beginning of the questionnaire to maintain chronicity (previous behaviors measured before behavioral intention). The TPB construct subscales and demographic items are described next. Operational definitions for the

TPB constructs are provided in Chapter 1 under the “definition of terms” heading. The full questionnaire can be viewed in Appendix G.

*Attitude toward the behavior subscale.* The first set of TPB items (3 through 9) measured attitude toward the behavior of crossing the street on campus while using a mobile device in the next week. One stem statement preceded all seven items that make up this subscale and read as follows, “For me to use a mobile device on campus while crossing the street in the next week would be.” Bipolar adjectives were used at the ends of each 7-point semantic differential scale item. Selection of the adjective pairs was informed by Fishbein and Ajzen (2010) as well as feedback from the expert panel. Fishbein and Ajzen (2010) posit that attitude toward the behavior can be placed into one of two categories which are termed “instrumental” and “experiential.” In the present questionnaire, four items measuring instrumental aspects of attitude toward the behavior, or aspects that relate to functionality of the behavior, contained the following adjective pairs: “extremely useless-extremely useful,” “extremely unnecessary-extremely necessary,” “extremely impractical-extremely practical,” and “extremely unsafe-extremely safe.” The remaining three attitude toward the behavior items measured experiential aspects of attitude toward the behavior, or aspects that tend to be more emotional in nature, and contained the following adjective pairs: “extremely unsatisfying-extremely satisfying,” “extremely boring-extremely fun,” and “extremely bad-extremely good.” Possible raw scores on the attitude toward the behavior subscale ranged from 7 to 49. The overall construct score was determined by calculating the mean of the item scores. Higher scores indicated a more favorable attitude toward the behavior of crossing the street on campus while using a mobile device in the next week.

***Subjective norm subscale.*** Seven items (10 through 16) measured the TPB construct of subjective norm. Again, Fishbein and Ajzen (2010) as well as feedback obtained from the expert panel informed the creation of these items. A 7-point semantic differential scale was used for this subscale. Consistent with two types of norms (“injunctive” and “descriptive”) described by Fishbein and Ajzen (2010), items 10 through 14 addressed injunctive norms and related to what a person ought not or ought to do. Items 15 and 16 addressed descriptive norms and related to perceptions of whether others were performing or not performing the behavior of crossing the street on campus while using a mobile device in the next week. Possible raw scores on the subjective norm subscale ranged from 7 to 49. The overall construct score was determined by calculating the mean of the item scores. Higher scores indicated more social pressure to engage in the behavior of crossing the street on campus while using a mobile device in the next week.

***Perceived behavioral control subscale.*** Four items (17 through 20) measured the TPB construct of perceived behavioral control. A 7-point semantic differential scale was used for this subscale. Fishbein and Ajzen (2010) as well as feedback obtained from the expert panel informed the creation of these items. Since the behavior under study was considered a risky behavior for the purposes of the present study, perceived behavioral control was measured in the context of *abstaining* from the behavior of crossing the street on campus while using a mobile device in the next week. Fishbein and Ajzen (2010) describe two types of perceived behavioral control (“capacity” and “autonomy”). Items 17 and 18 addressed capacity, or the perceived ability to abstain from the behavior. Items 19 and 20 addressed autonomy, or the perception of the degree of control over abstinence from the behavior. Since perceived behavioral control was measured in the context of abstaining from the behavior, reverse-coding of items 17, 18, and 20 was necessary to keep any association between the construct and behavioral intention positive

(i.e., the TPB posits that higher perceived behavioral control over abstinence is associated with lower behavioral intention scores). Item 19 did not require reverse-coding as it was the only item with wording in the context of abstinence being beyond a respondent's control. Possible raw scores on the perceived behavioral control subscale ranged from 4 to 28. The overall construct score was determined by calculating the mean of the item scores after reverse coding of items 17, 18, and 20. Lower scores after reverse-coding indicated greater perceived control over abstinence from crossing the street on campus while using a mobile device in the next week.

***Behavioral intention subscale.*** Three items (21 through 23) measured the TPB construct of behavioral intention to cross the street on campus while using a mobile device in the next week. In each item, one of the three phrases, "I intend," "I plan," and "I expect" preceded a statement of the behavior of crossing the street on campus while using a mobile device in the next week. A 7-point semantic differential scale was used for this subscale. Possible raw scores on the behavioral intention subscale ranged from 3 to 21. The overall construct score was determined by calculating the mean of the item scores. Higher scores indicated greater intent to cross the street on campus while using a mobile device in the next week.

***Demographics.*** As stated previously, all but two demographic items were placed at the end of the questionnaire. The demographic items placed at the beginning of the survey measured past behaviors related to typical mobile device use and crossing the street on campus while using a mobile device in the past week. The first item read, "on a typical day, how much do you use your mobile device?" Categorical response options were (1) "not at all," (2) "between 1 and 29 minutes per day," (3) "between 30 and 59 minutes per day," (4) "between 1 hour and 1 hour 59 minutes per day," (5) "between 2 hours and 2 hours 59 minutes per day," (6) "between 3 hours and 3 hours 59 minutes per day," (7) "between 4 hours and 4 hours 59 minutes per day," (8)

“between 5 hours and 5 hours 59 minutes per day,” (9) “between 6 hours and 6 hours 59 minutes per day,” (10) “between 7 hours and 7 hours 59 minutes per day,” and (11) “8 hours or more per day.” The second item measuring past behavior read, “during the past week, how often have you crossed the street on campus while using a mobile device?” The framework for response options to this item was derived from item 71 of the National Survey of Survey of Bicyclist and Pedestrian Attitudes and Behavior (Schroeder & Wilbur, 2013) and response options were worded as follows: (1) “nearly every time I crossed the street on campus,” (2) “more than half, but not quite all, of the times that I crossed the street on campus,” (3) “about half of the times that I crossed the street on campus,” (4) “less than half of the times that I crossed the street on campus,” (5) “almost never when I crossed the street on campus,” and (6) “never when I crossed the street on campus.” One demographic item provided a measure of previous exposure to pedestrian injury. For this item, respondents were instructed to select any of the following statements that applied to them: (1) *As a pedestrian*, I have had a close call with a vehicle where I was almost hit,” (2) “*As a pedestrian*, I have been hit by a vehicle,” (3) “I know a pedestrian who has been hit by a vehicle,” (4) “*As a driver*, I have had a close call where I almost hit a pedestrian,” (5) “*As a driver*, I have hit a pedestrian,” (6) “I know a driver who has hit a pedestrian,” and (7) “none of the above statements fit me.” Other items asked about on-campus or off-campus housing status, age in years, current year in school, and gender. Data on race and ethnicity were collected consistent with current U.S. Census recording methods which recommend an item related to ethnicity to precede the item related to race (“Revisions to the standards for the classification of federal data on race and ethnicity,” 1997).

**Theory of planned behavior questionnaire pilot test. Overview.** To ensure smooth administration of the TPB questionnaire, a pilot test preceded all primary TPB questionnaire data

collection activities. The pilot test served to inform any necessary refinements before full-scale TPB questionnaire administration. Specifically, feedback regarding readability, comprehensibility, and formatting was sought. Pilot test questionnaire feedback was collected using an anonymous form attached to the end of the pilot test questionnaire (see Appendix H). Completion time was recorded during pilot test data collection sessions from which an estimate of questionnaire completion time was derived.

***Recruitment.*** The pilot test involved administration of a draft TPB questionnaire to a small sample of the target population (Sharma & Petosa, 2014). The sample of 36 pilot test participants met the recommendation of Kuniavsky, Goodman, and Moed (2012) that a minimum of five members of the priority population participate in the pilot test. Permission to enter classrooms was sought via email from instructors of two undergraduate Principles and Foundations of Health Promotion (HHE 370) courses during the fall 2016 semester at the University of Alabama. Recruitment efforts resulted in 14 participants from one course and 22 participants from the other course. The recruitment email contained an outline of the study and provided the estimated completion time. Prior to pilot testing, it was estimated that the questionnaire data collection sessions would take 20 minutes each with an estimated 10 to 15 minutes devoted to completing the TPB questionnaire itself. See Appendix I for the recruitment email.

***Data collection.*** With permission from course instructors, the researcher entered the classroom and introduced himself. A recruitment script was then read aloud that outlined the study and informed the students of their rights regarding the research process. See Appendix J for the student recruitment script. After the recruitment script was read, the pilot test questionnaire was distributed with an informed consent document. The informed consent

document provided information about the study to include the study purpose, benefits and risks to participants, procedures for maintaining confidentiality, participants' rights, and the voluntary nature of the study. Students were asked to keep the informed consent document for their records. After the completed pilot test questionnaires were collected, the researcher thanked the students for their time.

***Data analysis.*** Qualitative analysis of completed pilot test TPB questionnaires and feedback forms informed the researcher's conversion of the TPB questionnaire draft to the final version. No major feedback was obtained from pilot test participants and much of the feedback related to standards and practices inherent of the TPB questionnaire creation process (e.g., repetitive wording of items). After considering the feedback obtained from pilot test participants, the researcher decided that no changes were necessary. Table 3.2 provides a demographic description of the pilot test sample. Table 3.3 lists the specific feedback obtained during the pilot test process.

Table 3.2

*Summary of Demographic Characteristics for Pilot Test Sample (N = 36).*

Variable	Frequency	% of total
Age (years)		
18	0	0.0
19	2	5.6
20	13	36.1
21	14	38.9
22	2	5.6
23	2	5.6
24	3	8.3
Year in school		
First year	0	0.0
Second year	3	8.3
Third year	16	44.4
Fourth year	13	36.1
Other	4	11.1
Housing		
On campus	9	25.0
Off campus	27	75.0
Gender		
Male	6	16.7
Female	29	80.6
Transgender	0	0.0
Prefer not to answer	1	2.8
Ethnicity		
Hispanic or Latino	3	8.3
No response	0	0.0
Race		
White	25	69.4
Black	10	27.8
American Indian or Alaska Native	0	0.0
Asian	1	2.9
Native Hawaiian or other Pacific Islander	0	0.0
Other/multiple races	0	0.0
Prefer not to answer	0	0.0
No response	1	2.8
Daily mobile device use (hours:minutes)		
0:01 - 0:29	0	0.0
0:30 - 0:59	0	0.0
1:00 - 1:59	5	13.9
2:00 - 2:59	2	5.6
3:00 - 3:59	8	22.2
4:00 - 4:59	8	22.2

Variable	Frequency	% of total
5:00 - 5:59	3	8.3
6:00 - 6:59	1	2.8
7:00 - 7:59	2	5.6
8:00 or more	7	19.4
Device use while crossing in the last week		
Never	0	0.0
Almost never	6	16.7
Less than half of the time	8	22.2
About half of the time	7	19.4
More than half but not all times	11	30.6
Nearly every time	4	11.1
Overall previous injury exposure		
Yes	26	72.2
No	10	27.8
Previous injury exposure by type*		
Close call as a pedestrian	18	50.0
Hit as a pedestrian	2	5.6
Know a pedestrian with previous close call	9	25.0
Close call with pedestrian as a driver	17	47.2
Hit a pedestrian as a driver	0	0.0
Know a driver who has hit a pedestrian	4	11.1

*Note.* \*Total exceeds sample size due to possibility of multiple previous injury exposures.

Table 3.3

*Summary of Pilot Test Feedback (N = 36).*

Question	Feedback
<p>Are the directions clear and concise? If not, what are some alternatives or suggestions?</p>	<ul style="list-style-type: none"> <li>• Yes (<math>n = 35</math>)</li> <li>• Some of the questions were weirdly worded ie: "Do you expect to" There was also no questions about why phones are used.</li> <li>• Some felt very repetitive.</li> <li>• A lot of the questions asked me to speculate how others feel about the topic so I just guessed. I would rather answer questions about my thoughts/intentions.</li> </ul>
<p>Are the questions easy to understand? If not, which questions were difficult to understand? Please provide suggestions for improvement.</p>	<ul style="list-style-type: none"> <li>• Yes (<math>n = 34</math>)</li> <li>• Some questions could be worded differently. like question #16. The question is assuming I will cross the street w/ a mobile device.</li> <li>• Clear for the most part, but I had to reread several statements of the study.</li> <li>• Some of the questions were hard to understand at first glance but after thinking about them I was able to answer.</li> <li>• Question 3 I had to read a few times. I don't think it makes sense for using a phone while crossing the street to be useless or useful. Same for number 7 (satisfying vs unsatisfying).</li> </ul>
<p>Is the layout clear and easy to use for answering the questions? If not, what are some suggestions for improvement?</p>	<ul style="list-style-type: none"> <li>• Yes (<math>n = 36</math>)</li> </ul>
<p>If you have any additional comments about the survey, please provide them below.</p>	<ul style="list-style-type: none"> <li>• Good, enjoyable survey.</li> <li>• I think this survey is very good and straight forward.</li> <li>• Questions were worded clearly -very easy and simple to take Great Job!</li> <li>• Survey should ask if students would become mindful of using mobile devices after taking this survey.</li> <li>• You could survey if college students think it is safe to cross the street while using a</li> </ul>

Question	Feedback
	<p>mobile device. Also, you could survey what the students are using their mobile devices for, while crossing the street (texting, apps, social media, music).</p> <ul style="list-style-type: none"> <li>• Great survey! I never really thought about how it can be dangerous to cross the street while using a cell phone!</li> <li>• I thought it was a good study/survey! Made me realize how often I am on my phone &amp; how unsafe it is. Maybe include more on cyclists still we have so many on campus.</li> <li>• Some questions were very similar, using words that almost mean the same thing. I felt repetitive or as if I needed to reconsider my answer.</li> <li>• It was extremely easy to comprehend. Most surveys have me pausing for a while trying to figure out what the question was truly asking. This survey is straight forward and I knew exactly what it was asking at all times.</li> <li>• Great survey!</li> <li>• None.</li> <li>• The survey was easy to understand and follow. It was short but I think it hit all the points he was looking for. Definitely think this is a good study.</li> <li>• This survey allowed me to realize walking across the street while using my mobile device is horrible.</li> </ul>

**Theory of planned behavior questionnaire test-retest. Overview.** After pilot testing was complete, stability of the questionnaire was assessed by performing a test-retest reliability analysis. The purpose of assessing test-retest reliability was to evaluate the questionnaire's ability to produce consistent results when the same people were given the same questionnaire on two different occasions. The time from initial questionnaire administration to the follow-up administration was two weeks (Nunnally & Bernstein, 1994; Sharma & Petosa, 2014). Sample size for the test-retest procedure was based on a power analysis using G\*Power Version 3.1.9.2

(Faul, Erdfelder, Buchner, & Lang, 2009). Sample size calculations were derived from the t-tests function with designated parameters (two tails; effect size = 0.5;  $\alpha$  = 0.05; power = 0.80). The calculation resulted in a sample size of  $n = 34$ . To ensure the sample size was met, two courses with 28 students each were used for test-retest recruitment.

The test-retest sample was recruited from two athletic training courses at the University of Alabama during the spring 2017 semester. The courses were one section of Clinical Evaluation and Diagnosis I (ATR 357) and one section of Principles of Rehabilitation and Reconditioning (ATR 456). All 27 students present in ATR 357 on the day of initial questionnaire administration participated. Of the 28 students present in ATR 456, 27 students participated. Exactly two weeks after administration of the first questionnaire, the researcher returned to the class and repeated questionnaire administration. On the second visit to the classes, 22 respondents from ATR 357 participated in the retest portion of this study and 17 respondents participated from ATR 456. The final test-retest sample of respondents who participated in the test and retest sessions and whose responses could be successfully matched across both questionnaire administrations were 20 and 14 for ATR 357 and ATR 456, respectively. The resultant test-retest sample size of 34 exceeded the minimum recommended test-retest sample size of 30 (Sharma & Petosa, 2014) and met the *a priori* sample size goal of 34 exactly. Evidence of TPB questionnaire test-retest reliability was obtained from a calculation of Pearson product-moment correlation coefficients for construct scores that were normally distributed and Spearman's rank-order correlation for nonparametric construct scores. A correlation coefficient of 0.70 or higher was set *a priori* as an indicator of acceptable test-retest reliability (Nunnally & Bernstein, 1994).

**Recruitment.** Procedures were the same for both the initial questionnaire administration as well as the follow-up questionnaire administration. Data collection for the test-retest phase involved entering classrooms and administering the TPB questionnaire in paper format. Permission to enter classrooms was sought from instructors of two undergraduate athletic training courses at the University of Alabama during the spring 2017 semester (ATR 357 and ATR 456). Requests for permission to enter the classroom were sent via email. The email contained an outline of the study and provided the estimated completion time. It was estimated that both TPB questionnaire test-retest data collection sessions would take 20 minutes each with an estimated 10 to 15 minutes devoted to completing the TPB questionnaire itself. See Appendix K for the recruitment email.

**Data collection.** Data collection procedures were the same for both the initial questionnaire administration as well as the follow-up questionnaire administration. With permission from course instructors, the researcher entered the classroom and introduced himself. To reduce the potential for feelings of coercion, the course instructor was asked to leave the room until the TPB questionnaire test-retest process was complete. Once the instructor left the room, a recruitment script was read to the students. See Appendix L for the student recruitment script. The recruitment script outlined the study and informed students of their rights regarding the research process. After the recruitment script was read, the TPB test-retest questionnaire was distributed with an informed consent document. The informed consent document provided information about the study to include the study purpose, benefits and risks to participants, procedures for maintaining confidentiality, participants' rights, and the voluntary nature of the study. Students were asked to keep the informed consent document for their records. After the

completed test-retest questionnaires were collected, the researcher thanked the students for their time and invited the instructor to return to the room.

**Data Analysis.** Statistical procedures were conducted using International Business Machines (IBM®) Statistical Package for Social Sciences (SPSS), version 23.0. From the construct scores on the two administrations of the test-retest TPB questionnaire, Pearson product-moment correlation coefficients were analyzed for construct scores that were normally distributed and Spearman's rank-order correlation calculations were analyzed for nonparametric construct scores. The resultant correlation coefficients were compared against the *a priori* reliability threshold of 0.70. A demographic description of the test-retest sample is contained in Table 3.4. The TPB constructs of attitude toward the behavior, subjective norm, and behavioral intention were normally distributed for time 1 and time 2. Thus, Pearson's correlation coefficients were used with those constructs to determine instrument stability. Perceived behavioral control data were not normally distributed; therefore, Spearman's rank correlation coefficients were used with that construct. Attitude toward the behavior ( $r(34) = 0.798, p < .001$ ) and subjective norm ( $r(34) = 0.852, p < .001$ ) constructs met the *a priori* correlation coefficient of 0.70. Although perceived behavioral control ( $R_s(34) = 0.566, p < .001$ ) and behavioral intention ( $r(34) = 0.686, p < .001$ ) did not meet the *a priori* correlation coefficient, test-retest reliability was deemed adequate based on the novelty of the subscales and expert opinions that coefficients greater than .50 are indicative of acceptable reliability (Bowling, 2005; Cronbach, 1951; Helmstadter, 1964).

Table 3.4

*Summary of Demographic Characteristics for Test-Retest Sample (N = 34).*

Variable	Frequency	% of total
Age (years)		
18	0	0.0
19	11	32.4
20	12	35.3
21	7	20.6
22	2	5.9
23	2	5.9
24	0	0.0
Year in school		
First year	0	0.0
Second year	15	44.1
Third year	13	38.2
Fourth year	3	8.8
Other	3	8.8
Housing		
On campus	3	8.8
Off campus	31	91.2
Gender		
Male	12	35.3
Female	22	64.7
Transgender	0	0.0
Prefer not to answer	0	0.0
Ethnicity		
Hispanic or Latino	0	0.0
No response	0	0.0
Race		
White	31	91.2
Black	2	5.9
American Indian or Alaska Native	0	0.0
Asian	1	2.9
Native Hawaiian or other Pacific Islander	0	0.0
Other/multiple races	0	0.0
Prefer not to answer	0	0.0
No response	0	0.0
Daily mobile device use (hours:minutes)		
0:01 - 0:29	0	0.0
0:30 - 0:59	1	2.9
1:00 - 1:59	6	17.6
2:00 - 2:59	8	23.5
3:00 - 3:59	6	17.6
4:00 - 4:59	7	20.6

Variable	Frequency	% of total
5:00 - 5:59	4	11.8
6:00 - 6:59	1	2.9
7:00 - 7:59	1	2.9
8:00 or more	0	0.0
Device use while crossing in the last week		
Never	1	2.9
Almost never	8	23.5
Less than half of the time	11	32.4
About half of the time	7	20.6
More than half but not all times	5	14.7
Nearly every time	2	5.9
Overall previous injury exposure		
Yes	27	79.4
No	7	20.6
Previous injury exposure by type*		
Close call as a pedestrian	15	44.1
Hit as a pedestrian	0	0.0
Know a pedestrian with previous close call	14	41.2
Close call with pedestrian as a driver	16	47.1
Hit a pedestrian as a driver	1	2.9
Know a driver who has hit a pedestrian	3	8.8

*Note.* \*Total exceeds sample size due to possibility of multiple previous injury exposures.

### **Theory of Planned Behavior Questionnaire Administration**

**Recruitment.** Procedures for TPB questionnaire data collection involved entering classrooms and administering the TPB questionnaire in paper format. Permission to enter classrooms was sought from instructors of various undergraduate courses at the University of Alabama during the spring 2017 semester. Participants were recruited from the following courses: Community and Public Health; Design and Evaluation of Health Promotion Programs; Drug Awareness; Environmental Health; Intro to Athletic Training; Life Span Human Development; Motor Development; Personal Health; Principles and Foundations of Health Promotion; and Stress Management. Requests for permission to enter the classroom were sent via email. The email contained an outline of the study and provided the estimated completion time. Based on pilot test data, it was estimated that the TPB questionnaire data collection process

would take 20 minutes total with an estimated 10 to 15 minutes of the total time devoted to completing the TPB questionnaire itself. See Appendix M for the recruitment email.

**Data collection.** With permission from course instructors, the researcher entered the classroom and introduced himself. To reduce the potential for feelings of coercion, the course instructor was asked to leave the room until the TPB questionnaire process was complete. Once the instructor left the room, a recruitment script was read to the students. See Appendix N for the student recruitment script. The recruitment script outlined the study and informed the students of their rights regarding the research process. After the recruitment script was read, the TPB questionnaire was distributed with an informed consent document. The consent document provided information about the study to include the study purpose, benefits and risks to participants, procedures for maintaining confidentiality, participants' rights, and the voluntary nature of the study. Students were asked to keep the consent document for their records. After the completed questionnaires were collected, the researcher thanked the students for their time and invited the instructor to return to the room.

**Data analysis.** Linear regression analyses were conducted to test univariate hypotheses in hypothesis set one while multiple regression analysis was used to test the multivariate hypothesis in hypothesis set two. One-way ANOVA and analyses were employed in hypothesis set three to test for differences between demographic subgroups. Analysis of frequencies of demographic items provided a description of the sample. Statistical procedures were conducted using International Business Machines (IBM®) Statistical Package for Social Sciences (SPSS), version 23.0. An *a priori* significance level of  $p < 0.05$  was set for rejecting null hypotheses. Analyses of data collected to answer RQ1 through RQ3 involved univariate linear regression analyses among the individual TPB constructs of attitude toward the behavior, subjective norm, and perceived

behavioral control, and behavioral intention. The hypotheses that related to RQ1 through RQ3 are as follows:

- **H<sub>0</sub> 1:** There will be no predictive relationship between attitude toward the behavior and behavioral intention to cross the street on campus while using a mobile device in the next week.

$$H_0 1: \beta = 0$$

**H<sub>A</sub> 1:** There will be a predictive relationship between attitude toward the behavior and behavioral intention to cross the street on campus while using a mobile device in the next week.

$$H_A 1: \beta \neq 0$$

- **H<sub>0</sub> 2:** There will be no predictive relationship between subjective norm and behavioral intention to cross the street on campus while using a mobile device in the next week.

$$H_0 2: \beta = 0$$

**H<sub>A</sub> 2:** There will be a predictive relationship between subjective norm and behavioral intention to cross the street on campus while using a mobile device in the next week.

$$H_A 2: \beta \neq 0$$

- **H<sub>0</sub> 3:** There will be no predictive relationship between perceived behavioral control and behavioral intention to cross the street on campus while using a mobile device in the next week.

$$H_0 3: \beta = 0$$

**H<sub>A</sub> 3:** There will be a predictive relationship between perceived behavioral control and behavioral intention to cross the street on campus while using a mobile device in the next week.

$$H_A 3: \beta \neq 0$$

Analysis of data collected to answer RQ4 involved a multiple regression analyses on the combined TPB constructs of attitude toward the behavior, subjective norm, and perceived behavioral control, and behavioral intention. The hypotheses that related to RQ4 are as follows:

- **H<sub>0</sub> 4:** There will be no predictive relationship between attitude toward the behavior ( $\beta_1$ ), subjective norm ( $\beta_2$ ), and perceived behavioral control ( $\beta_3$ ) and behavioral intention to cross the street on campus while using a mobile device in the next week ( $Y$ ).

$$H_0 4: \beta_1 = \beta_2 = \beta_3 = 0$$

**H<sub>A</sub> 4:** There will be a predictive relationship between attitude toward the behavior ( $\beta_1$ ), subjective norm ( $\beta_2$ ), and perceived behavioral control ( $\beta_3$ ) and behavioral intention to cross the street on campus while using a mobile device in the next week ( $Y$ ).

$$H_A 4: \text{At least one } \beta_j \text{ is } \neq 0$$

To answer RQ5, a series of one-way ANOVA analyses were conducted to test for differences in behavioral intention to cross the street on campus while using a mobile device in the next week between participants grouped by typical daily mobile device use, past device use while crossing, past injury exposure, and gender. The hypotheses that related to RQ5 are as follows:

- **H<sub>0</sub> 5:** There will be no difference in group means of behavioral intention to cross the street on campus while using a mobile device in the next week between participants grouped by typical daily mobile device use (between 1 minute and 2 hours and 59 minutes; between 3 hours and 5 hours and 59 minutes; and 6 or more hours per day).

$$H_0 5: \mu_{0:01-2:59} = \mu_{3:00-5:59} = \mu_{\geq 6:00}$$

**H<sub>A</sub> 5:** There will be a difference in group means of behavioral intention to cross the street on campus while using a mobile device in the next week between participants grouped by typical daily mobile device use (between 1 minute and 2 hours and 59 minutes; between 3 hours and 5 hours and 59 minutes; and 6 or more hours per day).

*H<sub>A</sub> 5:* At least one  $\mu_j$  is different

- **H<sub>0</sub> 6:** There will be no difference in group means of behavioral intention to cross the street on campus while using a mobile device in the next week between participants grouped by past device use while crossing (never or almost never; less than half or about half; more than half but not all or nearly every time).

*H<sub>0</sub> 6:*  $\mu_{\text{never/almost never}} = \mu_{\text{<half or half}} = \mu_{\text{≥half but not all/nearly every time}}$

**H<sub>A</sub> 6:** There will be a difference in group means of behavioral intention to cross the street on campus while using a mobile device in the next week between participants grouped by past device use while crossing (never or almost never; less than half or about half; more than half but not all or nearly every time).

*H<sub>A</sub> 6:* At least one  $\mu_j$  is different

- **H<sub>0</sub> 7:** There will be no difference in group means of behavioral intention to cross the street on campus while using a mobile device in the next week between participants with previous injury exposure and those without.

*H<sub>0</sub> 7:*  $\mu_{\text{previous exposure}} = \mu_{\text{no previous exposure}}$

**H<sub>A</sub> 7:** There will be a difference in group means of behavioral intention to cross the street on campus while using a mobile device in the next week between participants with previous injury exposure and those without.

*H<sub>A</sub> 7:*  $\mu_{\text{previous exposure}} \neq \mu_{\text{no previous exposure}}$

- **H<sub>0</sub> 8:** There will be no difference in group means of behavioral intention to cross the street on campus while using a mobile device in the next week between males and females.

$$H_0 8: \mu_{\text{male}} = \mu_{\text{female}}$$

**H<sub>A</sub> 8:** There will be a difference in group means of behavioral intention to cross the street on campus while using a mobile device in the next week between males and females.

$$H_A 8: \mu_{\text{male}} \neq \mu_{\text{female}}$$

**Missing data.** Questionnaire responses were examined for missing data. An *a priori* determination was made that if less than 5% of the cases contained missing data analyses would continue with list-wise deletion of cases with missing data.

### Phase Two

Collection of data for phase 1 and phase 2 was simultaneous. Figure 3.2 provides an outline of the phase three observation portion of this study.

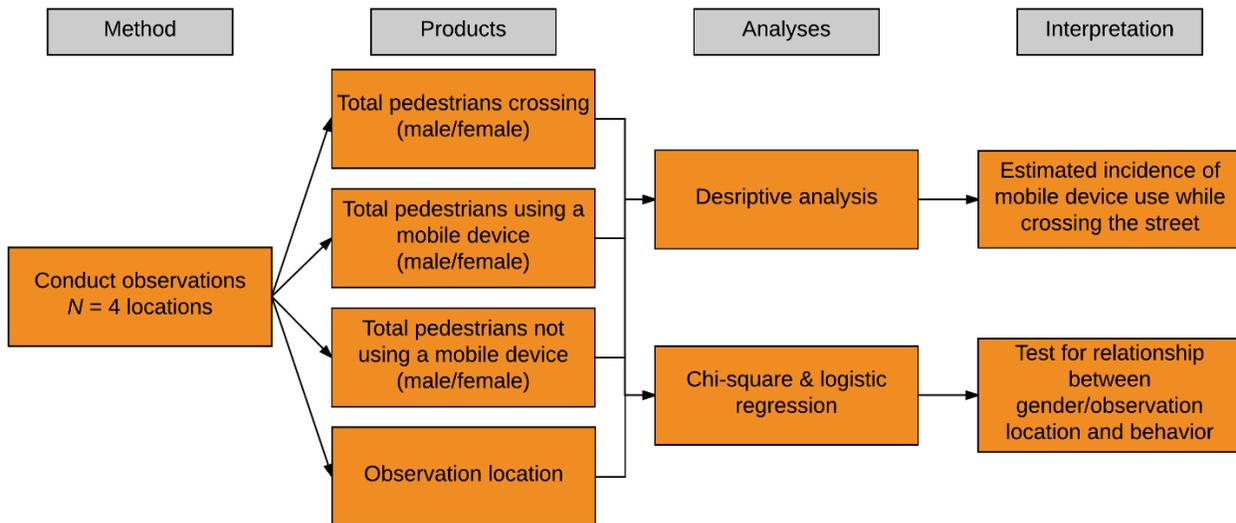


Figure 3.2. Outline of the phase three observation portion of the study.

## **Pedestrian Observations**

**Overview.** The purpose of the pedestrian observations was to measure the behavior of crossing the street on campus while using a mobile device. To facilitate data analysis, video data of pedestrian behavior was captured. Descriptive data gleaned from the observations allowed the researcher to provide an estimate of the incidence of distracted mobile device use among street-crossing pedestrians on the University of Alabama campus.

**Approval.** In addition to IRB approval, approval from the University of Alabama Office of Facilities and Grounds was required. An Application for Use of Campus Grounds was submitted and approved. See Appendix C for documentation of approval.

**Data collection.** The researcher utilized video recording equipment to facilitate data collection and analysis. The process of recording video involved the use of a magnetic mount to temporarily secure a recording device to existing traffic infrastructure. Two GoPro® brand recording devices were used to capture video data in the present study; A GoPro® HERO3+ Black Edition set to record at a resolution of 4096 by 2160 with a frame rate of 12 frames per second (fps) and a GoPro® HERO5 Session set to record at a resolution of 3840 by 2160 with a frame rate of 30 fps. Based on the aforementioned device settings, the GoPro® HERO3+ Black Edition had a horizontal field of view of 118.2 degrees (GoPro® Incorporated, 2017) and the GoPro® HERO5 Session had a horizontal field of view of 118.9 degrees (GoPro® Incorporated, 2017). Such fields of view allowed for a full view of location activities. Each recording device's field of view was positioned toward the observation location and left stationary to record for one hour.

Four locations that differ mainly by method of traffic control were chosen for observation. Illustration 3.1 shows a map of the locations. The first selected location was

University Boulevard and Colonial Drive. Because vehicle and pedestrian activity at the intersection were largely controlled by lighted signals, it was considered a “signalized” location for the purposes of this study. The second location was a “mid-block” crossing that crossed University Boulevard near the President’s Mansion and was not part of an intersection. Vehicle and pedestrian traffic at this location were controlled by lighted signals and was, therefore, considered a “signalized” location. The third location was a group of crosswalks at the intersection of McCorvey Drive and Campus Drive West. Stop signs for vehicles was the only type of traffic control at this intersection. For the purposes of this study, such crosswalks not controlled by a lighted signal were termed “un-signalized.” The fourth location was a “mid-block” crossing that crossed Hackberry Lane near Russell Hall and was not part of an intersection. Vehicle and pedestrian traffic at this “un-signalized” location were controlled only by “yield to pedestrian” signage.

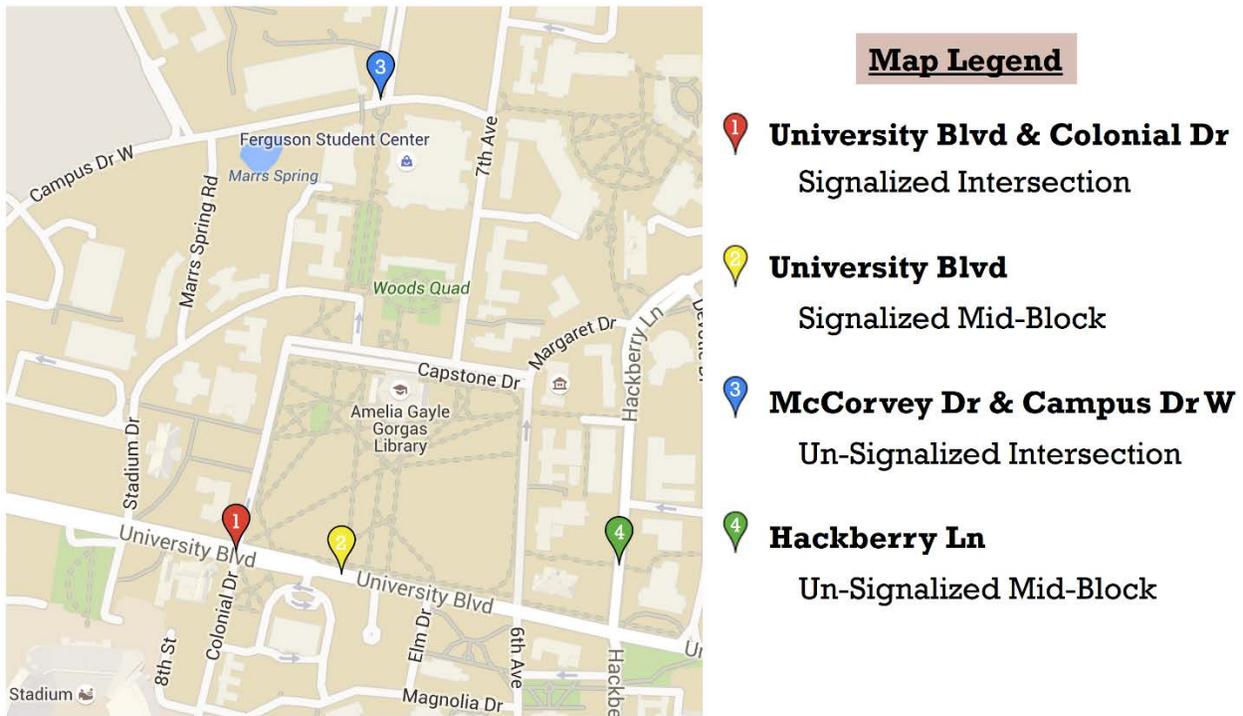
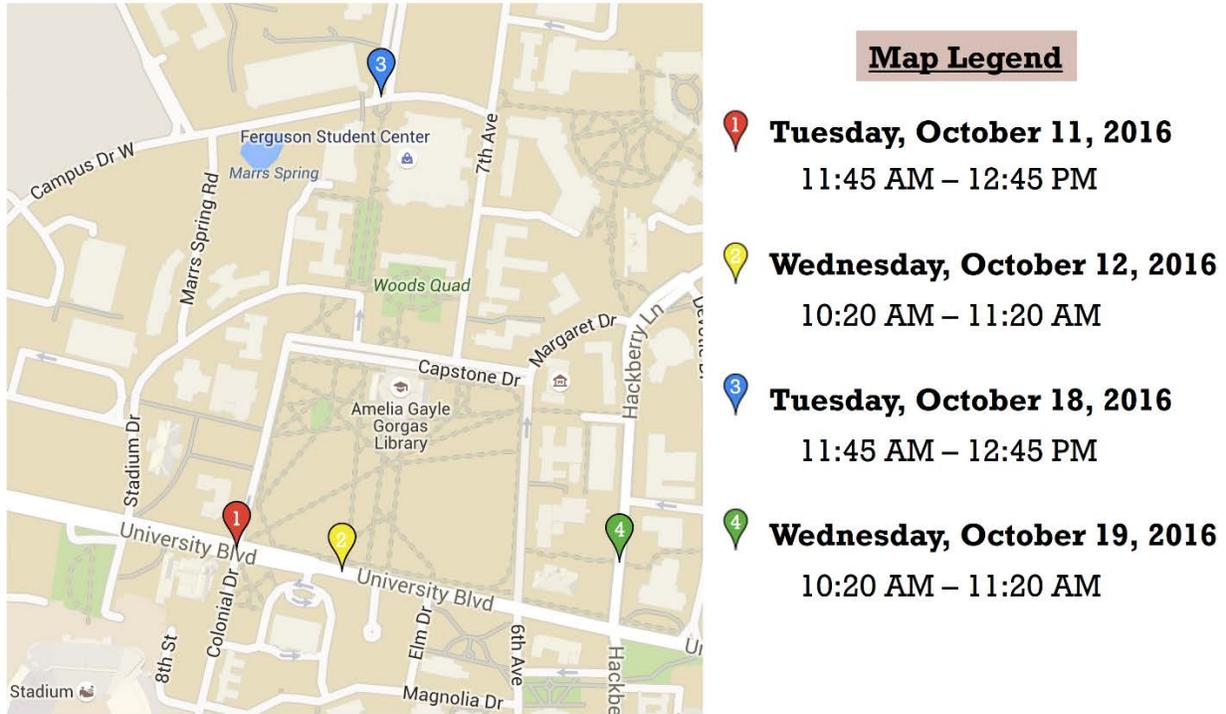


Illustration 3.1. Map of observation locations.

Observations took place at the University of Alabama(Tuscaloosa) campus over the course of two weeks during the fall 2016 semester. Illustration 3.2 shows the time, date, and location of each observation. The first location was observed on Tuesday of the first observation week and the second location was observed the next day on Wednesday of the first observation week. The third location was observed on Tuesday of the second observation week and the fourth location was observed the next day on Wednesday of the second observation week. Similar to an observational pedestrian study by Thompson et al. (2013), each location was observed once for one hour. At each location, the hour of observation began 30 minutes prior to a scheduled class release time and continued 30 minutes past the scheduled class release time. For example, a one-hour observation that took place from 11:45 AM to 12:45 PM covered the time before, during, and after the class release time of 12:15 PM. This timing scheme was chosen because it was expected that pedestrian traffic would be heaviest during times between consecutive classes.



*Illustration 3.2.* Map of observation timing scheme.

The observation days of Tuesday and Wednesday were chosen to ensure observation on days when Tuesday/Thursday classes were in session as well as days when Monday/Wednesday/Friday classes were in session. Those days were also chosen because they were toward the middle of the week. Mid-week observations were an attempt to reduce the influence of certain external factors such as a day’s proximity to the weekend or the influence of popular college sports events. The times of observations were selected to provide the opportunity to observe activity during a morning class change as well as an afternoon class change. To ensure the security of the video recording device and to protect participants' images from being accessed by unauthorized personnel, the researcher remained in the proximity of the device for the entire time it was placed for recording.

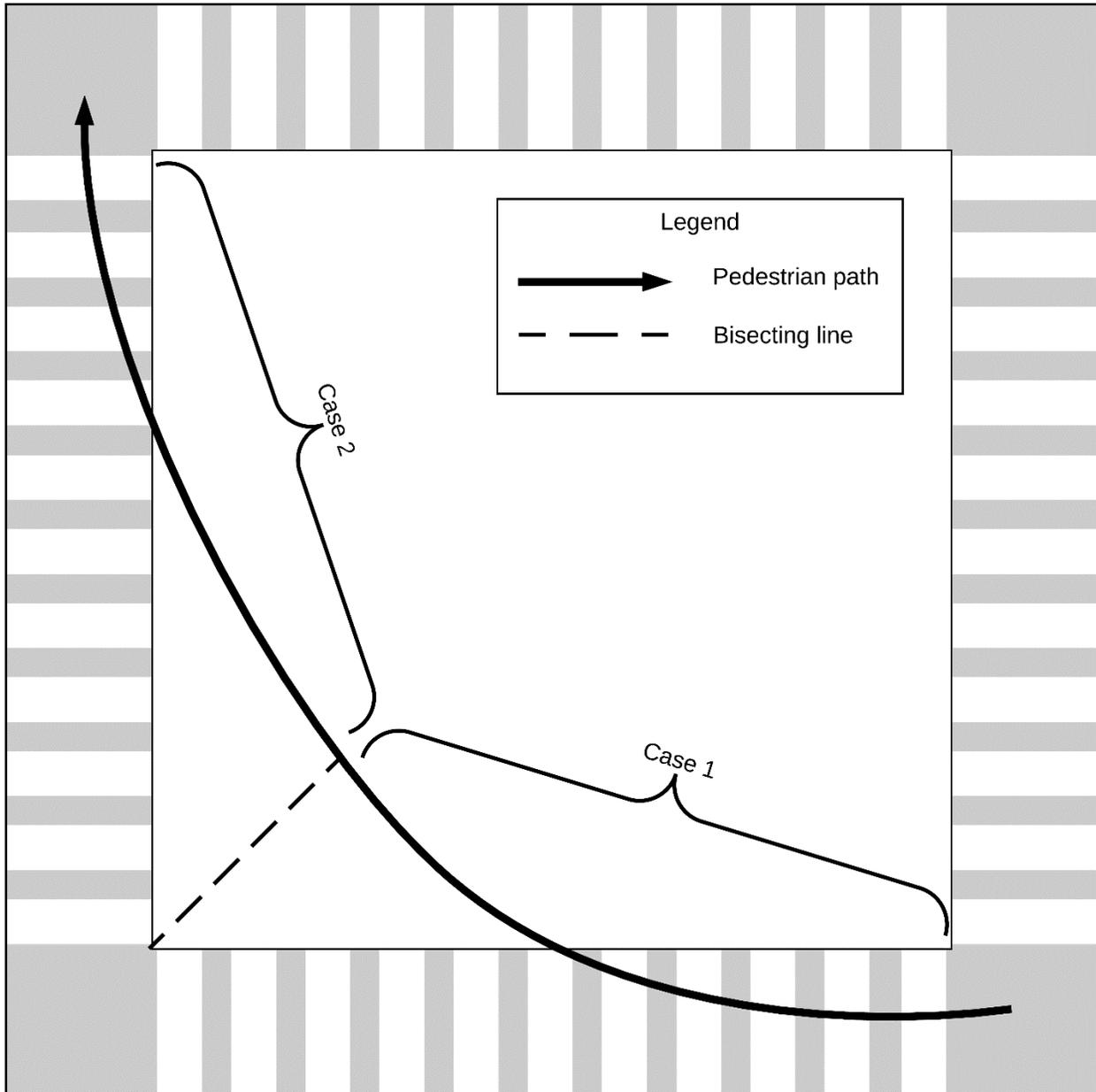
**Data coding.** Coding of observation data followed a modified version of an electronic device use observation protocol used as part of the National Occupant Protection Use Survey

(National Center for Statistics and Analysis, 2010). This protocol has been used to observe electronic device use among motor vehicle drivers and was modified for use in the pedestrian observation phase of the present study. Consistent with the existing observation protocol, participants were considered to be “using a mobile device” if they exhibited any of the following while crossing: (1) holding a device to their ears, (2) speaking with visible headsets on, or (3) visibly manipulating a handheld device. While the intended targets of observation throughout this study were the crosswalks at each observation location, pedestrians captured within the frame of the video camera but outside the physical boundaries of the crosswalk markings were still coded and analyzed. Thus, for simplicity, reference to participants in the “crosswalk” or “crossing” includes a small number of participants crossing outside of crosswalk markings.

Rather than coding and reporting the incidence of distracted mobile device use in terms of *number of pedestrians* observed engaging in the behavior, all coding and reporting was performed in terms of *crossing instances* where the behavior of distracted mobile device use was observed. For example, the same pedestrian at a four-way intersection crossing a road running East and West, then crossing the perpendicular road running North and South was coded as two separate crossing “cases” for the purpose of data analyses and reporting. Though a rare occurrence, pedestrians crossing an intersection diagonally and thus leaving the first crosswalk before reaching the other side of the road were also coded as two crossing cases. To differentiate case 1 from case 2 for these pedestrians, an imaginary bisecting line was created by the coder that extended from the corner of two adjoining crosswalks at a 45-degree angle. The bisecting line served as the point where one case ended and the other began. Each case was coded independently for the behavior of distracted mobile device use. Illustration 3.3 provides a

graphical representation of the aforementioned coding procedure for pedestrians crossing diagonally.

Coding in terms of crossing instances instead of number of pedestrians was necessary to address a limitation introduced by attempting to keep track of unique pedestrians. It is possible that a pedestrian crossed the same street more than once during an observation period. For example, a pedestrian could cross the street on her way to a 10-minute meeting, then cross the same intersection as she leaves the meeting. In such scenarios, it would be difficult for a coder to identify every repeat crosser and exclude them from further analyses.



*Illustration 3.3.* Overhead diagram of an intersection representing coding of a pedestrian crossing diagonally. Pedestrians crossing in this manner were split into two cases; each of which were coded independently for the behavior of distracted mobile device use. The gray and white stripes represent pedestrian crosswalks. The solid curved line gives an example of the typical diagonally-crossing pedestrian's path. The dashed line represents the imaginary line defining the boundary of case 1 and case 2.

Coding criteria are discussed next. All pedestrians were coded as either male or female based on a combination of such contextual factors as participant's clothing, hairstyle, and body figure. Pedestrians were classified as holding a device to their ear if they were seen holding a

device to their ear. Activities in this category included speaking, listening to messages, or conducting voice-activated dialing with a device held to the ear.

Pedestrians were coded as speaking with visible headsets on if they appeared to be speaking and wearing headsets with microphones. Activities in this category include engaging in conversation or conducting voice-activated dialing via a wireless earpiece on the ear or via an ear bud connected by wire to a mobile device. Talking via a visible Bluetooth headset is also an included activity.

Pedestrians were coded as visibly manipulating a handheld device if they appeared to be manipulating some type of electronic device such as a cell phone, a smart phone, personal digital assistant (PDA), MP3 player, video game, or some other device. Activities in this category included text messaging, using a Web-capable smart phone, or a PDA to view travel directions, checking e-mails or calendar appointments, or surfing the Internet. Also included were manual dialing, playing handheld games, and holding phones in front of their face to converse or check messages via speakerphone or use voice-activated dialing.

**Reliability.** Both rater-interrater and intra-rater reliability analyses were performed during analysis of observational data to provide an indicator of protocol reliability. Rater-interrater reliability is a measure of agreement between two or more observers making independent coding judgements at the same time (Sharma & Petosa, 2014). The level of inter-rater reliability has implications for reproducibility of the present study's observational protocol. A high degree of inter-rater reliability provides evidence that the procedures employed during the observational component are easily reproducible and that coding of pedestrian behaviors is accurate. The procedure for determining inter-rater reliability involved a second researcher coding a randomly selected video segment across which 100 pedestrians traversed the trafficway.

To select the video segment that was subjected reliability analyses, each segment was assigned a numerical identifier, after which one video segment was selected using a random number generator (Randomness and Integrity Services Ltd., 2017). Inter-rater reliability was assessed by calculating a Cohen's kappa coefficient (Cohen, 1960). Cohen's kappa statistics range from -1 to 1. A Cohen's kappa statistic of 1 indicates perfect agreement while a statistic of -1 indicates perfect disagreement (Sharma & Petosa, 2014). An a priori Cohen's kappa value of 0.70 was set as an indicator of satisfactory rater-interrater reliability (Sharma & Petosa, 2014).

A requirement of Cohen's kappa is that each case (pedestrian) have a unique identifier. This allows agreement to be assessed on each individual case, and a coefficient calculated representative of overall agreement across all cases (Cohen, 1960). After the video segment was randomly selected for reliability analyses, the segment was imported into video editing software whereafter a timecode was added to enable discreet identification of pedestrians based on the time they entered the trafficway. On occasions where more than one pedestrian entered the trafficway at the same time, the researcher briefly superimposed large red numbers above the pedestrians in question. This step was necessary to ensure that each pedestrian had a unique identifier in time of uncertainty. See Illustration 3.4 for a screenshot of the edited video showing examples of the timecode and superimposed numbers.

Intra-rater reliability analyses provide information on the extent of agreement of a single researcher's observations over time (McDermott & Sarvela, 1999; Sharma & Petosa, 2014). For this investigation, a high level of intra-rater reliability provides evidence that the analysis of each video recording session is consistent. The same edited video segment used during rater-interrater reliability analyses was used for intra-rater reliability analyses. The procedures for intra-rater reliability were identical to those for rater-interrater reliability except that the researcher's initial

coding was compared to his own coding 21 days later. The time period of 21 days between coding sessions was consistent with literature describing video reliability analyses (Wellmon, Degano, Rubertone, Campbell, & Russo, 2015). As with rater-interrater reliability analyses, a Cohen's kappa coefficient was calculated and compared to the *a priori* acceptability threshold of 0.70.

Results from the rater-interrater reliability analyses indicated perfect agreement between the two researchers,  $\kappa = 1.00$ ,  $p < .001$ . Results from the intra-rater reliability analyses indicated perfect agreement between the researcher's coding at time 1 and the researcher's coding 21 days later at time 2,  $\kappa = 1.00$ ,  $p < .001$ .



*Illustration 3.4.* Screenshot of edited video segment used for intra-rater and rater-interrater reliability. Human subjects were not obscured during reliability analyses, but have been obscured in this example for their protection. The timecode appeared in the lower-left corner of the video. Large red numbers appeared briefly above pedestrians entering the trafficway at the same time to allow for unique identification.

**Data analysis.** To answer RQ6, frequencies and percentages are reported for each observation location to provide an estimated incidence of distracted mobile device use among street-crossing pedestrians on the University of Alabama campus. RQ6 did not involve inferential statistics and, therefore, is not associated with a hypothesis. To answer RQ7, binary logistic regression analyses were utilized to test for differences in observed street-crossing on campus while using a mobile device between observation locations. Chi-square analyses were utilized to test for differences in observed street-crossing on campus while using a mobile device between males and females. Statistical procedures were conducted using International Business Machines (IBM®) Statistical Package for Social Sciences (SPSS), version 23.0. An *a priori*

significance level of  $p < 0.05$  was set for rejecting null hypotheses. The hypotheses that related to RQ7 are as follows:

- **H<sub>0</sub> 9:** There will be no difference in the proportion of those observed street-crossing on campus while using a mobile device between males and females.

$$H_0 \text{ 9: } \pi_{\text{male, use}} = \pi_{\text{female, use}}$$

$$\pi_{\text{male, no use}} = \pi_{\text{female, no use}}$$

**H<sub>A</sub> 9:** There will be a difference in the proportion of those observed street-crossing on campus while using a mobile device between males and females.

$$H_A \text{ 9: At least one } \pi_j \text{ is different}$$

- **H<sub>0</sub> 10:** There will be no relationship between those observed street-crossing on campus while using a mobile device and observation locations.

$$H_0 \text{ 10: } \beta_{\text{location 1}} = \beta_{\text{location 2}} = \beta_{\text{location 3}} = \beta_{\text{location 2}} = 0$$

**H<sub>A</sub> 10:** There will be a relationship between those observed street-crossing on campus while using a mobile device and observation locations.

$$H_A \text{ 10: At least one } \beta_j \text{ is } \neq 0$$

## CHAPTER 4

### RESULTS

In the United States, pedestrian injuries are an increasing public health concern. Persons of college-age are particularly affected by traffic-related pedestrian injuries. Use of mobile devices while walking has been implicated as a contributor to the problem of pedestrian injuries. The purpose of this study was to utilize the theory of planned behavior (TPB) to examine college students' behavioral intention to engage in the behavior of crossing the street on campus while using a mobile device in the next week. A secondary aim of the study was to estimate the incidence of distracted mobile device use on campus among street-crossing college student pedestrians at the University of Alabama (Tuscaloosa). The results of this study are detailed in Chapter 4.

#### **Theory of Planned Behavior Questionnaire**

##### **Participants and Data Reduction**

A total of 16 instructors of undergraduate courses were contacted for class recruitment during the spring 2017 semester and 15 instructors granted permission for the researcher to enter the classroom to perform recruitment procedures. The total number of participants in the sampling frame was 692. Given instances of participants being enrolled in more than one course making up the sampling frame, a true participation rate was unable to be determined. Despite this, the participation rate as calculated from the sampling frame and number of completed questionnaires was 74.4%.

The number of participants who were successfully recruited and who returned a questionnaire was 515. Of those 515 participants, 35 did not meet eligibility criteria because they were under 18 years of age (0.2%;  $n = 1$ ), over 24 years of age (3.3%;  $n = 17$ ), or did not report age (0.3%;  $n = 2$ ). An additional 20 (3.9%) participants were missing data for one or more of the TPB constructs and were excluded from analyses. As this was less than 5%, list-wise deletion was applied. The aforementioned data reduction procedures resulted in a final sample of 480 participants. Figure 4.1 provides a summary of data reduction procedures.

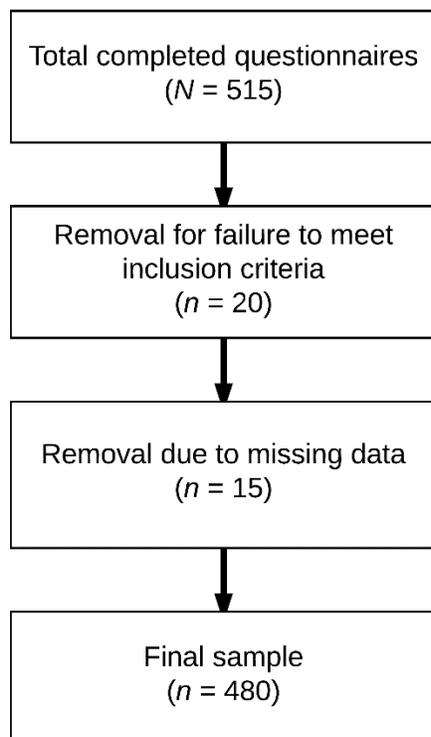


Figure 4.1. Flowchart of data reduction procedures.

### Demographic Characteristics of the Sample

The final sample of 480 was majority non-Hispanic (96.3%;  $n = 462$ ), White (76.0%;  $n = 365$ ), female (68.5%;  $n = 329$ ), lived off campus (61.5%;  $n = 295$ ), and had a previous injury exposure (77.3%;  $n = 371$ ). Mean age was 20.18 ( $SD = 1.50$ ). University-wide, 89.3% of undergraduate students are between the ages of 18 and 24, 84.1% of undergraduates identify as

white, and females make up 55.6% of the undergraduate population while males make up 44.3% (University of Alabama, 2016). Descriptive statistics are displayed in Table 4.1. Table 4.2 provides participant categorization resulting from k-means clustering analyses performed on typical daily device use and past use while crossing for males and females.

Table 4.1

*Participant Demographic Characteristics (N = 480).*

Variable	Frequency	% of total (N = 480)
Age (years)		
18	71	14.8
19	103	21.5
20	104	21.7
21	114	23.8
22	58	12.1
23	17	3.5
24	13	2.7
Year in school		
First year	121	25.2
Second year	93	19.4
Third year	135	28.1
Fourth year	119	24.8
Other	12	2.5
Housing		
On campus	185	38.5
Off campus	295	61.5
Gender		
Male	149	31.0
Female	329	68.5
Transgender	0	0.0
Prefer not to answer	2	0.4
Ethnicity		
Hispanic or Latino	13	2.7
No response	5	1.0
Race		
White	365	76.0
Black	79	16.5
American Indian or Alaska Native	2	0.4
Asian	11	2.3
Native Hawaiian or other Pacific Islander	1	0.2
Other/multiple races	16	3.3
Prefer not to answer	3	0.6
No response	3	0.6
Daily mobile device use [hours:minutes]		
0:01 - 0:29	1	0.2
0:30 - 0:59	11	2.3
1:00 - 1:59	39	8.1
2:00 - 2:59	80	16.7
3:00 - 3:59	76	15.8
4:00 - 4:59	83	17.3

Variable	Frequency	% of total (N = 480)
5:00 - 5:59	68	14.2
6:00 - 6:59	38	7.9
7:00 - 7:59	16	3.3
8:00 or more	68	14.2
Device use while crossing in the last week		
Never	23	4.8
Almost never	101	21.0
Less than half of the time	113	23.5
About half of the time	105	21.9
More than half but not all times	83	17.3
Nearly every time	55	11.5
Overall previous injury exposure		
Yes	371	77.3
No	109	22.7
Previous injury exposure by type*		
Close call as a pedestrian	205	42.7
Hit as a pedestrian	10	2.1
Know a pedestrian with previous close call	175	36.5
Close call with pedestrian as a driver	216	45.0
Hit a pedestrian as a driver	4	0.8
Know a driver who has hit a pedestrian	80	16.7
Behavioral intention category**		
High	75	15.6
Low	405	84.4

*Note.* \*Total exceeds sample size due to possibility of multiple previous injury exposures.

\*\*Participants with mean intention scores > 5.00 = high behavioral intention and participants with mean intention scores  $\geq$  5.00 = low behavioral intention.

Table 4.2

*K-Means Clustering Results for Typical Daily Device Use and Past Use While Crossing for Males (n = 149) and Females (n = 329).*

Variable	Frequency		% within gender		% of total
	Male	Female	Male	Female	
Typical daily device use (N = 480)					
0:01 - 2:59 (n = 131)	60	71	40.3	21.6	27.3
3:00 - 5:59 (n = 227)	62	165	41.6	50.2	47.3
6:00 or more (n = 120)	27	93	18.1	28.3	25.4
Past use while crossing (N = 480)					
Never or almost never (n = 124)	52	70	34.9	21.3	25.8
About half/< half (n = 218)	60	158	40.3	48.0	45.4
Nearly every time/ > half but not all (n = 138)	37	101	24.8	30.7	28.8

## Theoretical Construct Analyses

**Descriptive statistics and reliability. *Attitude toward the behavior.*** Table 4.3 provides a summary of the mean, standard deviation, possible range, observed range, and reliability statistics for the attitude toward the behavior subscale. Seven items assessed attitude toward the behavior (items 3, 4, 5, 6, 7, 8, 9) using a 7-point semantic differential scale. This subscale had a possible range of 7 to 49 with an observed range of 7 to 45 and a mean of 21.37 and a standard deviation of 7.61. Cronbach's alpha for this subscale was acceptable ( $\alpha = .87$ ). Higher scores on this construct indicated a more favorable attitude toward the behavior of crossing the street on campus while using a mobile device in the next week. Attitude toward the behavior data appear to be normally distributed with a skewness value of 0.006 and a kurtosis value of -0.265. A considerable proportion of participants (6.3%;  $n = 30$ ) attained the minimum possible score on this item; indicating the most unfavorable representation of attitude toward crossing the street on campus while using a mobile device in the next week. A visual representation of the data with a superimposed normal distribution curve is provided in Figure 4.2.

***Subjective norm.*** Table 4.3 provides a summary of the mean, standard deviation, possible range, observed range, and reliability statistics for the subjective norm subscale. Seven items assessed subjective norm (items 10, 11, 12, 13, 14, 15, 16) using a 7-point semantic differential scale. This subscale had a possible range of 7 to 49 with an observed range of 7 to 49 and a mean of 25.55 and a standard deviation of 7.43. Cronbach's alpha for this subscale was acceptable ( $\alpha = .82$ ). Higher scores on this construct indicated more social pressure to engage in the behavior of crossing the street on campus while using a mobile device in the next week. Subjective norm data appear to be normally distributed with a skewness value of 0.012 and a kurtosis value of -

0.325. A visual representation of the data with a superimposed normal distribution curve is provided in Figure 4.2.

***Perceived behavioral control.*** Table 4.3 provides a summary of the mean, standard deviation, possible range, observed range, and reliability statistics for the perceived behavioral control subscale. Four items assessed perceived behavioral control (items 17, 18, 19, 20) using a 7-point semantic differential scale. This subscale had a possible range of 4 to 28 with an observed range (after reverse-coding items 17, 18, and 20) of 4 to 20 and a mean of 7.00 and a standard deviation of 3.85. Cronbach's alpha for this subscale ( $\alpha = .64$ ) failed to meet the *a priori* threshold of .70. Based on arguments that Cronbach's alpha values higher than .50 are indicative of acceptable reliability (Bowling, 2005; Cronbach, 1951; Helmstadter, 1964), the value of .64 for the perceived behavioral control construct was deemed acceptable. Lower scores indicated greater perceived control over abstinence from crossing the street on campus while using a mobile device in the next week. Perceived behavioral control data appeared to deviate from a normal distribution with a skewness value of 1.350 and a kurtosis value of 0.964. A considerable proportion of participants (40.6%;  $n = 195$ ) attained the minimum possible score on this item; indicating the greatest possible representation of perceived behavioral control over refraining from crossing the street on campus while using a mobile device in the next week. A visual representation of the data with a superimposed normal distribution curve is provided in Figure 4.2.

***Behavioral intention.*** Table 4.3 provides a summary of the mean, standard deviation, possible range, observed range, and reliability statistics for the behavioral intention subscale. Three items assessed subjective norm (items 21, 22, 23) using a 7-point semantic differential scale. This subscale had a possible range of 3 to 21 with an observed range of 3 to 21 and a mean

of 9.42 and a standard deviation of 4.99. Cronbach's alpha for this subscale was acceptable ( $\alpha = .88$ ). Higher scores on this construct indicated greater intent to cross the street on campus while using a mobile device in the next week. Behavioral intention data appear to be normally distributed with a skewness value of 0.486 and a kurtosis value of -0.570. A considerable proportion of participants (15.0%;  $n = 72$ ) attained the minimum possible score on this item; indicating the lowest possible representation of intention to cross the street on campus while using a mobile device in the next week. A visual representation of the data with a superimposed normal distribution curve is provided in Figure 4.2.

***Theory of planned behavior construct correlations.*** To assess associations between the TPB predictor variables and behavioral intention, Pearson product-moment correlation coefficients were calculated for normally distributed variables and Spearman rank correlation coefficients were calculated for non-normal variables. Cohen (1988) suggests that correlation coefficients between 0.1 and 0.3 are weak, coefficients between 0.3 and 0.5 are considered moderate, and correlation coefficients greater than 0.5 are considered strong. There was a strong positive correlation between attitude toward the behavior and behavioral intention,  $r = .630, p < .001$ . There was a strong positive correlation between subjective norm and behavioral intention,  $r = .589, p < .001$ . There was a weak positive correlation between perceived behavioral control and behavioral intention,  $R_s = .278, p < .001$ . The correlations of TPB constructs with behavioral intention are displayed in Table 4.4.

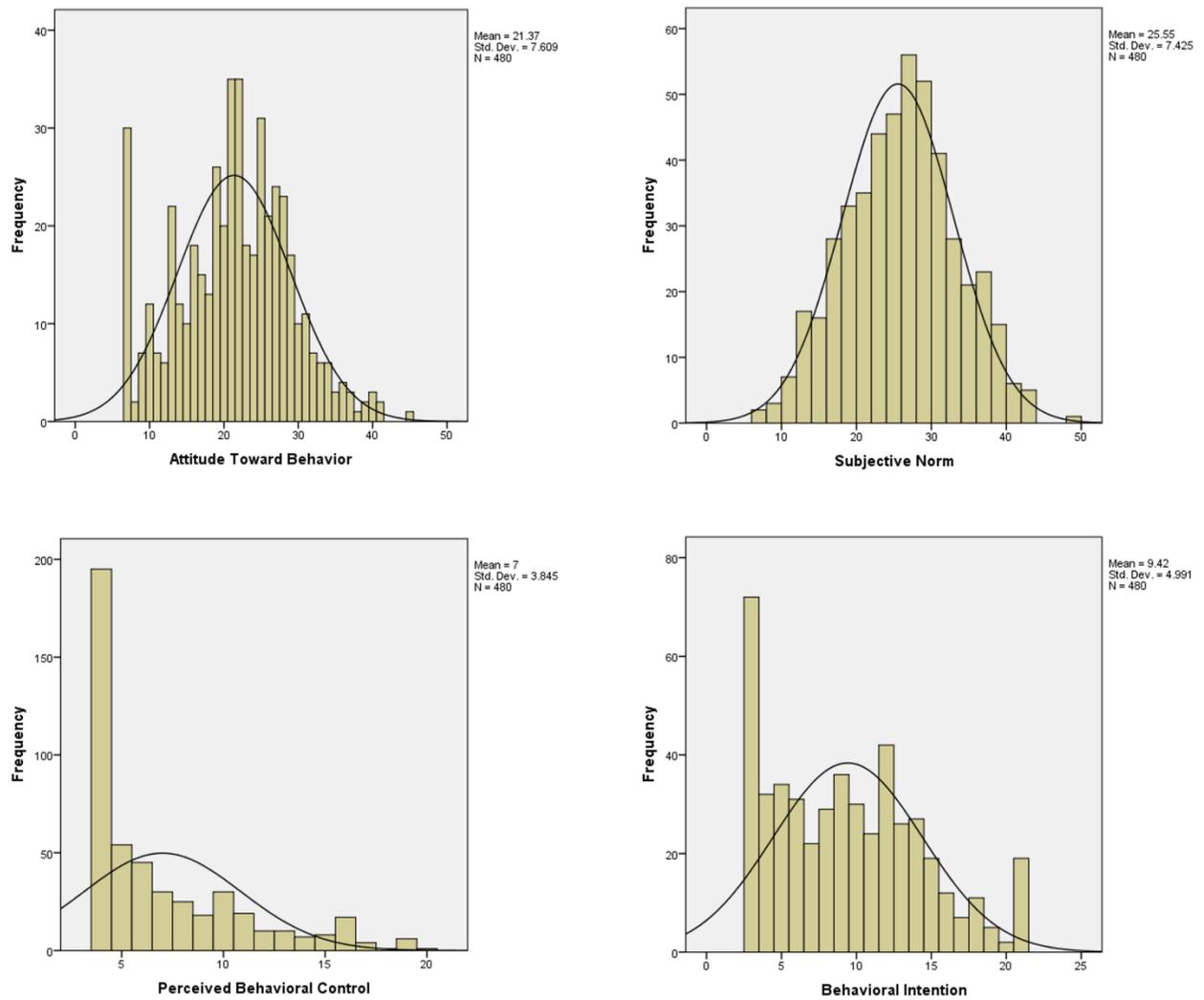


Figure 4.2. Visual representation of the TPB constructs of attitude toward the behavior, subjective norm, perceived behavioral control, and behavioral intention with superimposed normal distribution curves for the sample ( $N = 480$ ).

Table 4.3

*Ranges, Means, Standard Deviations, Cronbach's Alpha Coefficients, and Test-Retest Correlation Coefficients for the Theory of Planned Behavior Constructs (N = 480).*

Construct	Descriptive statistics				Reliability statistics	
	Possible range	Observed range	<i>M</i>	<i>SD</i>	Cronbach's $\alpha$	Pearson's $r^*$
Behavioral intention	3 – 21	3 – 21	9.42	4.99	0.88	.686**
Attitude toward the behavior	7 – 49	7 – 45	21.37	7.61	0.87	.798**
Subjective norm	7 – 49	7 – 49	25.55	7.43	0.82	.852**
Perceived behavioral control	4 – 28	4 – 20	7.00	3.85	0.64	.566†**

*Note.* \*Correlation coefficients were calculated to assess test-retest reliability using a sample of 34 undergraduate students. \*\*Correlation coefficient is significant at the  $p < .01$  level.

†Spearman rank correlation ( $R_s$ ) reported due to nonparametric data for the perceived behavioral control construct.

Table 4.4

*Theory of Planned Behavior Construct Correlations with Behavioral Intention.*

Construct	Correlation coefficients ( $r$ )			
	Behavioral intention	Attitude toward the behavior	Subjective norm	Perceived behavioral control
Behavioral intention	1	.630	.589	.278*

*Note.* \*Spearman rank correlation ( $R_s$ ) reported due to nonparametric data for the perceived behavioral control construct. All correlations significant at  $p < .001$ .

## Hypothesis Testing

**Null hypothesis 1.** There will be no predictive relationship between attitude toward the behavior and behavioral intention to cross the street on campus while using a mobile device in the next week. Linear regression was used to examine the relationship between attitude toward the behavior and behavioral intention to cross the street on campus while using a mobile device in the next week. Results of the analysis indicated that there was a significant positive slope,  $F(1,$

478) = 314.85,  $p < .001$ ; resulting in rejection of null hypothesis 1. Correlation between behavioral intention and attitude toward the behavior was .630 and attitude toward the behavior explained 39.7% of the variance in behavioral intention ( $r = 0.630$ ,  $r^2 = 0.397$ ). Figure 4.3 contains the histogram and P-P plot that were used to examine the normality of the standardized residuals. The resultant equation can be used to predict behavioral intention given a value of attitude toward the behavior:  $\widehat{BI} = 0.196 + 0.964*(\text{attitude toward the behavior})$ . Figure 4.4 provides a scatterplot with superimposed regression line and prediction equation. The maximum residual was 5.43, which was 4.12 standard deviations from the mean and was an outlier. The minimum residual was -3.88 and was 3.00 standard deviations from the mean. The linear regression model is summarized in Table 4.5.

Table 4.5

*Coefficients of Linear Regression Model for Behavioral Intention and Attitude Toward the Behavior (N = 480).*

Model	Unstandardized coefficients		Standardized coefficients	<i>t</i>	<i>p</i>
	<i>B</i>	Std. Error	Beta		
(Constant)	.196	.176	-	1.116	.265
Attitude toward the behavior	.964	.054	.630	17.744	< .001

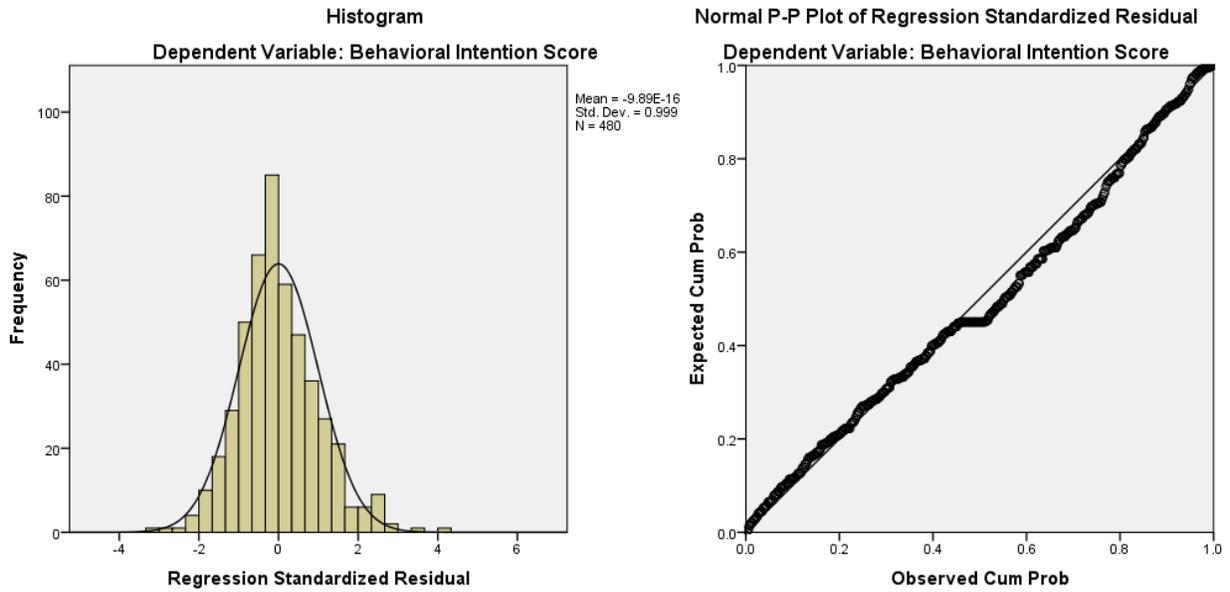


Figure 4.3. Histogram with superimposed normal distribution curve and normality plot of standardized residuals for the behavioral intention and attitude toward the behavior linear regression model ( $N = 480$ ).

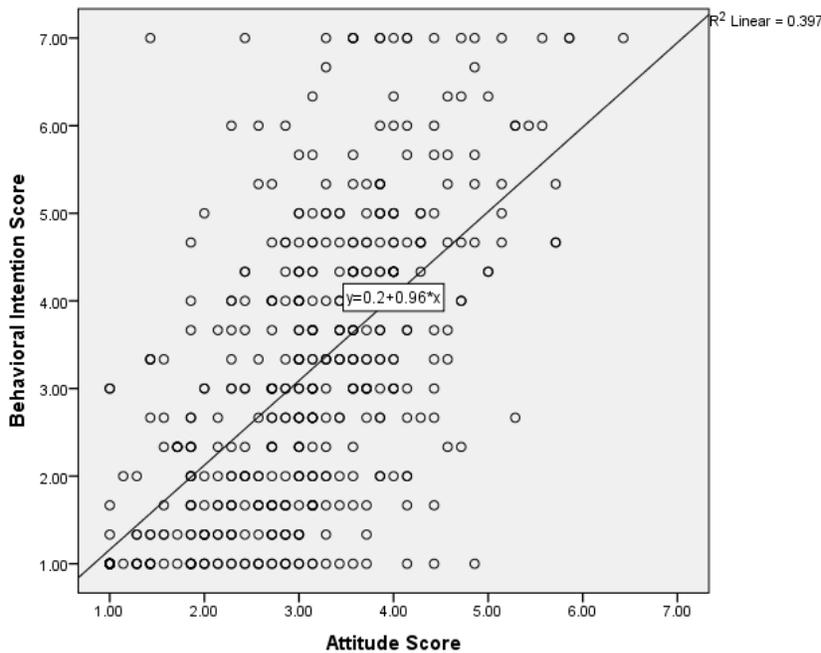


Figure 4.4 Scatterplot of the dependent variable of behavioral intention and the independent variable of attitude toward the behavior with superimposed regression line and prediction equation.

**Null hypothesis 2.** There will be no predictive relationship between subjective norm and behavioral intention to cross the street on campus while using a mobile device in the next week. Linear regression was used to examine the relationship between subjective norm and behavioral intention to cross the street on campus while using a mobile device in the next week. Results of the analysis indicated that there was a significant positive slope,  $F(1, 478) = 254.14, p < .001$ ; resulting in rejection of null hypothesis 2. Correlation between behavioral intention and subjective norm was .589 and subjective norm explained 34.7% of the variance in behavioral intention ( $r = 0.589, r^2 = 0.347$ ). Figure 4.5 contains the histogram and P-P plot that were used to examine the normality of the standardized residuals. The resultant equation can be used to predict behavioral intention given a value of subjective norm:  $\widehat{\mathbf{BI}} = -0.232 + 0.924*(\text{subjective norm})$ . Figure 4.6 provides a scatterplot with superimposed regression line and prediction equation. The maximum residual was 5.38, which was 4.00 standard deviations from the mean and was an outlier. The minimum residual was -3.78 and was 2.81 standard deviations from the mean. The linear regression model is summarized in Table 4.6.

Table 4.6

*Coefficients of Linear Regression Model for Behavioral Intention and Subjective Norm (N = 480).*

Model	Unstandardized coefficients		Standardized coefficients	<i>t</i>	<i>p</i>
	<i>B</i>	Std. Error	Beta		
(Constant)	-.232	.220	-	-1.055	.292
Subjective norm	.924	.058	.589	15.942	< .001

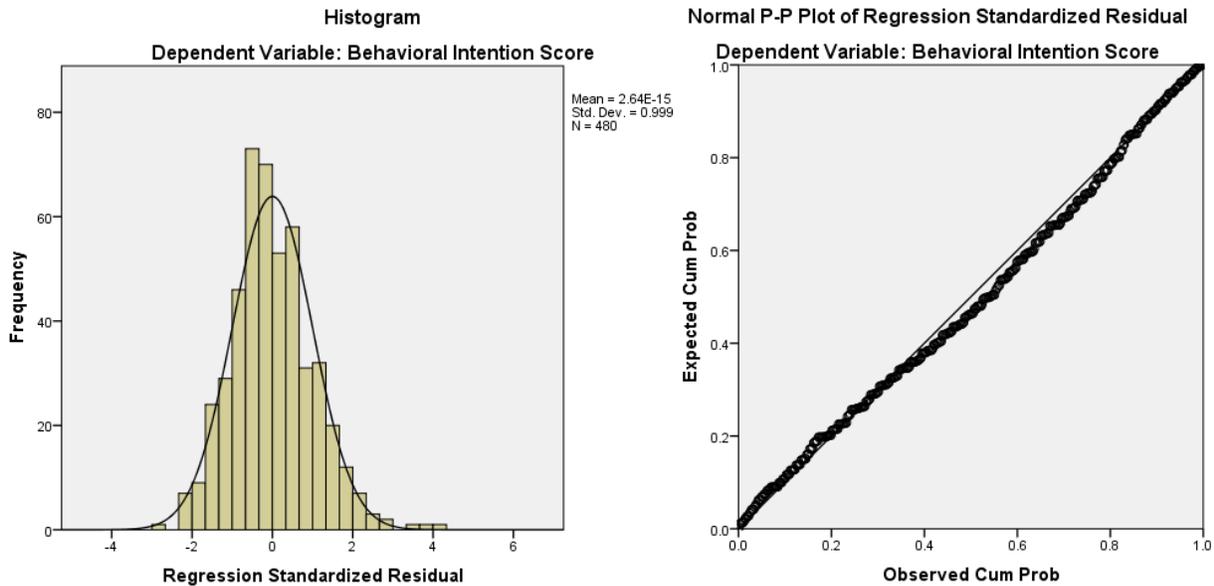


Figure 4.5. Histogram with superimposed normal distribution curve and normality plot of standardized residuals for the behavioral intention and subjective norm linear regression model ( $N = 480$ ).

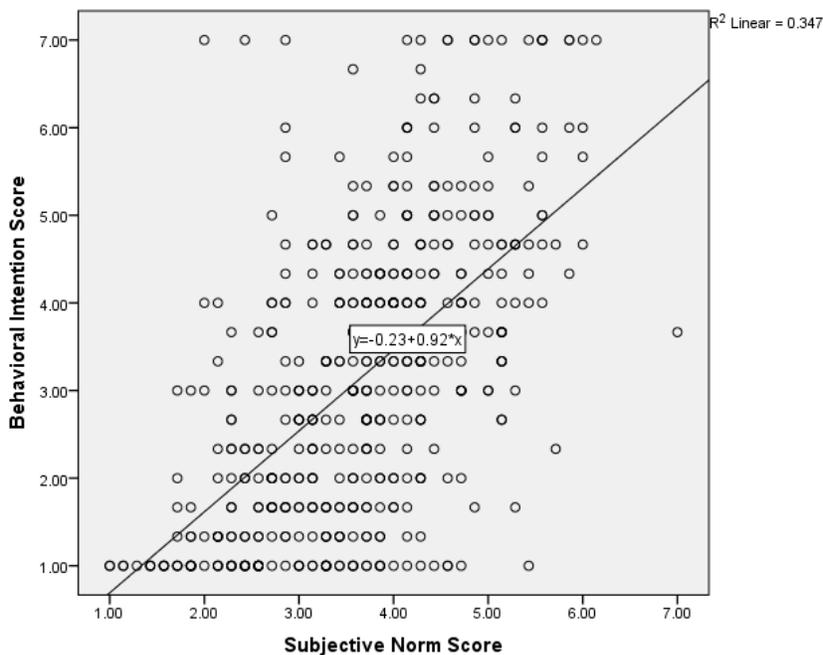


Figure 4.6 Scatterplot of the dependent variable of behavioral intention and the independent variable of subjective norm with superimposed regression line and prediction equation.

**Null hypothesis 3.** There will be no predictive relationship between perceived behavioral control and behavioral intention to cross the street on campus while using a mobile device in the next week. Linear regression was used to examine the relationship between perceived behavioral control and behavioral intention to cross the street on campus while using a mobile device in the next week. Results of the linear regression analysis indicated that there was a significant positive slope,  $F(1, 478) = 37.12, p < .001$ ; resulting in rejection of null hypothesis 3. Correlation between behavioral intention and perceived behavioral control was .268 and perceived behavioral control explained 7.2% of the variance in behavioral intention ( $r = 0.268, r^2 = 0.072$ ). Figure 4.7 contains the histogram and P-P plot that were used to examine the normality of the standardized residuals. The resultant equation can be used to predict behavioral intention given a value of perceived behavioral control:  $\widehat{\mathbf{BI}} = 2.327 + 0.465*(\text{perceived behavioral control})$ . Figure 4.8 provides a scatterplot with superimposed regression line and prediction equation. The maximum residual was 4.21 and was 2.62 standard deviations from the mean. The minimum residual was -3.19 and was 1.99 standard deviations from the mean. The linear regression model is summarized in Table 4.7.

Table 4.7

*Coefficients of Linear Regression Model for Behavioral Intention and Perceived Behavioral Control (N = 480).*

Model	Unstandardized coefficients		Standardized coefficients	<i>t</i>	<i>p</i>
	<i>B</i>	Std. Error	Beta		
(Constant)	2.327	.152	-	15.286	< .001
Perceived behavioral control	.465	.076	.268	6.092	< .001

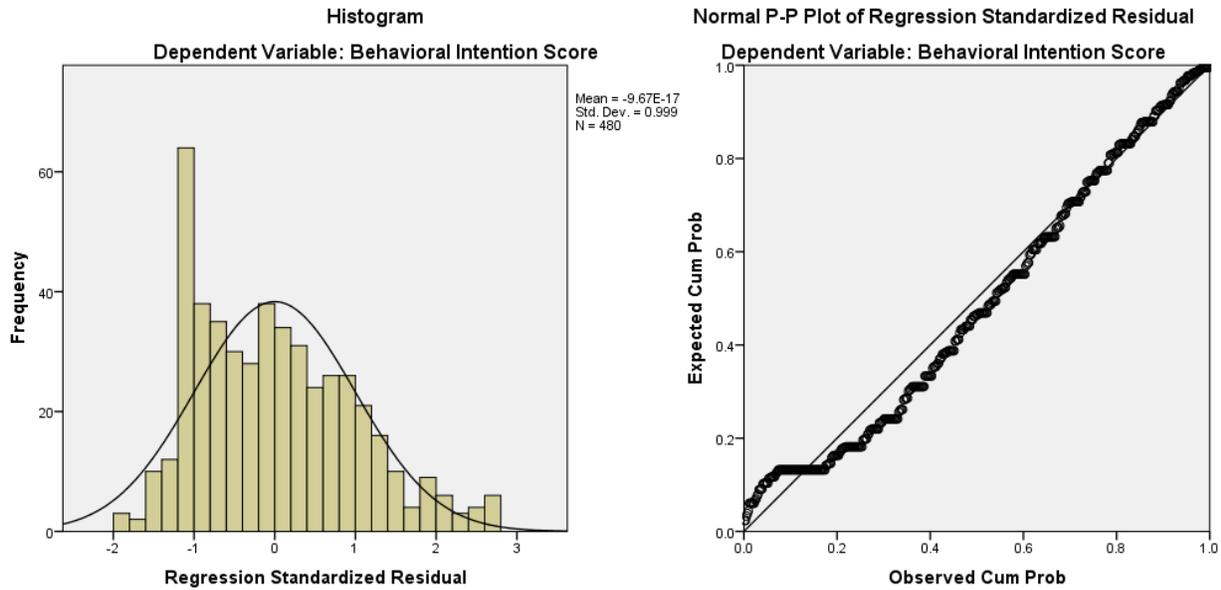


Figure 4.7. Histogram with superimposed normal distribution curve and normality plot of standardized residuals for the behavioral intention and perceived behavioral control linear regression model ( $N = 480$ ).

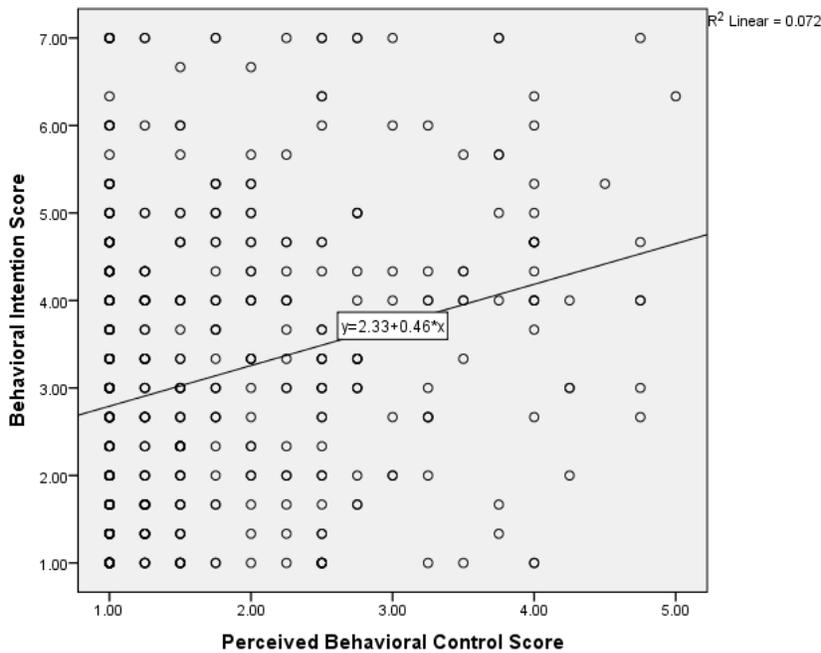


Figure 4.8 Scatterplot of the dependent variable of behavioral intention and the independent variable of perceived behavioral control with superimposed regression line and prediction equation.

**Null hypothesis 4.** There will be no predictive relationship between attitude toward the behavior ( $\beta_1$ ), subjective norm ( $\beta_2$ ), and perceived behavioral control ( $\beta_3$ ) and behavioral intention to cross the street on campus while using a mobile device in the next week ( $Y$ ).

Multiple regression was used to test the relationship of all the independent TPB constructs of attitude toward the behavior, subjective norm, and perceived behavioral control combined and the dependent TPB construct of behavioral intention to cross the street on campus while using a mobile device in the next week. Results of the multiple regression analysis indicated that there was a significant positive slope,  $F(3, 476) = 148.96, p < .001$ ; resulting in rejection of null hypothesis 4. When combined, the three independent TPB constructs result in a correlation of .696 and the model explained 48.4% of the variance in behavioral intention ( $r = 0.696, r^2 = 0.484$ ). Figure 4.9 contains the histogram and P-P plot that were used to examine the normality of the standardized residuals of the full model. Slopes for all variables in the model reached statistical significance at the  $p = 0.05$  level. The resultant equation can be used to predict behavioral intention given values of attitude toward the behavior, subjective norm, and perceived behavioral control:  $\widehat{BI} = -1.058 + (0.604 * \text{attitude toward the behavior}) + (0.514 * \text{subjective norm}) + (0.274 * \text{perceived behavioral control})$ . The maximum residual was 5.41, which was 4.52 standard deviations from the mean and was an outlier. The minimum residual was -3.78, which was 3.16 standard deviations from the mean and was an outlier. Regarding multicollinearity, analyses of tolerance and variance inflation factor (VIF) statistics for attitude toward the behavior (0.593; VIF = 1.687), subjective norm (0.611; VIF = 1.637), and perceived behavioral control (0.960; VIF = 1.042) indicated that multicollinearity between the predictor variables was not an issue. Homoscedasticity was confirmed, as assessed by visual inspection of a plot of studentized residuals and unstandardized predicted values. The multiple regression model is

summarized in Table 4.8. Percent variance explained by individual TPB constructs as well as by combined constructs is summarized in Table 4.9.

Table 4.8

*Coefficients of Multiple Regression Model for Behavioral Intention and Theory of Planned Behavior Construct Variables (N = 480).*

Model	Unstandardized coefficients		Standardized coefficients		
	B	Std. Error	Beta	t	p
(Constant)	-1.058	.215	-	-4.923	< .001
Attitude toward the behavior	.604	.065	.395	9.228	< .001
Subjective norm	.514	.066	.328	7.782	< .001
Perceived behavioral control	.274	.058	.158	4.709	< .001

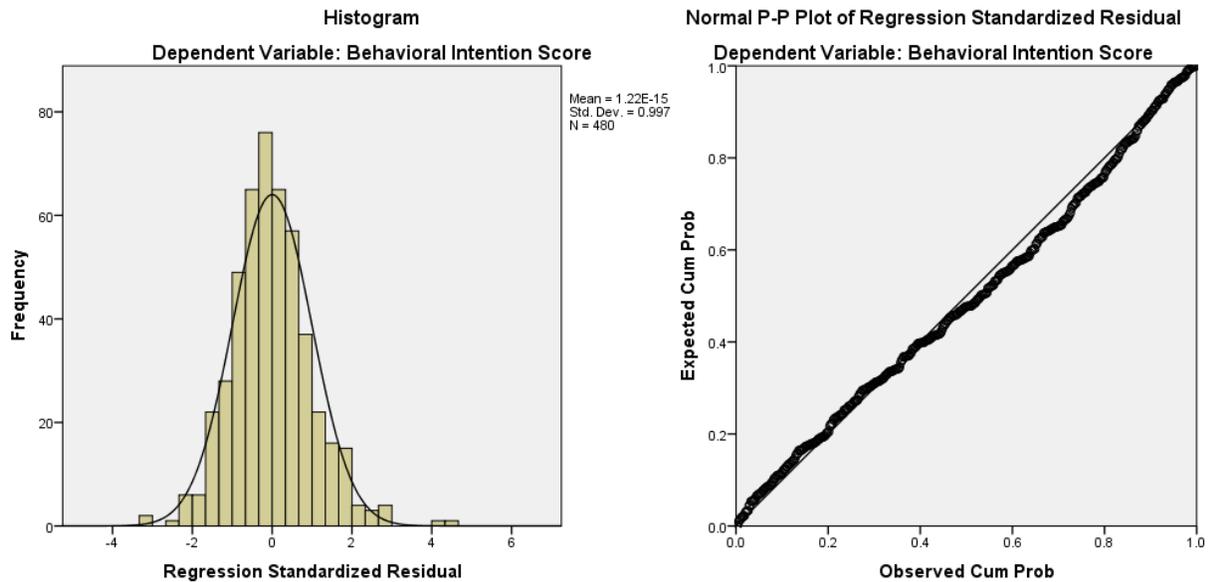


Figure 4.9. Histogram with superimposed normal distribution curve and normality plot of standardized residuals for the full theory of planned behavior multiple regression model (N = 480).

Table 4.9

*Percent Variance Explained by Individual Theory of Planned Behavior Constructs and All Constructs Combined.*

Construct	% variance explained ( $r^2$ )	Correlation ( $r$ )
Attitude toward the behavior	39.7	.630
Subjective norm	34.7	.589
Perceived behavioral control	7.7*	.278*
All constructs (multiple linear regression)	48.4	.696

*Note.* \*Spearman correlation ( $R_s$ ) used due to nonparametric distribution of perceived behavioral control variable. All values significant at the  $p < .001$  level.

**Null hypothesis 5.** There will be no difference in group means of behavioral intention to cross the street on campus while using a mobile device in the next week between participants grouped by typical daily mobile device use (between 1 minute and 2 hours and 59 minutes; between 3 hours and 5 hours and 59 minutes; and 6 or more hours per day). Questionnaire participants had the opportunity to select from one of eleven categories ranging from one minute of use to eight hours or more of use. Before performing inferential analyses on this variable, k-means clustering analyses were used to reduce the variable to three categories of typical daily mobile device use. The resultant groups and associated descriptive statistics were: (1) between 1 minute and 2 hours and 59 minutes ( $n = 131$ ,  $M = 3.04$ ,  $SD = 1.70$ ); (2) between 3 hours and 5 hours and 59 minutes ( $n = 227$ ,  $M = 3.07$ ,  $SD = 1.59$ ); and (3) 6 or more hours per day ( $n = 122$ ,  $M = 3.38$ ,  $SD = 1.75$ ). Group means, standard deviations, and percent totals are displayed in Table 4.10. One-way ANOVA analyses were performed to examine the mean differences in behavioral intention to cross the street on campus while using a mobile device in the next week between participants grouped by typical daily mobile device use. Normality of data in the groups was confirmed via analyses of skewness and kurtosis. Skewness values for groups 1, 2, and 3 were 0.663, 0.420, and 0.378, respectively. Kurtosis values for groups 1, 2, and 3 were -0.392, -

0.634, and -0.665, respectively. Homogeneity of variances was confirmed, as assessed by Levene's test of homogeneity of variances ( $p = .345$ ). Results of the analyses indicated that there was no significant difference among the means,  $F(2, 477) = 1.68, p = .187$ ; resulting in failure to reject null hypothesis 5.

**Null hypothesis 6.** There will be no difference in group means of behavioral intention to cross the street on campus while using a mobile device in the next week between participants grouped by past device use while crossing (never or almost never; less than half or about half; more than half but not all or nearly every time). Questionnaire participants had the opportunity to select from one of six categories ranging from never to nearly every time. Before performing inferential analyses on this variable, k-means clustering analyses were used to reduce the variable to three categories of past device use while crossing. The resultant groups and associated descriptive statistics were: (1) never or almost never ( $n = 124, M = 1.88, SD = 1.10$ ); (2) less than half or about half ( $n = 218, M = 3.13, SD = 1.42$ ); and (3) more than half but not all or nearly every time ( $n = 138, M = 4.30, SD = 1.61$ ). Group means, standard deviations, and percent totals are displayed in Table 4.10. One-way ANOVA analyses were performed to examine the mean differences in behavioral intention to cross the street on campus while using a mobile device in the next week between participants grouped by past device use while crossing. Normality of data in the groups was confirmed in all but one group via analyses of skewness and kurtosis. Skewness values for groups 1, 2, and 3 were 1.684, 0.376, and -.089, respectively. Kurtosis values for groups 1, 2, and 3 were 3.441, -0.416, and -0.510, respectively. Homogeneity of variances was not confirmed, as assessed by Levene's test of homogeneity of variances ( $p < .001$ ). Results of the analyses indicated that there was a significant difference among the means,

$F(2, 477) = 96.26, p < .001$ ; resulting in rejection of null hypothesis 5, albeit with violations of important assumptions.

Due to violations of normality and homogeneity of variance of the data under analysis for null hypothesis 5, Kruskal-Wallis nonparametric analyses were performed to test for differences between the group medians. Results indicated a statistically significant difference between groups,  $H(2) = 142.909, p = <.001$ ; resulting in rejection of null hypothesis 6. The proportion of variability in the ranked dependent variable of behavioral intention that was explained by past device use while crossing was 29.8% ( $\eta^2 = .298$ ) which indicated a large effect size (Cohen, 1988). Pairwise comparisons were performed using Dunn's (1964) procedure with a Bonferroni correction. Statistical significance of post-hoc tests was determined using an adjusted  $p$ -value based on the number of comparisons and adjusted  $p$ -values are reported herein. Post-hoc analyses revealed significant differences in median behavioral intention scores between all group comparisons ( $p < .001$ ). Median scores and mean ranks are as follows: never or almost never ( $Mdn = 1.67, Mrank = 129.16$ ); less than half or about half ( $Mdn = 3.00, Mrank = 245.06$ ); and more than half but not all or nearly every time ( $Mdn = 4.33, Mrank = 333.35$ ). All group differences were significantly different from each other according to the adjusted  $p$ -value for multiple comparisons.

**Null hypothesis 7.** There will be no difference in group means of behavioral intention to cross the street on campus while using a mobile device in the next week between participants with previous injury exposure and those without. The groups and associated descriptive statistics were: (1) previous injury exposure ( $n = 371, M = 3.22, SD = 1.63$ ) and (2) no previous injury exposure ( $n = 109, M = 2.89, SD = 1.75$ ). Group means, standard deviations, and percent totals are displayed in Table 4.10. One-way ANOVA analyses were performed to examine the mean

differences in behavioral intention to cross the street on campus while using a mobile device in the next week between participants grouped by previous injury exposure. Normality of data in the groups was confirmed via analyses of skewness and kurtosis. Skewness values for groups 1 and 2 were 0.473 and 0.607, respectively. Kurtosis values for groups 1 and 2 were -0.533 and -0.585, respectively. Homogeneity of variances was confirmed, as assessed by Levene's test of homogeneity of variances ( $p = .152$ ). Results of the analyses indicated that there was no significant difference among the means,  $F(1, 478) = 3.37, p = .067$ ; resulting in failure to reject null hypothesis 7.

Table 4.10

*Behavioral Intention Construct Means, Standard Deviations, and Percent of Total of Select Demographic Subgroups.*

Variable	<i>M</i>	<i>SD</i>	% of total
Typical daily device use ( $N = 480$ )			
0:01 - 2:59 ( $n = 131$ )	3.04	1.70	27.3
3:00 - 5:59 ( $n = 227$ )	3.07	1.59	47.3
6:00 or more ( $n = 122$ )	3.38	1.75	25.4
Past use while crossing ( $N = 480$ )			
Never or almost never ( $n = 124$ )	1.88	1.10	25.8
About half/less than half ( $n = 218$ )	3.13	1.42	45.4
Nearly every time/ > half but not all ( $n = 138$ )	4.30	1.61	28.8
Previous injury exposure ( $N = 480$ )			
Yes ( $n = 371$ )	3.22	1.63	77.3
No ( $n = 109$ )	2.89	1.75	22.7

*Note.* % of total column is the percentage of the total sample ( $N = 480$ ).

**Null hypothesis 8.** There will be no difference in group means of behavioral intention to cross the street on campus while using a mobile device in the next week between males and females. The groups and associated descriptive statistics were: (1) male ( $n = 149, M = 3.24, SD = 1.78$ ) and (2) female ( $n = 329, M = 3.11, SD = 1.60$ ). Means and standard deviations for males,

females, and the total sample are summarized in Table 4.11. One-way ANOVA analyses were performed to examine the mean differences in behavioral intention to cross the street on campus while using a mobile device in the next week between male and female participants. Normality of data in the groups was confirmed via analyses of skewness and kurtosis. Skewness values for males and females were 0.483 and 0.464, respectively. Kurtosis values for groups 1 and 2 were -0.654 and -0.566, respectively. Homogeneity of variances was confirmed, as assessed by Levene's test of homogeneity of variances ( $p = .090$ ). Results of the analyses indicated that there was no significant difference among the means,  $F(1, 476) = 0.71, p = .399$ ; resulting in failure to reject null hypothesis 8.

Table 4.11

*Theory of Planned Behavior Construct Means and Standard Deviations of Males (n = 149), Females (n = 329), and the Total Sample (N = 480).*

Variable	<i>M</i>			<i>SD</i>		
	Male	Female	Total	Male	Female	Total
Behavioral intention	3.24	3.11	3.14	1.78	1.60	1.66
Attitude toward the behavior	3.15	3.02	3.05	1.12	1.07	1.09
Subjective norm	3.60	3.69	3.65	1.14	1.01	1.06
Perceived behavioral control*	1.82	1.72	1.75	0.99	0.95	0.96

*Note.* \*Lower mean values for perceived behavioral control indicate increased control over abstaining from the behavior

## Phase Two Results

### Descriptive Statistics

Observation sessions across all locations yielded a total of 4,878 crossing instances. In total, 1,652 (33.9%) of the crossing instances were male and 3,226 (66.1%) were female.

Pedestrian crossing instances were observed at: (1) the intersection of University Boulevard and

Colonial Drive ( $n = 2,299$ ); (2) a crosswalk crossing University Boulevard near the President’s Mansion ( $n = 543$ ); (3) a group of crosswalks at the intersection of McCorvey Drive and Campus Drive West ( $n = 1,411$ ); and (4) a crossing that crossed Hackberry Lane near Russell Hall ( $n = 625$ ). Frequencies and percentages of crossing instances are summarized in Table 4.12. Across all observation locations, device use while crossing was observed 1,201 (24.6%) times. Of all male crossing instances, 277 (16.8%) were coded as using a device. Of all female crossing instances, 924 (28.6%) were coded as using a device.

Table 4.12

*Frequencies and Percentages of Male and Female Pedestrian Crossing Instances at Observed Locations During Observation Period (N = 4878).*

Location	Crossing instances		% total of each location	
	Male	Female	Male	Female
Signalized intersection ( $n = 2,299$ )	618	1,618	26.9	73.1
Signalized mid-block ( $n = 543$ )	86	457	15.8	84.2
Un-signalized intersection ( $n = 1411$ )	688	723	48.8	51.2
Un-signalized mid-block ( $n = 625$ )	260	365	41.6	58.4

*Note.* Signalized intersection = A four-way intersection with vehicle and pedestrian traffic controlled by lighted signals. Signalized mid-block = A single mid-block crosswalk with vehicle and pedestrian traffic controlled by lighted signals. Un-signalized intersection = A three-way intersection with only vehicle traffic controlled by stop signs. Un-signalized mid-block = A single mid-block crosswalk with only vehicle traffic controlled by passive “yield to pedestrian” signage.

### Hypothesis Testing

**Null hypothesis 9.** There will be no difference in the proportion of those observed street-crossing on campus while using a mobile device between males and females. Chi-square analyses were employed to test for significant differences in proportions of male and female pedestrians engaged in distracted mobile device use while crossing the street on campus. All expected cell frequencies were greater than five. Results indicate that of the 1,652 male crossing

instances, 277 (16.8%) instances of distracted mobile device use were observed. Of the 3,226 female crossing instances, 924 (28.6%) instances of distracted mobile device use were observed. This association between gender and device use while crossing was statistically significant as assessed by Fisher's exact test,  $p < .001$ , odds ratio = .50, 95% CI [.43, .58]; resulting in the rejection of null hypothesis 9. The association was considered weak (Cohen, 1988), Cramer's  $V = .130$ . With males set as the reference group, females were almost twice as likely to be observed using a device while crossing the street, odds ratio = 1.99, 95% CI [1.72, 2.32]. Table 4.13 provides frequencies and percentages of observed distracted mobile device use while crossing.

Table 4.13

*Frequencies and Percentages of Distracted Mobile Device Use Crossing Instances Among Males ( $n = 1,652$ ) and Females ( $n = 3,226$ ) Overall and by Observation Location.*

Device use	Male	Female	% of male*	% of female*
Yes ( $n = 1,201$ )	277	924	16.8	28.6
Signalized intersection ( $n = 585$ )	109	476	17.6	29.4
Signalized mid-block ( $n = 177$ )	16	161	18.6	35.2
Un-signalized intersection ( $n = 308$ )	119	189	17.3	26.1
Un-signalized mid-block ( $n = 131$ )	33	98	12.7	26.8

*Note.* \*Percentage distracted out of total male and female crossing instances at each observation location; Signalized intersection = A four-way intersection with vehicle and pedestrian traffic controlled by lighted signals. Signalized mid-block = A single mid-block crosswalk with vehicle and pedestrian traffic controlled by lighted signals. Un-signalized intersection = A three-way intersection with only vehicle traffic controlled by stop signs. Un-signalized mid-block = A single mid-block crosswalk with only vehicle traffic controlled by passive “yield to pedestrian” signage.

**Null hypothesis 10.** There will be no relationship between those observed street-crossing on campus while using a mobile device and observation locations. Bivariate logistic regression analyses were employed to test for a relationship between pedestrians engaged in distracted mobile device use while crossing the street on campus and observation location. Results indicated a statistically significant relationship,  $\chi^2(3) = 29.079$ ,  $p < .001$ . The model explained

0.9% (Nagelkerke  $r^2 = .009$ ) of the variance in distracted mobile device use. The Wald statistic of 29.582 ( $df = 3, p < .001$ ) provided evidence that observation location was a significant contributor to differences within the model. Of the observation locations, several location comparisons revealed significant differences ( $p < 0.05$ ). Odds ratios and 95% confidence intervals for the locations are shown in Table 4.14.

Since some observation locations had a high percentage of female crossing instances compared to male (see Table 4.12) and significantly more females were observed using a mobile device (see null hypothesis 9 and Table 4.13), loglinear analyses were utilized to assess the possible confounding influence of gender on frequency of device use. Results from loglinear analyses indicated that there was not a significant 3-way interaction between observation location, distracted mobile device use, and gender,  $p = .061$ . Further, after controlling for gender, a significant difference between observation location and device use remained  $\chi^2(3) = 8.866, p = .031$ . Partial associations associated with the loglinear analyses are displayed in Table 4.15.

To explore the influence of gender on the results of logistic regression analyses, gender was included in an additional logistic regression model and analyses were repeated. Results indicated a statistically significant relationship,  $\chi^2(4) = 99.975, p < .001$ . This second model explained 3.0% (Nagelkerke  $r^2 = .030$ ) of the variance in distracted mobile device use. A Wald statistic of 13.320 ( $df = 3, p = .004$ ) for observation location and 66.989 ( $df = 3, p < .001$ ) provided evidence that observation location and gender were significant contributors to differences within the model. Given that this model controlled for gender, some locations lost significance at the  $p < 0.05$  level compared to the previous model. Across all comparisons, location 2 emerged as significantly different ( $p < .01$ ). Odds ratios and 95% confidence intervals for the locations are shown in Table 4.16.

Table 4.14

*Logistic Regression Predicting Likelihood of Distracted Mobile Device Use Based on Observation Location.*

Location	B	SE	Wald	df	p	Odds ratio	95% CI for odds ratio	
							Upper	Lower
<b>Signalized intersection*</b>	-	-	-	-	-	-	-	-
Signalized mid-block	.348	.103	11.377	1	.001	1.417	1.157	1.735
Un-signalized intersection	-.201	.080	6.250	1	.012	.818	.699	.958
Un-signalized mid-block	-.252	.109	5.329	1	.021	.777	.627	.963
Constant	-1.075	.048	503.991	1	< .001	.341	-	-
Signalized intersection	-.348	.103	11.377	1	.001	.706	.576	.864
<b>Signalized mid-block*</b>	-	-	-	-	-	-	-	-
Un-signalized intersection	-.549	.112	24.062	1	< .001	.577	.464	.719
Un-signalized mid-block	-.601	.134	20.013	1	< .001	.548	.421	.713
Constant	-.726	.092	62.966	1	< .001	.484	-	-
Signalized intersection	.201	.080	6.250	1	.012	1.222	1.044	1.431
Signalized mid-block	.549	.112	24.062	1	< .001	1.732	1.391	2.157
<b>Un-signalized intersection*</b>	-	-	-	-	-	-	-	-
Un-signalized mid-block	-.052	.118	.193	1	.660	.950	.754	1.196
Constant	-1.276	.064	391.822	1	< .001	.279	-	-

Signalized intersection	.252	.109	5.329	1	.021	1.287	1.039	1.595
Signalized mid-block	.601	.134	20.013	1	< .001	1.824	1.402	2.373
Un-signalized intersection	.052	.118	.193	1	.660	1.053	.836	1.326
<b>Un-signalized mid-block*</b>	-	-	-	-	-	-	-	-
Constant	-1.327	.098	182.424	1	< .001	.265	-	-

*Note.* \*For each set of comparisons, the reference group has been bolded. Signalized intersection = A four-way intersection with vehicle and pedestrian traffic controlled by lighted signals. Signalized mid-block = A single mid-block crosswalk with vehicle and pedestrian traffic controlled by lighted signals. Un-signalized intersection = A three-way intersection with only vehicle traffic controlled by stop signs. Un-signalized mid-block = A single mid-block crosswalk with only vehicle traffic controlled by passive “yield to pedestrian” signage.

Table 4.15

*Partial Associations for Gender, Location, and Distracted Mobile Device Use Variables.*

Effect	Partial association $\chi^2$ (df)	<i>p</i> -value
Location*gender	270.209 (3)	< .001
Location*device use	8.866 (3)	.031
Gender*device use	66.682 (1)	< .001
Location	1612.672 (3)	< .001
Gender	517.090 (1)	< .001
Device use	1317.226 (1)	< .001

Table 4.16

*Logistic Regression Predicting Likelihood of Distracted Mobile Device Use Based on Observation Location and Gender.*

Location	B	SE	Wald	df	p	Odds ratio	95% CI for odds ratio	
							Upper	Lower
<b>Signalized intersection*</b>	-	-	-	-	-	-	-	-
Signalized mid-block	.287	.104	7.616	1	.006	1.333	1.087	1.634
Un-signalized intersection	-.069	.082	.700	1	.403	.933	.794	1.097
Un-signalized mid-block	-.167	.111	2.269	1	.132	.847	.682	1.051
Gender	.643	.079	66.989	1	< .001	1.902	1.630	2.218
Constant	-1.565	.079	394.021	1	< .001	.209	-	-
Signalized intersection	-.287	.104	7.616	1	.006	.750	.612	.920
<b>Signalized mid-block*</b>	-	-	-	-	-	-	-	-
Un-signalized intersection	-.356	.115	9.640	1	.002	.700	.559	.877
Un-signalized mid-block	-.454	.136	11.114	1	.001	.635	.487	.829
Gender	.643	.079	66.989	1	< .001	1.902	1.630	2.218
Constant	-.726	.092	62.966	1	< .001	.484	-	-
Signalized intersection	.069	.082	.700	1	.403	1.071	.912	1.259
Signalized mid-block	.356	.115	9.640	1	.002	1.428	1.140	1.788
<b>Un-signalized intersection*</b>	-	-	-	-	-	-	-	-
Un-signalized mid-block	-.098	.119	.678	1	.410	.907	.719	1.144
Gender	.643	.079	66.989	1	< .001	1.902	1.630	2.218

Constant	-1.634	.080	412.941	1	< .001	.195	-	-
Signalized intersection	.167	.111	2.269	1	.132	1.181	.951	1.467
Signalized mid-block	.454	.136	11.114	1	.001	1.574	1.206	2.055
Un-signalized intersection	.098	.119	.678	1	.410	1.103	.874	1.391
<b>Un-signalized mid-block*</b>	-	-	-	-	-	-	-	-
Gender	.643	.079	66.989	1	< .001	1.902	1.630	2.218
Constant	-1.732	.112	237.836	1	< .001	.177	-	-

*Note.* \*For each set of comparisons, the reference group has been bolded. Signalized intersection = A four-way intersection with vehicle and pedestrian traffic controlled by lighted signals. Signalized mid-block = A single mid-block crosswalk with vehicle and pedestrian traffic controlled by lighted signals. Un-signalized intersection = A three-way intersection with only vehicle traffic controlled by stop signs. Un-signalized mid-block = A single mid-block crosswalk with only vehicle traffic controlled by passive “yield to pedestrian” signage.

## CHAPTER 5

### DISCUSSION

In the United States, pedestrian injuries are an increasing public health concern. Persons of college-age are particularly affected by traffic-related pedestrian injuries. Use of mobile devices while walking has been implicated as a contributor to the problem of pedestrian injuries. To date, there exists a very small body of literature investigating the behavior of distracted walking (Barton et al., 2016; Lennon et al., 2017). The increased incidence of pedestrian injuries in college-age persons (National Center for Injury Prevention and Control, 2017b), the explosion in mobile data consumption (CTIA-The Wireless Association, 2016), and the increased risk to which college students are exposed (Balsas, 2003) necessitate further study in this area. The purpose of this study was to utilize the theory of planned behavior (TPB) to examine college students' behavioral intention to engage in the behavior of crossing the street on campus while using a mobile device in the next week. A secondary aim of the study was to estimate the incidence of distracted mobile device use on campus among street-crossing college student pedestrians at the University of Alabama (Tuscaloosa). Chapter 5 provides a discussion of study results, implications, limitations, and future directions.

The questionnaire development process produced a theory-based tool that was able to predict behavioral intention to cross the street on campus while using a mobile device in the next week. Given that behavioral intention can be predicted by the TPB constructs, theory-based interventions can be designed, implemented, and evaluated. Planners of such interventions can use the questionnaire to assess TPB constructs in a population of undergraduate college students

to inform intervention strategies. The questionnaire can also be used during and after intervention activities to examine changes in TPB constructs.

Data resulting from the secondary aim of the present study provide an estimate of the incidence of distracted mobile device use on campus among street-crossing pedestrians at the University of Alabama. Also emerging from the present study is a modified observation protocol based on the NHTSA National Occupant Protection Use Survey (NOPUS). The NOPUS is the NHTSA's primary method of estimating cell phone use by automobile drivers (National Center for Statistics and Analysis, 2010).

### **Phase One Discussion**

In the present study, attitude toward the behavior emerged as the strongest predictor of behavioral intention while perceived behavioral control was the weakest. This is in contrast to results of a recent TPB investigation that targeted the pedestrian behavior of distraction (Barton et al., 2016); where perceived behavioral control emerged as the strongest predictor of behavioral intention. Other studies that focused on some sort of pedestrian behavior (Evans & Norman, 1998, 2003; Xu et al., 2013; Zhou & Horrey, 2010; Zhou et al., 2009) have also had similar findings for the perceived behavioral control construct. In the aforementioned studies, perceived behavioral control was explored in terms of engaging in the behavior of interest while the present study explored the construct in terms of *refraining* from the behavior. Some pedestrian behavior studies have reported reliability issues when measuring perceived behavioral control in terms of abstinence from the behavior (Evans & Norman, 1998, 2003). One pedestrian study by Holland and Hill (2007) that measured perceived behavioral control in a way similar to the present study (in terms of refraining from the behavior of interest) also found perceived behavioral control to be the weakest predictor of behavioral intention. Another recent study measuring perceived

behavioral control in terms of performing distracted crossing found results closer to those in the present study (Lennon et al., 2017); perceived behavioral control was the weakest predictor of behavioral intention. As a possible explanation of this finding related to the particular behavior of distracted street-crossing, Lennon et al. (2017) suggest that persons who are heavy users of smart phones may feel so strongly in control of when and how they use their phones that it exerts little influence on their intention to use the phone while crossing the street.

In the few studies focusing solely on the pedestrian behavior of distracted mobile device use, the predictive ability of the other TPB constructs of attitude toward the behavior and subjective norm were inconsistent. Barton et al. (2016) found attitude toward the behavior to be the second-strongest predictor of behavioral intention while subjective norm was not a significant predictor. Similar to the present investigation, Lennon et al. (2017) found attitude toward the behavior to be the strongest predictor of behavioral intention and subjective norm to be the second-strongest predictor. The small number of TPB studies examining distracted pedestrian behavior makes it difficult to provide an explanation for the inconsistencies among studies. It should also be noted that the studies exploring distracted pedestrian behavior were conducted in different locales, used different operationalization of the behavior, employed questionnaires developed using different procedures, and utilized populations with different characteristics. Like the present study, Barton et al. (2016) investigated college students. While a proportion of the sample studied by Lennon et al. (2017) was recruited from a college campus, a larger proportion of participants were recruited from a non-college-student population.

Regarding differences in behavioral intention among participants grouped by select demographic characteristics, greater frequency of past distracted crossing behavior over the past week was positively and significantly associated with greater intention to perform the same

behavior in the future. Though this relationship between previous behavior and current behavioral intention may not be surprising, it is common among TPB studies that assess previous behavior and intention (Fishbein & Ajzen, 2010).

Though no significant difference was found between participants reporting previous injury exposure and those not reporting previous injury exposure, related analyses in the present study were very close to statistical significance at the  $p < .05$  level. Despite the lack of significance, the inverse relationship between previous injury exposure and behavioral intention is worth noting given findings by Barton et al. (2016) who also reported a measure of previous injury exposure. In their study, Barton et al. (2016) found significant differences such that participants who had both experienced a close call and knew someone who had been struck by a vehicle had significantly higher scores on the TPB constructs of subjective norm and perceived behavioral control than participants at lower levels of previous injury exposure. Though they concede that the limited body of research in this area makes causal inferences impossible, Barton et al. (2016) suggest that those with previous injury exposure might also hold the belief that they maintain adequate control over the behavior of distracted street-crossing despite the occasional injury. Thus, more research is needed to investigate the relationship between previous injury exposure and the behavior of distracted street-crossing (Barton et al., 2016).

### **Phase Two Discussion**

In phase two of the present study, descriptive statistics were used to estimate the incidence of distracted mobile device use while crossing the street on campus. Observation sessions across all locations yielded a total of 4,878 crossing instances. In total, 33.9% of the crossing instances were male and 66.1% were female. Across all observation locations, device use while crossing was observed 24.6% of the time. Of all male crossing instances, 16.8% were

coded as using a device. Of all female crossing instances, 28.6% were coded as using a device. Consequently, it is estimated that female pedestrians on campus use mobile devices while crossing the street almost twice as much as their male counterparts. Further, it is estimated that nearly one quarter of all pedestrians on campus use a mobile device while crossing the street.

Comparison of the present results to previous observation studies is limited given differences in operationalization of the term “distracted” and differences in observation methods. Despite this, in an observation study near a large university with 866 total participants, Bungum et al. (2005) reported mobile device distraction in 5.7% of those observed. It is important to note that headphone use was defined as a condition of distraction in that study. Further, investigators only observed the first pedestrian to reach the crosswalk at each traffic signal change and live coding (video data were not captured) was employed. A study of 546 pedestrians in an Australian suburb found that 33.3% of participants were observed using a mobile device. Live coding was also used in that study (Hatfield & Murphy, 2007). A study of 1,102 pedestrians conducted in Seattle, Washington reported that 29.8% of participants were distracted while crossing the street. In this study, listening to music was also included as a condition of distraction. Live coding was also employed in that study (Thompson et al., 2013).

In the present study, proportions of distracted mobile device use while crossing differed between male and female crossing instances. A significantly higher proportion of female crossing instances involved mobile device use compared to their male counterparts (28.6% versus 16.8%). Statistical analyses revealed that female crossing instances were almost twice as likely to involve mobile device use. One reason for a difference between males and females might be the tendency for females to initiate contact with friends and family more often than males (Forgays et al., 2014). Despite difficulty in providing an explanation of the gender

differences in the present study, an overall observation made by the researcher during coding is worth noting. It appeared that many of the female pedestrians did not have pockets as a feature of their clothing, while many more male pedestrians did. One area of future research investigating gender differences could include exploration of clothing differences and whether the absence of pockets makes a person more likely to hold their device in their hand; and whether holding a device in a person's hand due to lack of storage makes them more likely to use the device.

After controlling for the influence of gender on distraction at each observation location, differences were found among the locations. Comparison of all locations revealed one location that differed significantly from the rest. One characteristic that may be important in attempting to explain the observed difference between observation locations is the type of traffic control at the location. Results were such that the signalized mid-block location was significantly more likely to have device use when compared to all other locations. The greatest magnitude difference was found between the signalized mid-block location and the un-signalized mid-block location. The signalized mid-block location consisted of only one crosswalk that crossed two lanes of bi-directional traffic and both pedestrian and vehicular traffic was controlled by lighted signals. Thus, drivers at this location were commanded to stop by a traffic signal before pedestrians were advised to cross via a crosswalk signal. Similar to the signalized mid-block location, the un-signalized mid-block location featured only one crosswalk that crossed two lanes of bi-directional traffic, though vehicular traffic was controlled by a passive "yield to pedestrians" sign and no crossing instruction was provided to pedestrians. Further, despite characteristic similarities between the two aforementioned locations, statistical analyses revealed that the un-signalized mid-block location was not significantly different from the others. Though further exploration is required, this suggests that the presence of lighted traffic control signals and

simplified traffic flow may increase the tendency to cross while distracted by a mobile device. It may be that pedestrians at such locations perceive a lower risk due to the increased traffic control afforded by lighted signals and simpler bi-directional traffic patterns.

### **Implications for Health Education**

Results from this study indicate that there is utility in using the TPB to predict behavioral intention to cross the street on campus use a mobile device in the next week. Fishbein and Ajzen (2010) state, "...we believe that if we can bring about change in one or more of the theory's three major components [attitude toward the behavior, perceived social norm, and perceived behavioral control], we should observe changes in intentions and, in the presence of adequate volitional control, changes in behavior as well" (p. 322). Because of the relationship between TPB constructs and behavioral intention, the questionnaire resulting from the present study can be used to estimate the relative importance of each TPB construct being considered as targets of an intervention (Fishbein & Ajzen, 2010; Holland & Hill, 2007; Stead, Tagg, MacKintosh, & Eadie, 2005). Fishbein and Ajzen (2010) recommend the use of TPB construct means, standard deviations, regression weights, and correlation with behavioral intention to identify constructs as good candidates for change. Following the recommendation of Fishbein and Ajzen (2010), an overall assessment of the values for each construct highlight attitude toward the behavior and subjective norm as good candidates for change in the present sample population.

Inherently, the aforementioned characteristics of a TPB-based questionnaire also lend themselves to the utility of the questionnaire to serve as a measure of intervention effectiveness (Fishbein & Ajzen, 2010; Holland & Hill, 2007; Stead et al., 2005). Initial administration of the questionnaire at baseline can be followed-up with subsequent administrations in order to look for meaningful change in the TPB constructs over the course of an intervention.

Given the maximum mean score of 7.00 for all TPB constructs, the mean score for behavioral intention (3.14;  $SD = 1.66$ ) across the entire sample indicates moderate intention to use a mobile device while crossing the street on campus in the next week. Additionally, the aggregate mean score for those reporting high behavioral intention (participants with mean scores  $\geq 5.00$ ) was 5.90 ( $SD = 0.78$ ;  $n = 75$ ; 15.6%), while the aggregate mean score for those reporting low behavioral intention (participants with mean scores  $< 5.00$ ) was 2.63 ( $SD = 1.22$ ;  $n = 405$ ; 84.4%). Thus, there is a substantial proportion of the sample (15.6%) who reported high intention to use a mobile device while crossing the street in the next week. This finding, combined with observation findings that estimate 24.6% of pedestrians engage in distracted mobile device use while crossing the street bolsters rationale for an intervention to reduce behavioral intention among college students at the University of Alabama.

Attitude toward the behavior was the strongest predictor of behavioral intention in this study. In an effort to reduce behavioral intention, interventions in the population from which the sample was obtained could utilize strategies to increase negative attitudes toward using a mobile device while crossing the street on campus. Targeting behavioral beliefs as they relate to device use while crossing the street can work to influence behavioral beliefs. Challenging existing behavioral beliefs that crossing in such a manner is fun, useful, or offers practical advantages is one way to influence behavioral beliefs. Emphasizing disadvantages of using a device while crossing is another way to influence behavioral beliefs. Appropriate messages that highlight the safety risk of device use while crossing could be used.

Many existing interventions with the goal of improving pedestrian safety focus largely on the driver's role in protecting pedestrian safety, engineering improvements to the built environment, or safety education aimed at young children (Brookshire, Sandt, Sundstrom,

Thomas, & Blomberg, 2016; Candappa, Stephan, Fotheringham, Lenné, & Corben, 2014; Goodwin et al., 2015). As of the most recent edition of the NHTSA's *Countermeasures That Work* publication, evaluated interventions that focus on distracting pedestrian behaviors were not identified (Goodwin et al., 2015). Discussing the problem of distracted pedestrians briefly, Goodwin et al. (2015) mentioned that while a number of universities have been known to conduct pedestrian safety campaigns, program effects have not been evaluated.

Despite a lack of evaluated interventions, efforts that might have an influence on attitude toward the behavior exist. Reports of municipalities conducting awareness campaigns have surfaced in recent years (Cortez, 2012). In Delaware, safety officials have used sidewalk decals at busy intersections in an attempt to get the attention of pedestrians who may be looking down at their mobile devices. Such decals read, "Look up. Drivers aren't always looking out for you." In Philadelphia, as part of a safety campaign disguised as an April Fool's Day joke, an "e-lane" was created for the exclusive use of distracted pedestrians on a sidewalk. Experiments with in-ground pedestrian signals have even been reported (Noack, 2016). A campaign in San Francisco was launched in response to a series of adverse events related to distracted walking. The campaign included outdoor, radio, and television ads that aimed to raise awareness of the dangers of using a mobile device while walking. Safety advice to the public also appears in the San Francisco Municipal Railway Rider's Guide and reads, "Avoid using your cell phone, texting or other multitasking while walking" (San Francisco Municipal Transportation Agency, 2016). Further, an awareness-raising prank in New York City involved the use of people wearing orange safety vests with the words "Seeing Eye Person" written on them. The idea behind the prank was to make it appear as if a service existed that allowed distracted pedestrians to be guided by a human in order to safely text and walk (Improv Everywhere, 2013).

A number of social media awareness campaigns relating to distracted walking have been launched in the recent past. Current social media awareness campaigns include #devicedown and #walksafely (Safe Kids Worldwide, 2013), #eyesup (Interbrand North America, 2015), and #digitaldeadwalker (American Academy of Orthopaedic Surgeons, 2015a).

Subjective norm was also a strong predictor of behavioral intention in the present study. Intervention strategies aimed at changing subjective norms can focus on either injunctive norms (what others expect a person to do) or descriptive norms (what others are doing) (Fishbein & Ajzen, 2010). Social marketing campaigns that aim to change subjective norms have shown promise when applied to college students and alcohol use (Glassman, Dodd, Miller, & Braun, 2010). Further, prioritizing focus on injunctive norms in college student populations might be more efficacious due to participants' desire for social approval (Glassman et al., 2010). It is also posited that when descriptive norms pertaining to a negative behavior are the focus of an intervention, a reverse effect can take place where the negative behavior is normalized (Cialdini, 2003; Lawrence, 2015; Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007). One intervention study focusing on injunctive norms associated with the behavior of texting and driving used the placement of signs as an attempt to change injunctive norms (Lawrence, 2015). Signs that simply communicated "do not text and drive" were found to be ineffective while signs with a stronger focus on injunctive norms, such as, "97% of Dukes [Dukes refers to faculty, staff, and students that make up the university community] disapprove when you text and drive" were found to create a short-term effect of reducing observed distracted driving behavior (Lawrence, 2015). Given similarities between distracted driving and distracted walking, perhaps similar messaging strategies targeting distracted pedestrians could influence injunctive norms positively. As part of a larger pedestrian safety campaign recently conducted at a large university,

messaging in the form of signs affixed to various sidewalks around campus was used (Neff-Henderson, 2016). Though the campaign's slogan of "heads up Hokies" weakly addressed injunctive norms as described by Lawrence (2015), such programs should be evaluated to gauge their effectiveness. Messages used in such campaigns should have a strong focus on injunctive norms.

The present study identified perceived behavioral control as the weakest predictor of behavioral intention. Overall, the mean score for this construct score was low, indicating strong perceived behavioral control over refraining from the behavior. Further, a large percentage (40.6%) of participants attained the lowest possible score on the perceived behavioral control scale; indicating the greatest possible representation of perceived behavioral control over refraining from crossing the street on campus while using a mobile device in the next week. While participants' perception that they can refrain from the behavior of using a mobile device while crossing the street can be advantageous, its value can be diminished by favorable attitude and subjective norm toward performing the negative behavior. While other investigations of pedestrian behavior have framed perceived behavioral control items in terms of refraining from the behavior in question (Holland & Hill, 2007), item wording in terms of performing the behavior has been used and has produced consistent, relatively strong, predictive utility (Barton et al., 2016; Evans & Norman, 1998, 2003; Xu et al., 2013; Zhou & Horrey, 2010; Zhou et al., 2009). Thus, for the purpose of designing and evaluating an intervention, it might be more useful in future investigations to elicit participant responses in terms of performing the behavior rather than abstaining from it. Regarding high predictive utility of perceived behavioral control found in many studies, Barton et al. (2016) and Evans and Norman (1998) give the possible explanation that many people view crossing the street as a mundane task. It is posited that the

relative ease of crossing the street might mitigate perceptions of risk associated with crossing the street while using a mobile device (Barton et al., 2016).

In populations where perceived behavioral control is identified as a strong predictor of behavioral intention, interventions could focus on raising awareness of how the human brain handles “multitasking” situations. In the literature, multitasking is often defined as a frequent switching between multiple tasks rather than a process where multiple tasks are completed in a truly simultaneous fashion (Salvucci, Taatgen, & Borst, 2009). Thus, it is posited that those who perceive themselves to be skilled at multitasking are only good at placing multiple activities on a temporary hold until they return to them. The term “task switching” has been used as an appropriate alternative to the word “multitasking” because of its emphasis on the brain’s frequent switching between tasks when it is responsible for processing multiple streams of information at the same time (Avc, 2015; Salvucci et al., 2009). One skill found to be important for efficient task switching is a good “working memory.” A well-functioning working memory allows an individual to minimize the time it takes to reorient with various tasks as they switch back to them (König, Bühner, & Mürling, 2005). While an efficient working memory might be advantageous when switching back and forth between a text message and static academic course notes, arguably, working memory is of little use in such a dynamic environment as a pedestrian crosswalk. This phenomenon has been demonstrated and termed “inattention blindness” by some pedestrian distraction researchers (Hyman et al., 2010). Thus, education aimed at reframing the utility of multitasking among the target population might decrease levels of perceived behavioral control over performing the behavior.

Policy combined with highly visible enforcement has been successful at reducing many high-risk driving behaviors (Goodwin et al., 2015). Creating similar barriers to

distracting pedestrian behaviors may be effective in decreasing perceived behavioral control over using a mobile device while crossing the street. Though there exist many cities and states with laws banning types of distracted driving, there is a paucity of legislation aimed at pedestrian behaviors such as mobile device use while walking. Lack of evaluation makes it difficult to gauge the effectiveness of such policies aimed at pedestrians (Goodwin et al., 2015).

The observation portion of the study has important implications as science works to gain a better understanding of the distracted pedestrian problem. The observation protocol used in the present study was based on a nationally implemented protocol that has been used in its current form since 2005 to collect data on driver electronic device use (National Center for Statistics and Analysis, 2010). Adapting the existing and consistently-used protocol to explore device use behavior in pedestrians is an important step toward ensuring uniform data collection procedures across future research studies. Also, the ability to replay high-quality video data captured in the present study facilitated analysis of congested intersections where live coding was impractical. Video analyses also allowed for reliability testing that provided evidence of strong rater-interrater and intra-rater reliability. As portable video camera technology becomes increasingly capable of capturing high resolution video at high frame rates, researchers now have the ability to incorporate discreet video recording into future observation protocols to improve rigor.

### **Future Research**

The university setting, with its high concentration of pedestrians as well as a younger population that is more likely to take risks, has been identified as an important setting in which pedestrian safety interventions can be delivered (Goodwin et al., 2015). Some pedestrian safety campaigns exist on college campuses (Neff-Henderson, 2016), yet intentional use of a theoretical framework is not clear. Further, formally evaluated interventions are not known to exist

(Goodwin et al., 2015). Similar development and evaluation strategies should be employed outside of the college student population to broaden the reach of potential interventions to involve communities at large. As previously stated, well-crafted TPB questionnaires have utility in both intervention development and evaluation phases (Fishbein & Ajzen, 2010).

While the present TPB questionnaire and observation protocol are useful for the measurement of behavioral intention and actual behavior, comprehensive outcome evaluation is dependent upon data collection protocols that reveal more than behavioral intention and simple incidence of distracted crossing. The overall aim of health education interventions in this area should be to decrease morbidity and mortality associated with distracted walking. Therefore, an effort to create standardized data collection procedures will: (1) allow for a better understanding of the risk associated with device use while crossing the street and (2) allow for assessment of intervention effectiveness on long-term outcomes (Mwakalonge et al., 2015). Though a significant proportion of pedestrian crossings result in injury or death, most pedestrian crossings are uneventful. This makes the chances of observing even one vehicle-pedestrian crash at sampled crossing locations unlikely; making statistical analyses of risk difficult. To alleviate this, future research can focus on traffic conflicts (events where a pedestrian or driver had to perform a mild-to-severe maneuver to avoid a crash) as a proxy measure of actual crashes (Brumfield & Pulugurtha, 2011; Scopatz & Zhou, 2016).

Future research should also focus on understanding which distracted walking countermeasures will be most effective given the target population and crossing environment (Mwakalonge et al., 2015). Research on interventions to reduce college student alcohol use have successfully used focus groups with members of the target population to inform intervention strategies (Glassman et al., 2010). Further, qualitative follow-up with members of the target

population could help explain any differences between gender, observation location, and previous injury exposure that are identified during future investigation. Such qualitative follow-up with intent to explain previous quantitative findings is a form of mixed methods research that is often used to help explain phenomena about which little is known (Creswell & Plano Clark, 2010). Such differences could also be explored by modifying the present TPB questionnaire to elicit responses in the context of several scenarios that differ by characteristics of the crossing environment.

Although behavioral intention is a necessary precursor to behavior, it is not a direct measure of actual behavior. Since the ultimate goal of a behavior change intervention is to influence actual behavior, exploring methods to measure behavior is an important area of future research. In early 2015, the maker of the popular iPhone smartphone, Apple, Inc. announced a project called ResearchKit. ResearchKit gives researchers the ability to collect data from iPhone users through the installation of a research application on the device (Apple Incorporated, 2015). Once the application is installed, consenting participants can be notified to complete follow-up questionnaires at regular intervals. Such measurement of actual behavior could take place daily for the duration of a study to limit participant recall issues. Such smartphone-based data collection has the potential to alleviate issues with attrition as well. A similar data collection framework, called ResearchStack, exists with the also popular Android mobile operating system common on many non-Apple smartphones (Haddad, 2016). For participants with incompatible devices or for those not consenting to complete study procedures on their device, an option to collect data through an online survey or in paper format should be available.

In future studies, use of structural equation modeling can be advantageous. Structural equation modeling enables testing of theory construct relationships simultaneously, rather than in

discreet steps. This is particularly useful when researchers wish to comprehensively evaluate a theory in the presence of behavioral data. In situations where such behavioral data are available, not only can structural equation modeling assess how TPB constructs predict intention, but assessment of how the theory predicts behavior is also possible.

### **Limitations**

Several important limitations are important to consider when interpreting results of the present study. Data related to the TPB were collected in the context of a very specific behavior and population (college students between 18 and 24 years of age, crossing the street on campus while using a mobile device in the next week). It is possible that responses to TPB constructs would be different with inquiry in the context of off-campus crossing locations or with inquiry that involves participants of a different age group. Though the highly specific operationalization of the behavior limits generalizability to broader populations, Francis et al. (2004) and Fishbein and Ajzen (2010) argue its necessity to increase predictive utility of questionnaires based on the TPB. Despite the limitations imposed on generalizability, the scope of the present study adheres to the recommendation that the TPB behavior of interest be narrowly defined (Francis et al., 2004). Another limitation to generalizability is inherent in the use of the convenience sampling employed in the present study. Given that not every member of the population had an equal chance of being selected, findings cannot be generalized beyond the participants sampled. Also noteworthy is the fact that no 18-year-old participants were successfully recruited during pilot testing. The absence of this demographic may have impacted pilot testing.

Some participants were recruited from courses within the Department of Health Science at the University of Alabama. Though courses such as Personal Health are requirements of several majors outside of the Department of Health Science, many courses from which

participants were recruited were majority health science majors at varying stages of their degree program. It is possible that the results of the present study were influenced by participants who were more cognizant of risk associated with various behaviors due to their academic background in health science. To limit the influence of coursework delivered during the semester in which the main TPB questionnaire was administered, all data collection was completed within four weeks of the semester start date. Courses outside of health sciences were also included in recruitment.

Though several documented pedestrian incidents take place outside of crosswalks, this investigation did not explore those crossing the street outside of crosswalks. Further, observations were delimited to daylight hours. While a number victims of documented fatal and nonfatal pedestrian injuries are under the influence of alcohol at the time of injury, questionnaire items did not ask about situations where respondents were under the influence of alcohol. It was assumed that those questioned and those observed were not under the influence of alcohol. Exploration of the aforementioned factors and their association with distracted pedestrian injuries was beyond the scope of the present investigation. The limitations discussed in this paragraph are similar to other observation studies with similar research questions (Scopatz & Zhou, 2016). Subsequently, the findings of this study are not explicitly generalizable beyond the study participants at the University of Alabama. Generalizability of findings to intoxicated pedestrians, pedestrians crossing at night, as well as those crossing outside of crosswalks is also limited.

Questionnaire responses involved self-reporting of information while participants were near each other and the researcher. Thus, it was possible that some participants felt inclined to respond in a way that was perceived to be socially acceptable instead of providing authentic

information. To reduce the potential for social desirability bias, participants were asked to not write their name on the questionnaire and to not share their answers. The researcher also assured participants that their responses would be kept confidential. Another limitation lies in the possibility that participants misinterpreted questionnaire items. Given that one purpose of this investigation was to create a novel questionnaire, the researcher employed a pilot test of the questionnaire before full-scale implementation. Pilot test participants were asked to provide feedback on clarity of instructions, clarity and readability of items, and questionnaire layout. Another limitation is borne out of the cross-sectional design of the present study. Since such a design is limited to conclusions based on data collected from a single point in time, it was impossible to infer causation between variables.

As with the application of any theory to a health behavior, there are also limitations inherent to the TPB. Although the TPB was successful in predicting intention to use a mobile device while crossing the street, the theory operates under the assumption that behavioral intention is the direct antecedent to actual behavior (Fishbein & Ajzen, 2010). Since many behaviors are difficult to measure directly, it can be difficult to test the predictive ability of behavioral intention in some situations (Barton et al., 2016). While evidence exists to support predictive power of the TPB (Ajzen, 2015; Sharma, 2017), the theory does not necessarily explain behavior change (Sharma, 2017). Follow-up investigation should focus on a greater understanding of contributors to the behavior. Further, the measurement of a person's perceived behavioral control may not be an accurate indicator of a person's actual behavioral control which can be affected by factors outside of an individual's perception (Sharma, 2017). Finally, the TPB assumes that all thoughts about a behavior are rational (Sharma, 2017). Despite these limitations, successful use of the theory in distracted pedestrian research and the need for more theory-based

health behavior research justified its use in the present study. To account for factors not considered by the TPB, it has also been suggested that future research focus on certain factors such as inhibitory control, sensation seeking, and the built environment (Barton et al., 2016).

The observation portion of the present study presents limitations. The cross-sectional nature of the observations made it difficult to determine whether a behavior exhibited by an observed participant was a behavior in which they engaged frequently or rarely. This introduced the possibility of a phenomenon known as *regression toward the mean*. For example, a person observed engaging in use of a mobile phone while crossing could have engaged in this behavior infrequently and could have had weak behavioral intention while another person observed crossing while not using a mobile phone could have engaged in this behavior very frequently and could have had strong behavioral intention. Despite this potential limitation, it was expected that any such extreme cases exerted relatively little influence given their dispersion amongst the large number of observed cases. Given that analyses of observational data in the present study relied on the researcher's judgement of whether participants appeared to be engaging in distracted mobile device use, there was a possibility of misclassification of pedestrian behavior in the present study. To address this limitation, both rater-interrater and intra-rater reliability analyses were performed to provide an indicator of protocol reliability. The researcher's determination of participant gender based on factors such as clothing, hairstyle, and body figure introduced the possibility for misclassification of gender. Although the observation locations differed by traffic control devices and traffic flow, the small sample of observation locations made it difficult to determine whether any differences between locations were due to these characteristics or whether other factors were at play. Widespread use of a standardized observation protocol would help to reduce the impact of these limitations.

Regarding the observation analyses, an important note should be made about the assumption that chi-square and logistic regression analyses be performed across independent samples. Since analyses were performed on crossing instances and not members of the population, it was possible that some of the same pedestrians could have been present at multiple observation locations; thus violating assumptions of independent samples to an undeterminable degree. Despite this limitation, observation studies with similar methods have deemed such analyses appropriate (Lawrence, 2015).

### **Conclusions**

The present study contributed to the literature by expanding understanding of the ability of the TPB to predict behavioral intention to use a mobile device while crossing the street; an important risk factor for pedestrian injury. The study also served to increase understanding of the incidence of distracted mobile device use while crossing the street. The results of this study bolster the need for further exploration in this emerging area of research.

In the present sample of undergraduate college students, all three TPB constructs were significant predictors of behavioral intention to cross the street on campus while using a mobile device in the next week. Attitude toward the behavior and subjective norm were the strongest predictors and should be prioritized based on results from the present study; though future studies should consider the context in which perceived behavioral control is measured (engaging in the behavior versus refraining). According to the TPB, all constructs are technically modifiable and the TPB questionnaire is useful not only in the design of interventions but can be used as a component of evaluation. Through observations, the present study also found that a sizeable proportion of pedestrians at the University of Alabama use a mobile device while crossing the street; a behavior that has been implicated as a risk factor for traffic-related injury.

Further, differences in distracted mobile device while crossing the street were found between gender as well as by observation location. College campuses have many desirable characteristics that make them a fitting venue for intervention.

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APPENDIX A

Copy of University of Alabama Institutional Review Board Approval Letter

August 22, 2016

Andrew Piazza  
Department of Health Sciences  
College of Human Environmental Sciences  
Box 870311

Re: IRB # 16-OR-287, "Investigating Pedestrian Behaviors in College Students"

Dear Mr. Piazza:

The University of Alabama Institutional Review Board has granted approval for your proposed research.

Your application has been given expedited approval according to 45 CFR part 46. You have also been granted the requested waiver of informed consent. Approval has been given under expedited review category 7 as outlined below:

*(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.*

Your application will expire on August 21, 2017. If your research will continue beyond this date, please complete the relevant portions of the IRB Renewal Application. If you wish to modify the application, please complete the Modification of an Approved Protocol form. Changes in this study cannot be initiated without IRB approval, except when necessary to eliminate apparent immediate hazards to participants. When the study closes, please complete the Request for Study Closure form.

Should you need to submit any further correspondence regarding this proposal, please include the above application number.

Good luck with your research.

Sincerely,



Carpantato T. Myles, MSM, CIM, CIP  
Director & Research Compliance Officer  
Office for Research Compliance  
The University of Alabama

APPENDIX B

Copy of University of Alabama Institutional Review Board Revisions Approval Letter

November 15, 2016

Andrew Piazza, M.S.  
Department of Health Sciences  
College of Human Environmental Sciences  
The University of Alabama  
Box 870311

Re: IRB # 16-OR-287 (Revision # 2) "Investigating Pedestrian Behaviors in College Students"

Dear Mr. Piazza:

The University of Alabama Institutional Review Board has reviewed the revision to your previously approved expedited protocol. The board has approved the change in your protocol.

Please remember that your approval period expires one year from the date of your original approval, August 22, 2016, not the date of this revision approval.

Should you need to submit any further correspondence regarding this proposal, please include the assigned IRB application number. Changes in this study cannot be initiated without IRB approval, except when necessary to eliminate apparent immediate hazards to participants.

Good luck with your research.

Sincerely,



Stuart Usdan, Ph.D.  
Chair, Non-Medical Institutional Review Board  
The University of Alabama

APPENDIX C

Copy of University of Alabama Application for Use of Campus Grounds Approval Letter

University Facilities  
Office of the  
Assistant Vice President



2/26/2017

Dear Mr. Andrew Piazza,

This letter is to inform you that your requested event, to be held on the various dates listed in your GUP, has been **approved**. Please make sure to have this form with you on site in the event that UAPD or UA official requests to see it for verification.

Please place a work order through the work order help desk by calling 348-6001 for any electrical needs, grounds requests such as trash cans and liners, ensuring irrigation systems have been turned off in the event area, or any other needs. Events/Parties that set up tents for their functions must remove them after the event has concluded. If a tent company has been contracted to set up a tent, it must be understood that tents may remain on campus no later than 10 a.m. the following day. As a reminder...please note: ***The collection of donations, funding or monies at outdoor campus events is not permissible for reasons of safety.*** If you have questions or concerns, please contact our office.

Regards,

Donna McCray  
*Director of Grounds Use Permits & Facilities Operations*

Justin Miles  
*Grounds Use Permit Coordinator*

Allie Wolfe  
*Office Associate II*

Facilities Complex  
1205 14th Street  
Box 870294  
Tuscaloosa, Alabama 35401-0294  
(205) 348-8092  
FAX (205) 348-0335

## APPENDIX D

### Expert Panel Profiles

<b>Name</b>	<b>Position/Affiliation</b>	<b>Email Address</b>	<b>Expertise</b>
Paul Branscum, Ph.D., R.D.	Assistant Professor, Department of Health and Exercise Science, University of Oklahoma	pbranscum@ou.edu	<ul style="list-style-type: none"> <li>• Theory/Instrument Development</li> </ul>
Hannah Catalano, Ph.D.	Assistant Professor, Department of Public Health Studies, University of North Carolina Wilmington	catalanoh@uncw.edu	<ul style="list-style-type: none"> <li>• Theory/Instrument Development</li> <li>• College Students</li> </ul>
Manoj Sharma, MBBS, Ph.D.	Professor, Department of Behavioral and Environmental Health, Jackson State University	manoj.sharma@jsums.edu	<ul style="list-style-type: none"> <li>• Theory/Instrument Development</li> <li>• College Students</li> </ul>
Michael Stellefson, Ph.D.	Assistant Professor and Associate Chair, Department of Health Education and Behavior, University of Florida	mstellefson@hhp.ufl.edu	<ul style="list-style-type: none"> <li>• Theory/Instrument Development</li> </ul>

APPENDIX E

Copy of Dr. Benjamin Barton Permission Email

## Re: TPB Questionnaire Request

1 message

**Andrew Piazza** <ajpiazza@crimson.ua.edu>  
To: "Dr. Benjamin Barton" <drbbarton@gmail.com>

Tue, Jun 28, 2016 at 3:37 PM

Thank you very much!

--

**Andrew Piazza, MS, MCHES, CSCS**

Doctoral Student / Graduate Assistant

Department of Health Science  
The University of Alabama  
462 Russell Hall  
Box 870311, Tuscaloosa, AL, 35487



On Tue, Jun 28, 2016 at 3:23 PM, Dr. Benjamin Barton <drbbarton@gmail.com> wrote:

Andrew,

Absolutely, you have my permission to use the questionnaire and modify it as necessary to fit your hypotheses.

Cheers,

Ben

On Tue, Jun 28, 2016 at 1:13 PM, Andrew Piazza <ajpiazza@crimson.ua.edu> wrote:

Dr. Barton,

I sincerely appreciate you taking the time out of your day to have a conversation with me. I enjoyed learning about your research and I value the advice you provided.

I would like to ask if you would be willing to let me use the Theory of Planned Behavior questionnaire for a component of my dissertation research as described in the article: Barton, Benjamin K., Susan M. Kologi, and Anne Siron. "Distracted pedestrians in crosswalks: An application of the Theory of Planned Behavior." *Transportation Research Part F: Psychology and Behaviour* 37 (2016): 129-37.

Should you grant permission, I may also wish to modify the questionnaire to fit the participant population and, thus, would like to see if that is acceptable.

Of course, I would cite the Barton, Kologi, and Siron (2016) article if allowed to use the questionnaire.

Thank you again for your time.

--

**Andrew Piazza, MS, MCHES, CSCS**

Doctoral Student / Graduate Assistant

Department of Health Science  
The University of Alabama  
462 Russell Hall  
Box 870311, Tuscaloosa, AL, 35487

## APPENDIX F

### Theory of Planned Behavior Scoring Guide

All TPB item scales are from 1 to 7. Questionnaire items are scored as follows:

**Attitude toward behavior** construct score is obtained by calculating the mean of the item scores for items 3 through 9. Possible raw subscale scores range from 7 to 49.

**Subjective norm** construct score is obtained by calculating the mean of the item scores for items 10 through 16. Possible raw subscale scores range from 7 to 49.

**Perceived behavioral control** construct score is obtained by first reverse-coding items 17, 18, and 20, then calculating the mean of the item scores for items 17 through 20. Possible raw subscale scores range from 4 to 28.

**Behavioral intention** construct score is obtained calculating the mean of the item scores for items 21 through 23. Possible raw subscale scores range from 3 to 21.

**Inclusion criteria:** To ensure that each participant has the potential to engage in the behavior of interest, potential participants are screened for inclusion using 4 unnumbered items on page 1. These responses are not scored.

**Demographic items:** Items 1, 2, and 24 through 30 are for demographic and descriptive purposes and are not scored.

## APPENDIX G

### Full Theory of Planned Behavior Questionnaire

## College Student Pedestrian Behaviors Survey

Are you currently an undergraduate student at The University of Alabama?

- Yes  
 No

Are you on campus at least once per week?

- Yes  
 No

If yes, do you cross the street on foot or using an assistive device (e.g., wheelchair, walker, crutches) at least once when you are on campus?

- Yes  
 No

Do you use a mobile device (such as an iPod, iPhone, Android Phone, MP3 player, or a basic "flip phone") that allows you to do at least one of the following?

- Send or receive text messages or email messages
- Display content from the internet (such as a web page or email attachment)
- Access content using mobile apps including but not limited to Blackboard, Snapchat, Facebook, Instagram, Twitter, or Yik Yak
- Place or receive voice or video calls (whether to your ear or through headphones/Bluetooth/speakerphone)

- Yes  
 No

If you answered "Yes" to ALL of the questions above, please take the rest of this survey.

If you answered "No" to ANY of the questions above, please STOP and DO NOT take this survey. Thank you for your time!

For this survey, “*using a mobile device*” is defined as doing **any** of the following on a mobile device (such as an iPod, iPhone, Android Phone, MP3 player, or a basic “flip phone”):

- Sending or viewing text messages or email messages
- Viewing content from the internet (such as a web page or email attachment)
- Viewing content using mobile apps including but not limited to Blackboard, Snapchat, Facebook, Instagram, Twitter, or Yik Yak
- Being on a phone or video call (whether to your ear or through headphones/Bluetooth/speakerphone)

**1. On a typical day, how much do you use your mobile device?**

- Not at all
- between 1 and 29 minutes per day
- between 30 and 59 minutes per day
- between 1 hour and 1 hour 59 minutes per day
- between 2 hours and 2 hours 59 minutes per day
- between 3 hours and 3 hours 59 minutes per day
- between 4 hours and 4 hours 59 minutes per day
- between 5 hours and 5 hours 59 minutes per day
- between 6 hours and 6 hours 59 minutes per day
- between 7 hours and 7 hours 59 minutes per day
- 8 hours or more per day

**2. During the past week, how often have you crossed the street on campus while using a mobile device? (choose ONE response)**

- Nearly every time I crossed the street on campus
- More than half, but not quite all, of the times that I crossed the street on campus
- About half of the times that I crossed the street on campus
- Less than half of the times that I crossed the street on campus
- Almost never when I crossed the street on campus
- Never when I crossed the street on campus

**Instructions for items 3 – 23:** These items make use of a 7-point rating scale. For each question, please choose **ONLY ONE** response along the 7-point scale that best describes your opinion. Some of the questions may appear to be similar, but they are asking about different issues. Please read each question carefully.

**Use the following statement for numbers 3 – 9:**

**For me to use a mobile device on campus while crossing the street in the next week would be**

3. extremely useless : 1 : 2 : 3 : 4 : 5 : 6 : 7 : extremely useful

4. extremely unnecessary : 1 : 2 : 3 : 4 : 5 : 6 : 7 : extremely necessary

5. extremely impractical : 1 : 2 : 3 : 4 : 5 : 6 : 7 : extremely practical

6. extremely unsafe : 1 : 2 : 3 : 4 : 5 : 6 : 7 : extremely safe

7. extremely unsatisfying : 1 : 2 : 3 : 4 : 5 : 6 : 7 : extremely satisfying

8. extremely boring : 1 : 2 : 3 : 4 : 5 : 6 : 7 : extremely fun

9. extremely bad : 1 : 2 : 3 : 4 : 5 : 6 : 7 : extremely good

**10. My friends think it would be acceptable to cross the street on campus while using a mobile device during the next week.**

strongly disagree : 1 : 2 : 3 : 4 : 5 : 6 : 7 : strongly agree

**11. My parent(s) or legal guardian(s) think it would be acceptable to cross the street on campus while using a mobile device during the next week.**

strongly disagree : 1 : 2 : 3 : 4 : 5 : 6 : 7 : strongly agree

**12. University officials think it would be acceptable to cross the street on campus while using a mobile device during the next week.**

strongly disagree : 1 : 2 : 3 : 4 : 5 : 6 : 7 : strongly agree

**13. Motorists think it would be acceptable to cross the street on campus while using a mobile device during the next week.**

strongly disagree : 1 : 2 : 3 : 4 : 5 : 6 : 7 : strongly agree

**14. Other pedestrians think it would be acceptable to cross the street on campus while using a mobile device during the next week.**

strongly disagree : 1 : 2 : 3 : 4 : 5 : 6 : 7 : strongly agree

**Continue to next page →**

**15. Most people like me will cross the street on campus while using a mobile device during the next week.**

strongly disagree :   1   :   2   :   3   :   4   :   5   :   6   :   7   : strongly agree

**16. How many people similar to you will cross the street on campus while using a mobile device during the next week?**

none :   1   :   2   :   3   :   4   :   5   :   6   :   7   : all

**17. I am confident that I could cross the street on campus without using a mobile device during the next week.**

strongly disagree :   1   :   2   :   3   :   4   :   5   :   6   :   7   : strongly agree

**18. It would be easy for me to cross the street on campus without using a mobile device during the next week.**

strongly disagree :   1   :   2   :   3   :   4   :   5   :   6   :   7   : strongly agree

**19. The decision to cross the street on campus without using a mobile device during the next week is beyond my control.**

strongly disagree :   1   :   2   :   3   :   4   :   5   :   6   :   7   : strongly agree

**20. I have complete control over whether I cross the street on campus without using a mobile device during the next week.**

strongly disagree :   1   :   2   :   3   :   4   :   5   :   6   :   7   : strongly agree

**21. In the next week, I intend to cross the street on campus while using a mobile device.**

strongly disagree :   1   :   2   :   3   :   4   :   5   :   6   :   7   : strongly agree

**22. In the next week, I plan to cross the street on campus while using a mobile device.**

strongly disagree :   1   :   2   :   3   :   4   :   5   :   6   :   7   : strongly agree

**23. In the next week, I expect to cross the street on campus while using a mobile device.**

strongly disagree :   1   :   2   :   3   :   4   :   5   :   6   :   7   : strongly agree

Continue to next page →

**24. Please choose the statement or statements that best fit you. (choose all that apply)**

- As a *pedestrian*, I have had a close call with a vehicle where I was almost hit.
- As a *pedestrian*, I have been hit by a vehicle.
- I know a *pedestrian* who has been hit by a vehicle.
- As a *driver*, I have had a close call where I almost hit a pedestrian.
- As a *driver*, I have hit a pedestrian.
- I know a *driver* who has hit a pedestrian.
- None of the above statements fit me.

**25. Do you live on campus?**

- Yes  No

**26. What is your age? \_\_\_\_\_ years**

**27. What is your current year in school?**

- First year  Second year  Third year  Fourth year  Other: \_\_\_\_\_

**28. What is your gender?**

- Male  Female  Transgender  Prefer not to answer

**29. What is your ethnicity?**

- Hispanic or Latino  Not Hispanic or Latino

**30. What is your race? (choose all that apply)**

- White  Black or African American  American Indian or Alaska Native
- Asian  Native Hawaiian or Other Pacific Islander  Prefer not to answer
- Other: \_\_\_\_\_

**END OF SURVEY**

**YOU MAY NOW TURN IN YOUR SURVEY  
THANK YOU FOR YOUR TIME!**

## APPENDIX H

### Pilot Test Feedback Form

Are the directions clear and concise?

Yes

No

If not, what are some alternatives or suggestions?

Are the questions easy to understand?

Yes

No

If not, which questions were difficult to understand? Please provide suggestions for improvement.

Is the layout clear and easy to use for answering the questions?

Yes

No

If not, what are some suggestions for improvement?

If you have any additional comments about the questionnaire, please provide them below:

## APPENDIX I

### Instructor Pilot Test Recruitment Email

[Instructor Name],

My name is Andrew Piazza and I am a doctoral student at the University of Alabama in the Department of Health Science. As part of my dissertation research, I am seeking students to pilot test a questionnaire that asks about college students' street-crossing behavior on campus. I am asking for your help to kindly allow me visit your class to administer the questionnaire and a feedback form that will ask students for their feedback on the questionnaire. This process is estimated to take 10-15 minutes to complete. To prevent any student feelings of coercion, the instructor will be asked to leave the room during the questionnaire process. If you are able and willing to assist, please let me know a good day and time to visit your class.

Thank you for your time!

## APPENDIX J

### Student Pilot Test Recruitment Script

Hello. My name is Andrew Piazza and I am affiliated with the Department of Health Science at the University of Alabama. I am conducting a study on college students and how they make decisions about how to cross the street. You must be at least 18 years old to participate. If you are interested in participating, you will be asked to fill out a survey during class that will ask about how you cross the street. After you complete the survey, you will be asked to write any feedback that you have about the survey to make sure it is appropriate for college students. The survey should take about 10 to 15 minutes to complete. Your participation is completely voluntary meaning that you do not have to participate. If you choose to participate you can later choose to stop at any time with no penalty to you.

I will now hand out an information sheet, the survey, and a feedback form. After reviewing the information sheet, if you choose to not participate, you may sit quietly at your desk and hand in your blank survey and feedback form as they are collected from everyone else. Thank you for your time!

## APPENDIX K

### Instructor Test-Retest Recruitment Email

[Instructor Name],

My name is Andrew Piazza and I am a doctoral student at the University of Alabama in the Department of Health Science. As part of my dissertation research, I am seeking students to complete a 30-item questionnaire at two different times. I am asking for your help to kindly allow me visit your class to administer the questionnaire once, and then repeat the process a second time one to two weeks later. This will help me assess the test-retest reliability of the questionnaire. The questionnaire is estimated to take 10-15 minutes to complete. To prevent any student feelings of coercion, the instructor will be asked to leave the room during the questionnaire process. If you are able and willing to assist, please let me know a good day and time to visit your class. I can be available as early as the first day of class.

Thank you for your time!

## APPENDIX L

### Student Test-Retest Recruitment Script

Hello. My name is Andrew Piazza and I am affiliated with the Department of Health Science at the University of Alabama. I am conducting a study on college students and how they make decisions about how to cross the street. You must be at least 18 years old to participate. If you are interested in participating today, you will be asked to fill out a survey during class that will ask about how you cross the street. After you take the survey today, I plan to come back to your class in about two weeks and ask you to take the survey one more time. Both surveys should take about 10 to 15 minutes to complete. Your participation is completely voluntary meaning that you do not have to participate. If you choose to participate you can later choose to stop at any time with no penalty to you.

I will now hand out an information sheet and the survey. After reviewing the information sheet, if you choose to not participate, you may sit quietly at your desk and hand in your blank survey as the other surveys are collected. Thank you for your time!

## APPENDIX M

### Main Questionnaire Instructor Recruitment Email

[Instructor Name],

My name is Andrew Piazza and I am a doctoral student at the University of Alabama in the Department of Health Science. As part of my dissertation research, I am seeking students to complete a 30-item questionnaire that asks about college students' street-crossing behavior on campus. I am asking for your help to kindly allow me visit your class (XYZ123.000 held on MTWRF 12:00PM – 1:00PM) to administer the questionnaire. The questionnaire is estimated to take 10-15 minutes to complete. To prevent any student feelings of coercion, the instructor will be asked to leave the room during the questionnaire process. If you are able and willing to assist, please let me know a good day and time to visit your class. I can be available as early as the first day of class.

Thank you for your time!

## APPENDIX N

### Main Questionnaire Student Recruitment Script

Hello. My name is Andrew Piazza and I am affiliated with the Department of Health Science at the University of Alabama. I am conducting a study on college students and how they make decisions about how to cross the street. You must be at least 18 years old to participate. If you are interested in participating, you will be asked to fill out a survey during class that will ask about how you cross the street. You will only be asked to take this survey one time. The survey should take about 10 to 15 minutes to complete. Your participation is completely voluntary meaning that you do not have to participate. If you choose to participate you can later choose to stop at any time with no penalty to you.

I will now hand out an information sheet and the survey. After reviewing the information sheet, if you choose to not participate, you may sit quietly at your desk and hand in your blank survey as the other surveys are collected. Thank you for your time!