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Study of Distracted Pedestrians' Behavior when using Crosswalks

Dean Patrick Harrison

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By

Dean Harrison

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By

Dean Harrison

Approved:

Lesley Strawderman
(Major Professor)

Stanley F. Bullington
(Committee Member/Graduate Coordinator)

Reuben F. Burch V
(Committee Member)

Jason M. Keith
Dean
Bagley College of Engineering

Name: Dean Harrison

Date of Degree: May 5, 2017

Institution: Mississippi State University

Major Field: Industrial Engineering

Major Professor: Dr. Lesley Strawderman

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Candidate for Degree of Master of Science

The dangers of using a cell phone while driving are well documented, but recently studies have aimed at determining the effect cell phones have on a pedestrians' walking behaviors. This observational experiment captured video footage of distracted pedestrians, or pedestrians using cell phones, when using two different crosswalks (midblock and intersection) on the campus of Mississippi State University in order to study safety behaviors, such as speed, number of looks, and wait time. Two types of crosswalks were filmed until a sufficient number of pedestrians (N=982) were recorded. All variables (cell phone use, gender, type of crosswalk, presence of car, time of day, and density) significantly influenced speed and number of looks. Gender, type of crosswalk and presence of car all showed significant effects on wait time of pedestrians. Pedestrians observed using earphones were observed to look more and to walk slower than any other level of cell phone use.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The influence technology has on our daily lives is astounding, especially when considering that 92% of U.S. adults have a cell phone or a smartphone (Anderson, 2015). Millennials, or people ranging from 18 to 34, are more dependent on their cell phones than any other age group. In a survey conducted by USA Today, almost 90% of millennials indicated they always keep their phone by their side (Kiplinger, 2016). Due to the incredibly fast development of these smartphones, our dependence on them will only increase, possibly to a dangerous level. According to a report from the Governor's Highway Safety Association, 54% of adult cell phone users claim to having been bumped into by a person who was distracted by their cell phone (Governors' Highway Safety Association 14-18). Additionally, the same report found that 51% of the millennial age group admits to having bumped into something or someone while using their cellphone.

While the dangers of using a cell phone when driving have been extensively researched and laws now exist prohibiting its practice, cell phone use while walking lacks attention. Research has shown that cell phone use (e.g. texting, talking on the phone) affects pedestrians' abilities to respond to external stimuli in much the same ways as drivers. The distraction generated by cell phone use can cause pedestrians to perform unsafe behaviors while on the crosswalk of a busy intersection or in an area where there is a chance for vehicle-pedestrian interactions. Several observational studies have found that when pedestrians use a cell phone they walk slower (Hatfield, 2007), recall fewer objects when conversing (Nasar, 2008), and are generally more unsafe when crossing a street (Nasar, 2008).

Of the 2,910 fatal crashes attributed to distraction that were reported in the USA in 2010, 12% of those killed were pedestrians (GHSA, 14). “Researchers at The Ohio State University found that between 2004 and 2010, the number of pedestrians killed while using a cell phone increased from less than 1% to 3.6% of the total 11% of motor deaths attributed to pedestrians (Nasar and Troyer as cited in Alan M. Voorhees Transportation Center, 2014)” (GHSA, 15). The study also showed that the number of pedestrians who were injured because of distraction by a cell phone has doubled since 2005. There have been numerous studies conducted over many years to determine the exact number of pedestrian deaths which are caused by their own distraction. Currently, the statistics of pedestrian deaths which occur on crosswalks make no distinction between the types of crosswalks (signalized intersection, unsignalized intersection, signalized midblock crossing, and unsignalized midblock crossing, etc.). There has been little research studying how distracted pedestrians behave when using these different types of street crossings. This research makes an attempt to determine whether pedestrians engage in more or less safety actions such as looking for traffic or waiting for cars to pass or increasing their speed, when using different crossings while using their phones.

CHAPTER II

LITERATURE REVIEW

Research shows that the usage of a cell phone distracts us in a variety of ways including our cognitive, auditory, physical, and visual response types (Lamble et al., 1999). Using a semi-immersive virtual environment, Neider et al. (2010) found that pedestrians conversing on a cell phone took longer to initiate crossing the street; however, these distracted pedestrians were found to be less likely to successfully cross the street. In a similar experiment, Stavrinos et al. (2011), found that pedestrians' attention to traffic was affected by cognitively-demanding conversation over the phone. The researchers concluded that although the participants made the appropriate "safe" actions (e.g. stopping at curb, looking right to left) before attempting to cross, they may have failed to accurately capture and/or process the critical information needed to cross the street.

In addition to affecting a pedestrian's attention to oncoming traffic, being distracted by a cell phone can have an effect on how they walk. A person's gait, or manner of walking, is no longer viewed as an autonomous motor activity but one that involves a great deal of brain function. Research shows that alterations in executive function, or higher cognitive processes, and attention are linked to a number of gait disturbances. Yogev states that, "Executive function includes brain activities that are necessary for effective, goal-directed actions and for the control of attentional resources which are at the basis of the ability to manage independent activities of daily living (pg. 2).” It is easy to see that actions which require any type of mental energy would lead to an irregularity in a person’s stride length, walking speed, or direction (Yogev et al, 2008). This disruption in a pedestrian’s stride could lead them into dangerous situations with oncoming traffic.

At the heart of this issue lies a common misunderstanding that humans are capable of performing multiple tasks simultaneously or “multitasking”. While most people define multitasking as engaging in two or more activities at the same time, a more research-based definition states that multitasking is performing multiple tasks sequentially and in quick succession. The switching between activities when multitasking requires a change in an individual’s attention and focus (Delbridge, pp 1-10). Delbridge (2001) calls this “attention switching” and notes that when an individual attempts to perform two tasks at the same time, the individual’s performance of each task takes on an inverse relationship. As one task is performed well, the other is left to fall by the wayside. In the case of a pedestrian crossing the street, the task left by the wayside could be looking up to see an oncoming car or walking fast enough to avoid being hit by a vehicle.

Observational studies have been performed before to determine the frequency of distracted walking at intersections (Zegeer et al. 2002; Marisamynathan and Vedagiri, 2015; Littleton and Cotton, 2013; Kotz, 2012; O’Brien, 2015). The majority of distracted pedestrian behavior research has been aimed at determining pedestrian behavior at signalized versus unsignalized crossings and doesn’t look at differences between types of crosswalks.

A crosswalk can take many forms and there are countless types and styles of crosswalks constructed. Some may include signs, lighted traffic signals, road markings, or even speed tables. However, in the United States, a crosswalk can exist even with the absence of any or all of these precautionary warning signs. The Manual on Uniform Traffic Control Devices (MUTCD), which sets the standards for all U.S. traffic signs and signals, road service markings, etc., defines a crosswalk as:

> *(a) That part of a roadway at an intersection included within the connections of the lateral lines of the sidewalks on opposite sides of the highway measured from the curbs or in the absence of curbs, from the edges of the traversable roadway, and in the absence of a sidewalk on one side of the roadway, the part of a roadway included within the extension of the lateral lines of the sidewalk at right angles to the center line.*
>
> *(b) Any portion of a roadway at an intersection or elsewhere distinctly indicated as a pedestrian crossing by pavement marking lines on the surface, which might be supplemented by contrasting pavement texture, style, or color* .(pg. 13)

Using this rather imprecise definition, crosswalks across the country are being designed that may or may not be adequately marked to best ensure pedestrian safety.

Hatfield & Murphy (2007), conducted an observational study to view the effect of mobile phone use on pedestrians when crossing intersections. They found that crossing behaviors differed between distracted men and women when using intersections. They found that men talking on the phone walked significantly more slowly than the no-phone control group and women walked approximately the same. This study, however, only considered differences in behavior at signalized intersections and unsignalized intersections.

To date there has been no indication that the behavior of pedestrians at intersection crossings differ from midblock crossings. Observational studies performed by Kotz (2012) & Littleton et al. (2005) were performed on the campuses of the University of Georgia and the University of Washington, respectively. Kotz observed that approximately 33% of the pedestrians crossing the intersections were distracted and Littleton and Cotton observed that about half of the pedestrians were engaged in some sort of distracting activity. Both studies concluded that the pedestrians involved in the distracting activity took approximately one to two seconds longer to cross the street and were more likely to engage in unsafe behavior (i.e. ignoring the walk light, not looking both ways). Kuan-min et al., 2012 and Qi & Yuan, 2012 learned from their studies that pedestrians are facing interactions with vehicle movement because of pedestrian crossing speed variations and also pedestrians may encounter greater risk and conflict when they cross intersections in groups.

A controversial topic in the United States is whether the addition of marked crosswalks increase or decrease pedestrian safety at crossing locations which are not marked by a traffic signal or stop sign. Some pedestrians view the marked crossings to enhance pedestrian safety, but it seems that just as many are unsure of the legal obligations for the driver of vehicles when it comes to these marked crossings. This confusion’s problem is two-fold: these people don’t know what to do when they are driving a vehicle or when they are the pedestrian crossing the street. The research on the topic is just as difficult to interpret. Many researchers have found that the presence of markings increase the rate of crashes(Herms, 1972; LA County Road Department, 1967; Gurnett, 1974; Ekman, 1996) while just as many found the opposite to be true(Gibby, 1994; Tobey et al, 1983). One caveat to the interpretation of this data is that marked crosswalks experience more pedestrian volume than unmarked crosswalks (Herms, 1972; Knoblauch et al., 1999). In one study performed by Knoblauch et al. (1999), they observed an intersection before and after a crosswalk was marked where pedestrian scanning behavior (before stepping out into the street) actually increased. This seems to contradict a widely-held belief that marked crosswalks made pedestrians more careless. When Herms (1972) found a similar result he was quick to state, "Evidence indicates that the poor crash record of marked crosswalks is not due to the crosswalk being marked as much as it is a reflection on the pedestrian's attitude and lack of caution when using the marked crosswalk. (pg. 1)"

To date no researchers have made an attempt to study the differences in distracted pedestrian behavior across the multiple types of road crossings. The only efforts made have been to study distracted pedestrian behavior and safety on signalized and unsignalized crossings. It is hypothesized that a significant difference in behavior will be observed between distracted pedestrians and non-distracted pedestrians, with distracted pedestrians behaving in a less safe manner. Additionally, a significant difference in crossing behavior will be observed based on type of unsignalized crossing, with pedestrians at midblock crossings demonstrating more safe behaviors.

CHAPTER III

METHODS

Experimental Design

This study's main purpose was to determine if distracted pedestrians exhibit significantly different safety behaviors while crossing the street using crosswalks, such as increasing the number of times looking for traffic or pausing before entering the street. The areas observed were a midblock crossing and an intersection crossing on Mississippi State University's campus. Both crosswalks were not signalized but did have marked lines and reflectors on the ground. Specific cases of cell phone usage were studied to determine how they may affect pedestrians' safety behavior. The cases studied were pedestrians holding a cell phone in their hand (phone-in-hand), pedestrians talking on the phone to their ear (phone-to-ear), and pedestrians using earphones with their phone (phone-to-earbuds). The Phone-in-Hand subgroup included both pedestrians holding a cell phone by their side and pedestrians actively engaged in typing. Video footage was taken in order to not miss any pedestrians because of heavy volume. The data collection sheet used to record the data from the videos is shown below in Figure 3.1.

Data Collection Sheet										
Ped. ID Number	Video Name	Enter Street Time	Description	Location	Cell Phone Use	Gender	Duration to cross street	Number of times looking for traffic	Car Present?	Comments

Figure 3.1 Data Collection Sheet

Variables

The independent variables chosen for this study are type of cell phone use (phone-in-hand, phone-to-ear, phone-to-earbuds, no phone), type of crosswalk (intersection and midblock), presence of car (car approaching, car waiting, or none), gender (male or female), density (2-5 seconds between ped.[High density], 5-20 sec. between ped.[Medium density], or > 20 sec. between peds[Low density]), and time of day (before 9:30 and after 9:30). The dependent variables are duration to cross the street, number of times looking for traffic, and time spent waiting for traffic. All variables were collected directly from reviewing the video and no information was collected while recording. In addition to recording all data for variables the observer took note of all traffic incidents, such as near misses or traffic accidents. Pedestrians who are walking with a pet, child, or pushing a device (e.g. stroller, cart, and bicycle) were excluded from this study. Persons on wheeled vehicles (e.g. skateboard, bicycle, skates) were also excluded. Only pedestrians crossing alone were considered in this study to avoid collecting data that may have been affected because of a 'group safety' effect, which is outside the scope of this research. The dependent variables were measured as follows:

Speed in crossing the street (Speed) – The timing of this variable was begun when the pedestrian took their first step onto the street and was ended once the pedestrian took their last step off of the street. This time was then divided by the length of each crosswalk. Any time spent on the side observing the road was not included in this variable. Also, if any pedestrian walked outside of the crosswalk borders, this was noted and their times were excluded from this variable. However, all data for other variables was included.

Number of times looking for traffic (Number of Looks) – This variable counted the total number of times the pedestrian looks left or right for oncoming traffic. A 'look' was defined as a clear turn of the head for the purpose of looking for traffic. However, if a pedestrian looked in one direction for an extended time while they were crossing the street, this was counted only once. The observer began collecting data for this variable when the pedestrian was approximately fifteen feet from entering the street area of the crosswalk to account for any and all preemptive safety behaviors.

Time spent waiting for traffic (Wait Time) – This variable measured how much time each pedestrian spent at the entrance of the crosswalk waiting to cross the street. It was measured from the moment the pedestrian stopped at the entrance of the crosswalk and was ended the moment they entered the crosswalk. A pedestrian simply slowing down before entering the crosswalk in order to avoid traffic was not considered a part of this variable and was not measured.

Participants

The participants of this study were the pedestrians who used the areas of interest during the time of video collection. The majority of participants were college students appearing to be between the ages of 18 and 25. IRB approval was obtained prior to data collection.

Protocol

This observational study was conducted on two different types of intersections on the campus of Mississippi State University. The first type of crosswalk observed was an unsignalized intersection.   Below in Figure 3.2, the intersection crosswalk is shown.

Figure 3.2 Intersection Crosswalk

In order to keep the data collection simple, only one crosswalk was studied at a time. Therefore, when the video was taken of the intersection chosen for data collection, the camera was positioned in a location which had the best view of a single crosswalk and the other two intersections were not considered.

The second type of crosswalk observed was a midblock crosswalk. Several options were considered for this study and the best option was selected and can be seen below in Figure 3.3.

Figure 3.3 Midblock Crosswalk

The only crosswalks considered for this study were located on two-lane, two-way streets in order to maintain consistency between the two types of crosswalks and to make the data much more comparable. All crosswalks were recorded at approximately the same time, 7:45 a.m. to 11:30 a.m. These are historically busy times on MSU's campus between classes on Monday through Thursday. Video was collected until 984 pedestrians had been recorded using each type of crosswalk. The camcorder used to record video was a HC-V750 Panosonic with a 29.5 mm lens.

Once video was recorded, the data from each pedestrian was assigned an ID number (Ped ID) and a brief description of their clothing for later identification, to which their individual behaviors will be attributed. Upon completion of the video collection, crossing behavior for 451 pedestrians using the midblock crossing and 533 pedestrians using the intersection was recorded (total sample size n=984). After this data was coded in Excel according to a coding key (see Table 3.2 below), it was imported into SPSS v. 24. Before descriptive statistics were calculated box plots were formed for all independent variables. Two outliers were identified and removed from the data set. The remaining 982 pedestrians were used to find overall descriptive statistics and each variables' respective minimum, maximum, mean, and standard deviation using SPSS. A series of inferential tests were performed using Chi-Square comparisons for the discrete variables and Analysis of Variance (ANOVA) for all continuous variables. For all significant continuous variables, Tukey's test was performed to determine which levels showed significance. Next, multivariate tests were performed to look for any interactions between variables.

Table 3.2 Coding key for SPSS

Independent Variables	Level	Code
Cell Phone Use		
	None	1
	Phone to Ear	2
	Phone in Hand	3
	Ear Phones	4
Type of Crosswalk		
	Midblock	1
	Intersection	2
Presence of Car		
	None	1
	Approaching	2
	Waiting	3
Gender		
	Male	1
	Female	2
Time of Day		
	7:45 – 9:30	1
	9:31 – 11:45	2
Density		
	High Density	1
	Medium Density	2
	Low Density	3

CHAPTER IV

RESULTS

Descriptive Statistics

The following descriptive statistics shown below in Tables 4.1, 4.2, and 4.3 were calculated. The maximum and minimum speed seen at either crosswalk were 2.60 m/s and 0.59 m/s, respectively. The average speed of all pedestrians that used both crosswalks was 1.29 m/s. The average wait time of the pedestrians using the crosswalks was 0.36 seconds. This may be slightly misleading because a large majority of pedestrians (n=861) did not wait at all before crossing the street. The longest any pedestrian waited before stepping into the crosswalk was 9.91 seconds. The maximum and minimum number of looks seen at both crosswalks was 0 and 7. However, due to the small number of pedestrians (n=12) that demonstrated more than 4 looks, all pedestrians that took 4 or more looks were coded as 4 looks. There were 1 47 pedestrians who looked for traffic fewer than two times before entering the roadway. These pedestrians can be categorized as "unsafe", because they entered the crosswalks with abandon without looking both ways. The remaining 835 pedestrians looked two or more times exhibiting a "safe" behavior. Approximately 45 percent of the pedestrians included in this experiment were considered "distracted", meaning they were engaged in some type of interaction with a cell phone device.

Table 4.1 Speed Descriptive Statistics

Speed (m/s)						
		Min	Max	Mean	SD	N
Overall Descriptive Statistics		0.59	2.60	1.29	0.45	982
Cell Phone Use	None	0.67	2.42	1.33	0.46	438
	Phone to Ear	0.73	2.21	1.22	0.41	70
	Phone in Hand	0.59	2.59	1.26	0.45	402
	Ear Phones	0.73	2.28	1.18	0.39	72
Type of Crosswalk	Midblock	1.09	2.59	1.73	0.24	450
	Intersection	0.59	1.57	0.91	0.11	532
Presence of Car	None	0.59	2.30	1.23	0.42	382
	Approaching	0.70	2.31	1.39	0.45	416
	Waiting	0.67	2.59	1.19	0.45	184
Gender	Male	0.65	2.59	1.38	0.46	505
	Female	0.59	2.27	1.19	0.41	477
Density	High Density	0.68	2.31	1.36	0.47	314
	Medium Density	0.59	2.60	1.25	0.45	332
	Low Density	0.65	2.30	1.26	0.42	336
Time of Day	Before 9:30	0.59	2.42	1.26	0.47	616
	After 9:30	0.64	2.60	1.33	0.41	366

Table 4.2 Wait-Time Descriptive Statistics

Wait Time (sec)						
		Min	Max	Mean	SD	N
Overall Descriptive Statistics		0.00	9.91	0.36	1.12	982
Cell Phone Use	None	0.00	8.30	0.38	1.11	438
	Phone to Ear	0.00	5.30	0.24	0.88	70
	Phone in Hand	0.00	8.12	0.34	1.08	402
	Ear Phones	0.00	9.91	0.43	1.54	72
Type of Crosswalk	Midblock	0.00	8.30	0.61	1.38	450
	Intersection	0.00	9.91	0.15	0.77	532
Presence of Car	None	0.00	3.82	0.01	0.20	382
	Approaching	0.00	9.91	0.81	1.58	416
	Waiting	0.00	3.05	0.06	0.37	184
Gender	Male	0.00	9.91	0.43	1.24	505
	Female	0.00	7.57	0.28	0.96	477
Density	High Density	0.00	9.91	0.33	1.10	314
	Medium Density	0.00	6.42	0.35	1.01	332
	Low Density	0.00	8.30	0.40	1.23	336
Time of Day	Before 9:30	0.00	9.91	0.36	1.16	616
	After 9:30	0.00	7.57	0.35	1.04	366

Table 4.3 Number-of-Looks Descriptive Statistics

Number of Looks						
		Min	Max	Mean	SD	N
Overall Descriptive Statistics		0	4	2.23	0.78	982
Cell Phone Use	None	1	4	2.28	0.74	438
	Phone to Ear	0	4	2.27	0.83	70
	Phone in Hand	0	4	2.09	0.73	402
	Ear Phones	1	4	3.08	0.83	72
Type of Crosswalk	Midblock	0	4	2.37	0.96	450
	Intersection	0	4	2.16	0.72	532
Presence of Car	None	0	4	2.18	0.82	382
	Approaching	0	4	2.46	0.90	416
	Waiting	0	4	2.01	0.68	184
Gender	Male	0	4	2.32	0.91	505
	Female	0	4	2.19	0.77	477
Density	High Density	0	4	2.16	0.76	314
	Medium Density	0	4	2.17	0.75	332
	Low Density	0	4	2.36	0.81	336
Time of Day	Before 9:30	0	4	2.25	0.78	616
	After 9:30	0	4	2.20	0.78	366

Speed

The results of the data analysis revealed many significant interactions between the independent and dependent variables. Specifically, the ANOVA tests performed to analyze each independent variable's influence on speed found all to be significant. A summary of these findings, along with the Tukey's test result for post hoc analysis is shown below in Table 4.4.

Table 4.4 Results of Speed Inferential Tests

Speed			
Independent Variable	F Value	*p* value	Result of Tests
Cell Phone Use	F(3, 978) = 3.918	0.009	Earphones < None
Gender	F(1, 980) = 47.14	< 0.001	Female < Male
Type of Crosswalk	F(1, 980) = 4946.86	< 0.001	Intersection < Midblock
Presence of Car	F(2, 979) = 18.744	< 0.001	Car Waiting and None < Car Approaching
Density	F(2, 979) = 5.817	0.003	Low and Medium density < High density
Time of Day	F(1, 980) = 4.494	0.034	Before 9:30 < After 9:30

The density or closeness of pedestrians using each crosswalk and time of day were investigated upon completion of the initial data analysis to determine its effect on the independent variables. The results of the Tukey's Test on the Density subgroups indicated the Low-density category walked significantly faster than the other two categories, which had very little difference between them. For time of day, it was found that pedestrians walking later in the morning were significantly faster than the ones walking earlier in the morning. However, a large proportion of the pedestrians that were walking later in the morning were from the Midblock crosswalk. Therefore, to say that all pedestrians increase walking speed as the day goes on would be misleading.

Wait Time

A summary of the ANOVA conducted for the dependent variable, Wait Time, along with the Tukey's test result for post hoc analysis is shown below in Table 4.5. The first variable found to significantly affect wait time was Gender. The 'Male' subgroup waited significantly longer on average than the 'Female' group. Pedestrians were shown to wait longer at the 'Midblock' crosswalk. Finally, Tukey's test indicated that the pedestrians categorized as interacting with the 'Car Approaching' subgroup waited significantly longer on average than the other Presence-of-Car levels. No other independent variables were found to show any significant effect on a pedestrian's wait time.

Table 4.5 Results of Wait-Time Inferential Tests

Wait Time			
Independent Variable	F Value	*p* value	Result of Tests
Cell Phone Use	F(3, 978) = .456	0.713	N/A
Gender	F(1, 980) = 4.633	0.032	Female < Male
Type of Crosswalk	F(1, 980) = 43.043	< 0.001	Intersection < Midblock
Presence of Car	F(2, 979) = 65.705	< 0.001	Car Waiting and None < Car Approaching
Density	F(2, 979) = .348	0.706	N/A
Time of Day	F(1, 980) = 0.05	0.823	N/A

Number of Looks

Due to the categorical nature of the Number-of-Looks variable, a Chi-Square test was performed in order to determine the significance of each independent variable. The results of the Chi-Square tests can be seen below in Table 4.6. All independent variables were found to significantly affect the Number of Looks.

Table 4.6 Results of Number-of-Looks Inferential Tests

Number of Looks			
Independent Variable	Pearson Chi-Square	*p* value	*Cross Tabulation Result*
Cell Phone Use	$\chi 2$ (12, N = 982) = 124.67	< 0.001	All others < Earphones
Gender	$\chi 2$ (4, N = 982) = 12.14	< 0.001	Females < Males
Type of Crosswalk	$\chi 2$ (4, N = 982) = 24.04	< 0.001	Intersection < Midblock
Presence of Car	$\chi 2$ (8, N = 982) = 45.44	0.016	None and Car Waiting < Car Approaching
Density	$\chi 2$ (8, N = 982) = 5.82	0.003	Medium and High density < Low density
Time of Day	$\chi 2$ (4, N = 982) = 11.32	0.023	After 9:30 < Before 9:30

A cross tabulation for each independent variable which significantly affected the Number of Looks was performed to better see the distribution among the subgroups. Using the graph below in Figure 4.1, it can be seen that the pedestrians using Earphones looked on average more times than any other subgroup.

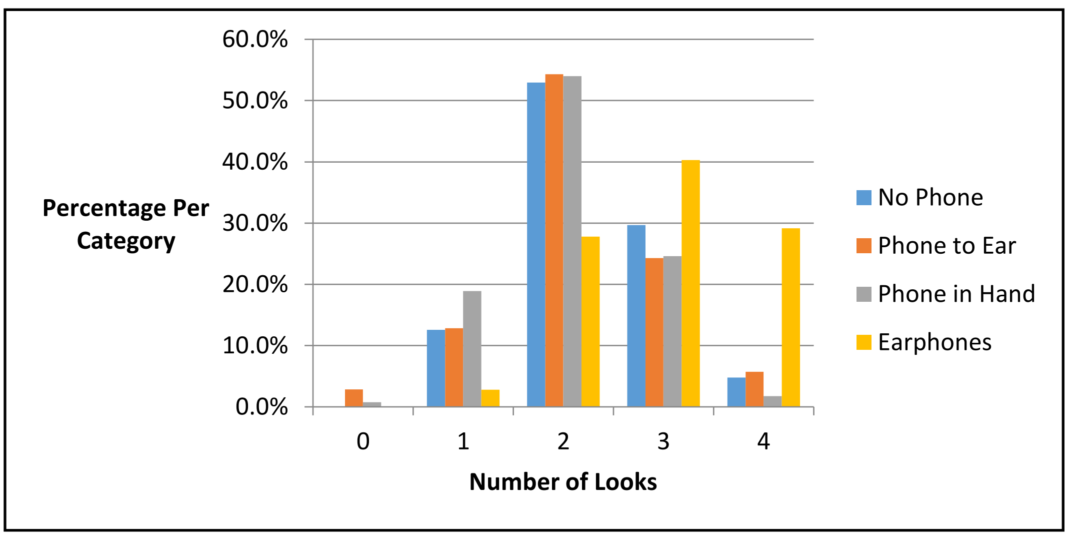

Figure 4.1 Cell-Phone-Use Cross Tabulation

The cross tabulation also shows that the difference in Number of Looks was also significant between the Gender Values 'Male' and 'Female.' Males were found to look more often and were more likely to look multiple times than Females. This can be seen in Figure 4.2 below.

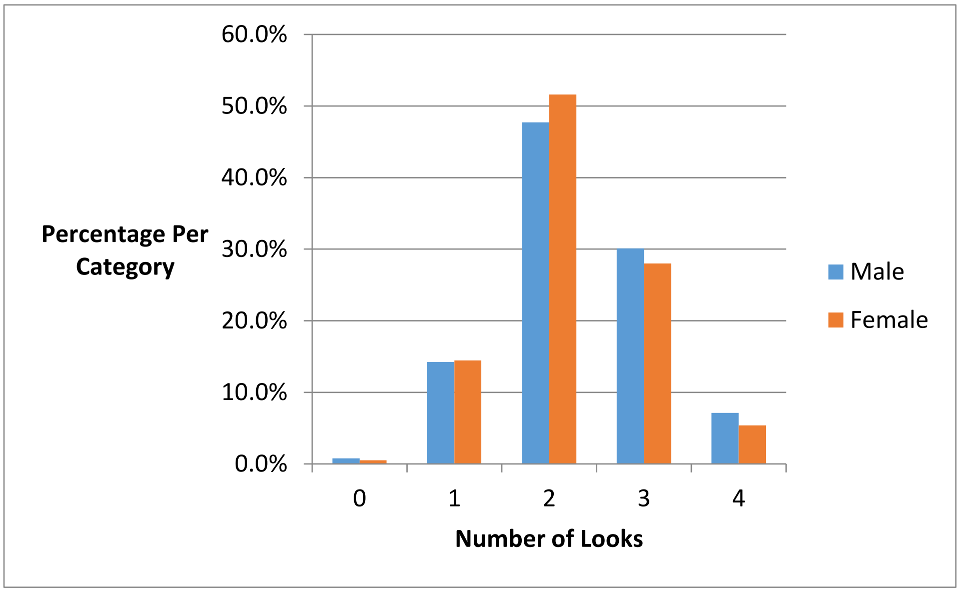

Figure 4.2 Gender Cross Tabulation

The Number of Looks between pedestrians using each type of crosswalk was significantly different as well. Pedestrians using the Midblock crosswalk were seen to make more looks more often than the pedestrians at the intersection. This can be seen below in Figure 4.3.

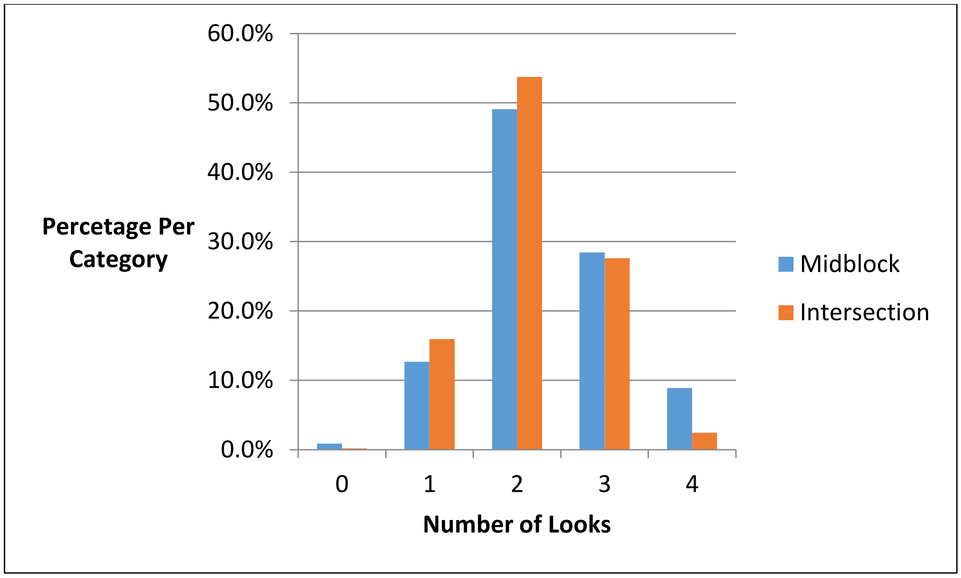

Figure 4.3 Type-of-Crosswalk Cross Tabulation

Additionally, the Number of Looks differed significantly between the levels of Car Presence. The pedestrians that encountered a ‘Car Approaching’ were seen to look more times than those of the other two levels. This can be seen below in Figure 4.4.

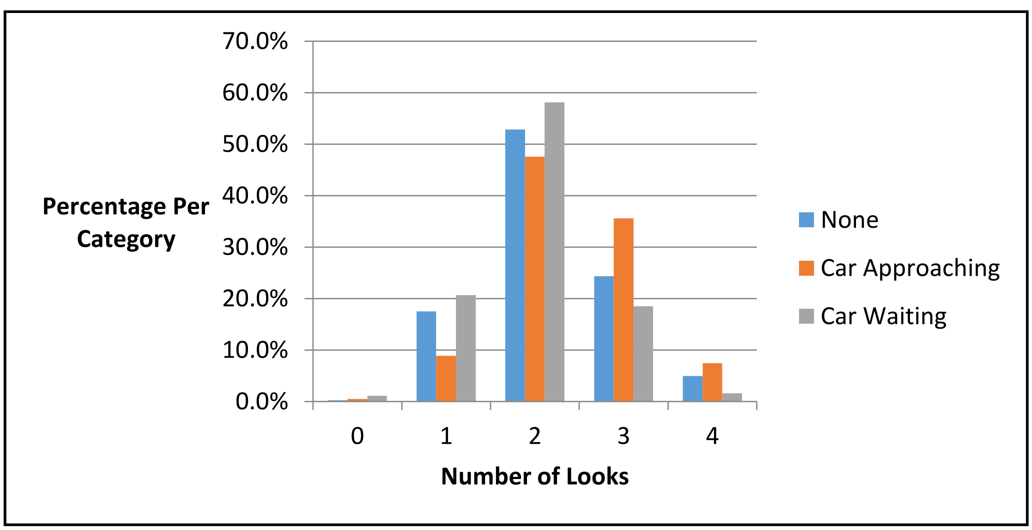

Figure 4.4 Presence-of-Car Cross Tabulation

After the initial data were analyzed certain trends were also studied to observe their possible effects. These trends were Time of Day and Density of Pedestrians. After analysis, Density of Pedestrians was found to significantly affect the Number of Looks among pedestrians. The category that showed significant difference was the pedestrians that were not within twenty seconds of another pedestrian. These pedestrians looked significantly more times than the other two categories, as shown below in Figure 4.5.

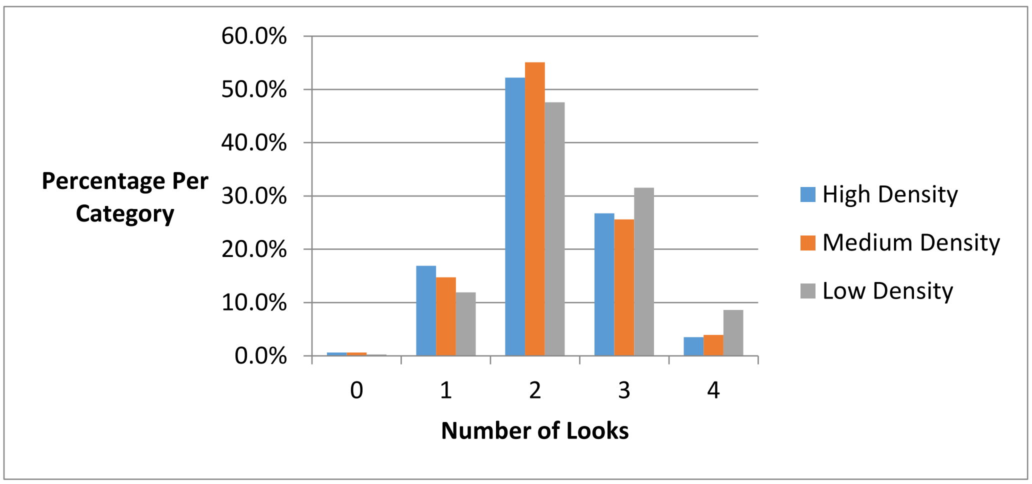

Figure 4.5 Density Cross Tabulation

Time of Day was also found to significantly affect the Number of Looks. Pedestrians who walked later in the morning, in the category of "After 9:30", were more likely to look more times than the pedestrians that used the crosswalk in the early morning, "before 9:30". This is shown below in Figure 4.6**.**

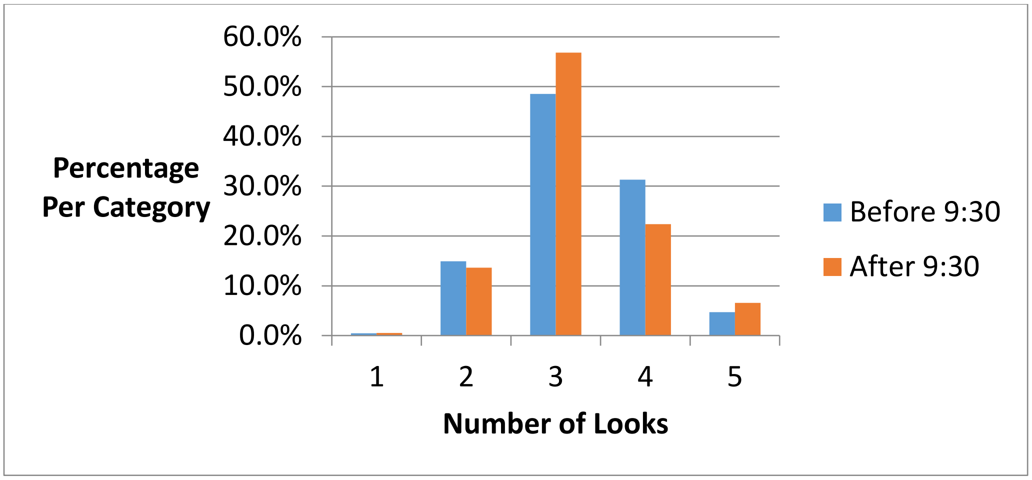

Figure 4.6 Time-of-Day Cross Tabulation

Multivariate Tests

In order to test the full effect each independent variable has on the dependent variables, a series of multivariate tests were conducted. From these tests, there was found to be an interaction between the following independent variables and Wait Time and Speed, shown below in Table 4.7.

Table 4.7 Results of Wait-Time and Speed Multivariate Tests

Wait Time		
Independent Variables	**F Value**	***p* value**
Type of Crosswalk * Presence of Car	F(2, 770) = 5.424	0.005
Speed		
Independent Variables	**F Value**	***p* value**
Type of Crosswalk * Cell Phone Use	F(2,770) = 6.684	>0.001
Type of Crosswalk * Time of Day	F(1,770) = 7.162	0.008
Cell Phone Use * Gender	F(3,770) = 2.814	0.038
Cell Phone Use * Presence of Car	F(6,770) = 2.577	0.018
Cell Phone Use * Time of Day	F(3,770) = 3.158	0.024

To observe how these independent variables interacted with each other an Error Bar Plot with a (2+-) Standard Error of Mean was constructed in SPSS as shown below in Figure 4.7. Using this graph, it is clear that the wait time for pedestrians that encountered a car approaching them was much greater at the Midblock crosswalk than the intersection.

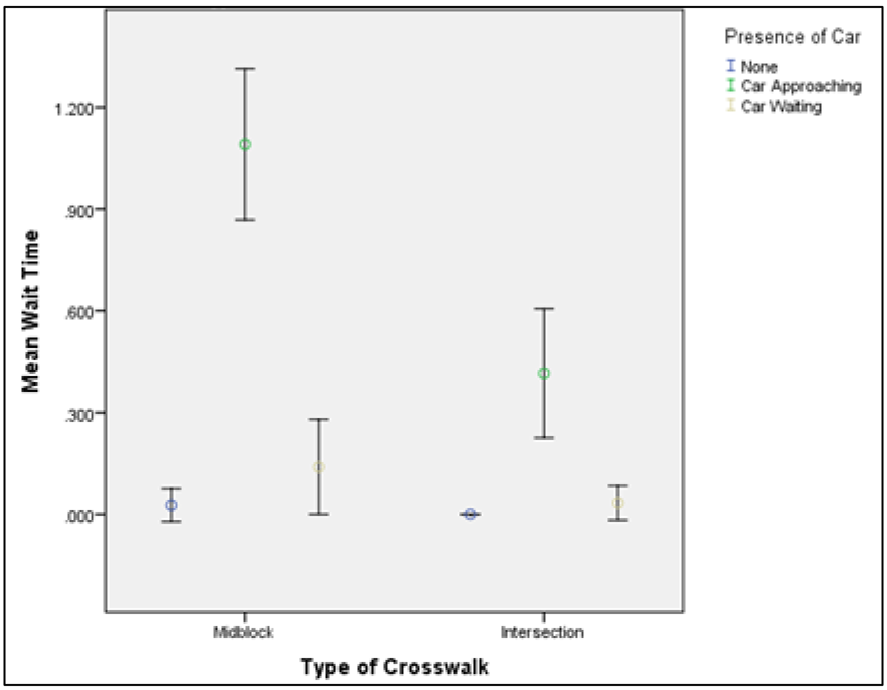

Figure 4.7 Type-of-Crosswalk * Presence-of-Car Interaction

The Car Approaching subgroup has a much higher speed than any other subgroup across the board. However, when compared to the different levels of Cell Phone Use, there is a much higher difference in Speed for the None subgroup of Cell Phone Use. This distribution is shown below in Figure 4.8.

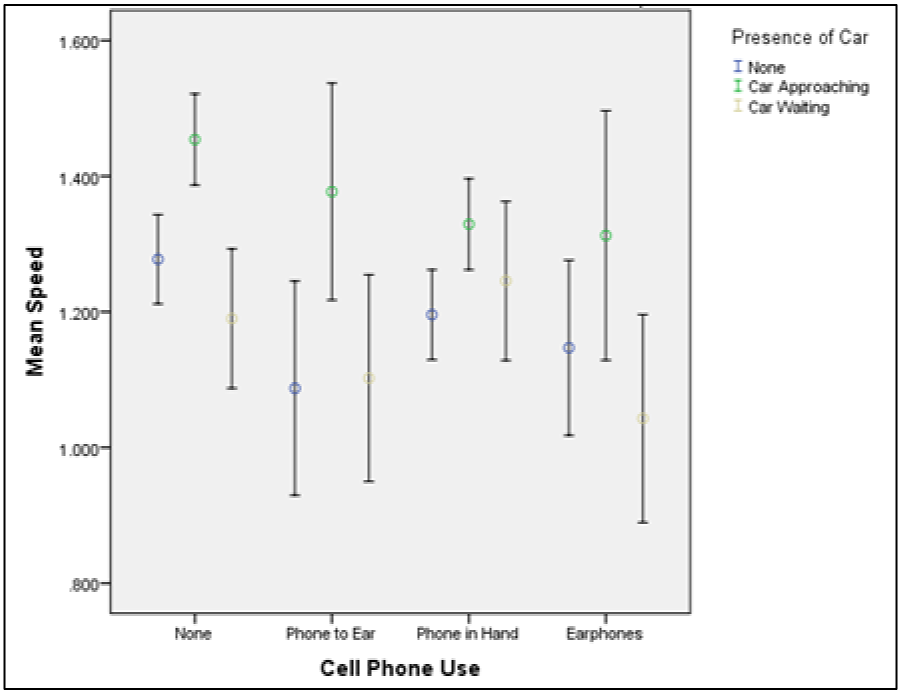

Figure 4.8 Cell-Phone-Use * Presence-of-Car Interaction

The Type of Crosswalk and Presence of Car interacted to affect Speed. There is a distinct difference in the speed between the Type-of-Crosswalk categories. When each type of Cell Phone is separated using the Error Bar Plot shown below in Figure 4.9, it is easy to see that the levels have much more spread in the Midblock crossing than the Intersection crosswalk. There is not much difference in Speed between the subgroups of Cell Phone Use at the Intersection crosswalk.

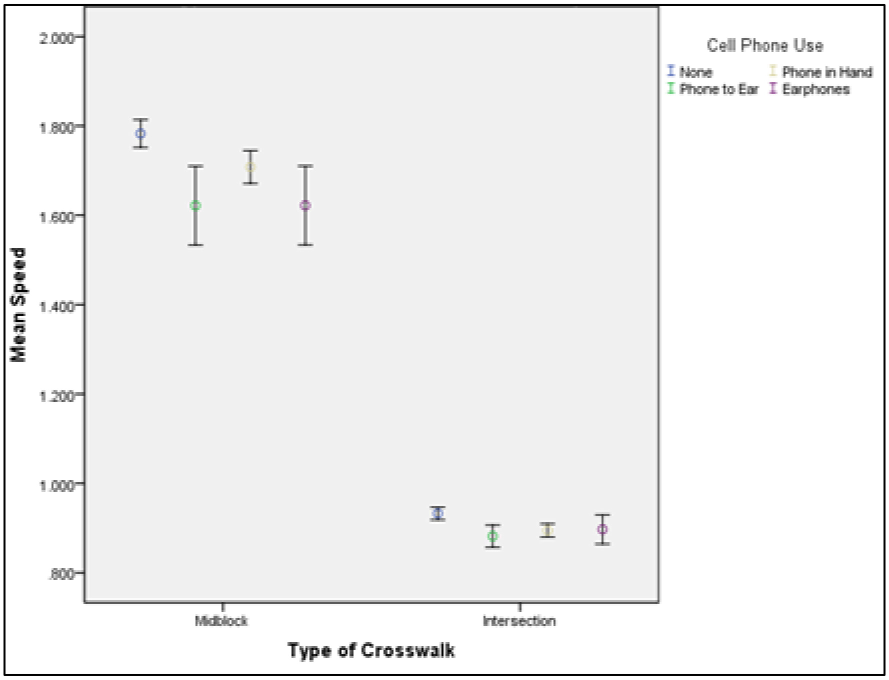

Figure 4.9 Type-of-Crosswalk * Cell-Phone-Use Interaction

The Type-of-Crosswalk and Time-of-Day variables also have an interaction when compared to the Speed dependent variable, shown below in Figure 4.10. The pedestrians who used the Midblock crossing early in the morning walked faster than the pedestrians who used it later in the morning. However, the opposite was seen at the Intersection crosswalk. The pedestrians using the Intersection crossing in the early morning were slower than later in the morning.

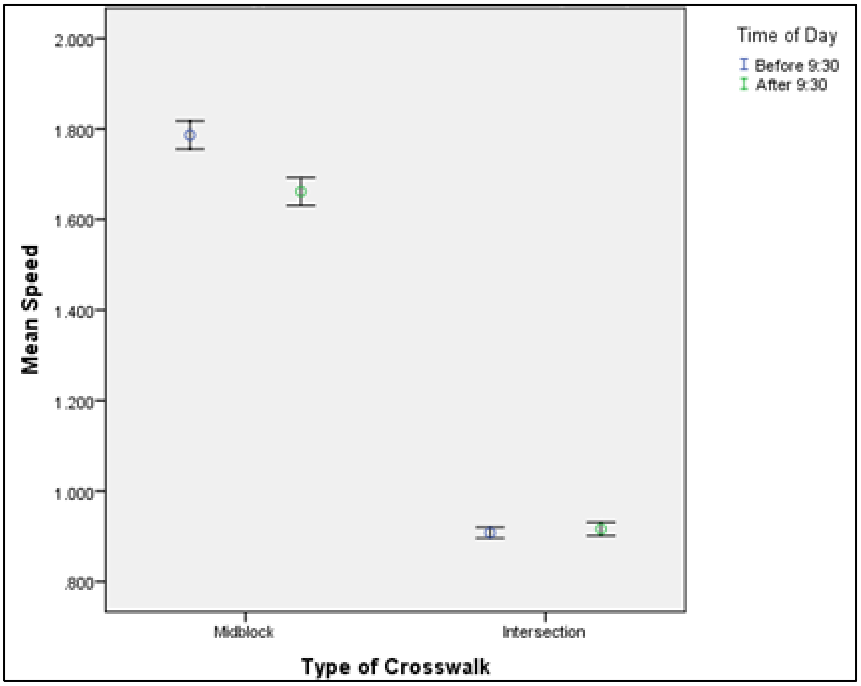

Figure 4.10 Type-of-Crosswalk * Time-of-Day Interaction

Interaction between Gender and Cell Phone Use was also seen to significantly affect Speed. Using the Error Bar Plot, as shown below in Figure 4.11, it is shown that Males walked faster in every category of Cell Phone Use except for Earphones. For pedestrians using earphones, the Female subgroup walked faster than Males.

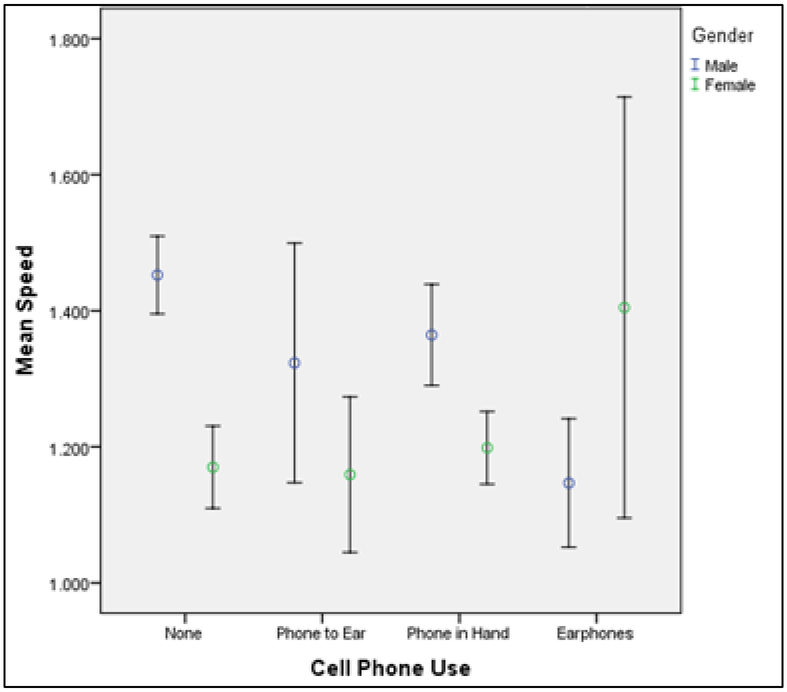

Figure 4.11 Cell-Phone-Use * Gender Interaction

Cell-Phone-Use and Time-of-Day also showed a significant interaction on Speed of pedestrians as seen below in Figure 4.12. For all categories of Cell Phone Use except for Phone to Ear, the pedestrians that used the crosswalks in the early morning walked faster. However, the pedestrians in the Phone-to-Ear category walked much slower in the early morning compared to the late morning.

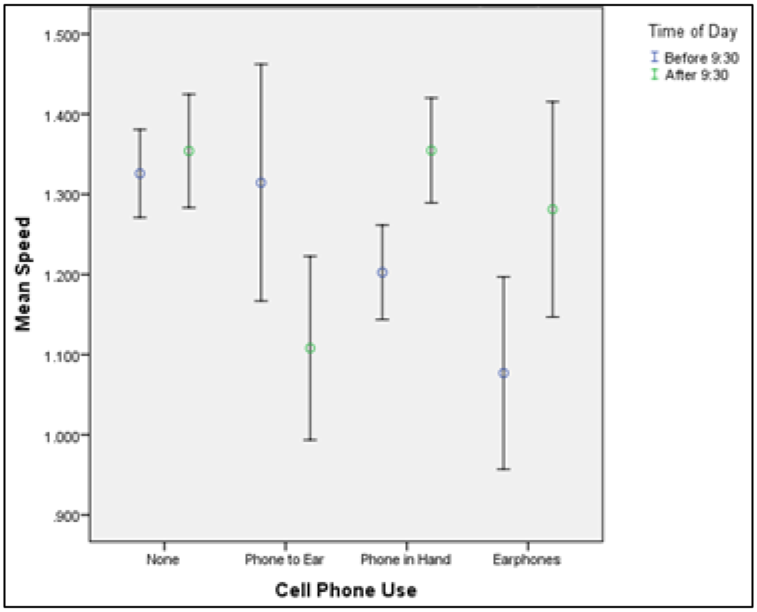

Figure 4.12 Cell-Phone-Use * Time-of-Day Interaction

CHAPTER V

DISCUSSION

Hypotheses Confirmed

The results of this study confirm the original hypothesis as stated in Chapter I, that pedestrians engage in different safety behaviors based on both the type of crosswalk and cell phone use. Additionally, many other factors were discovered to significantly affect these safety behaviors, such as gender, time of crossing, density of pedestrians, and the presence of cars. Each independent variable studied had different effects on the pedestrians' safety behaviors. Some of their effects were intuitive; however, others were not. For example, one can expect that at a midblock crosswalk, a pedestrian will wait longer before crossing the street because of a lack of assurance that an approaching car will see them and stop. This assumption was confirmed by the results of the average wait time for the Midblock crosswalk than the Intersection crosswalk. Upon a closer look at the interaction between the two variables, Presence of Car and Type of Crosswalk, it is seen that the only level of Presence of Car that is significantly different between both crosswalks, is the Car-Approaching level. The wait time for the other levels of Presence of Car, None and Car Waiting, were approximately the same.

One counter-intuitive finding of this study was the effect Earphones have on pedestrian safety behaviors. The natural assumption is that a pedestrian using earphones is being distracted from the outside world, therefore, they will pay less attention to their surroundings. Contrary to this widely-held belief, this study found the opposite to be true. Pedestrians using earphones looked more times on average than any other level of cell phone use, even the None level. Some researchers, such as Stavrinos et al. (2011), may argue that although these pedestrians looked more times, they were less cognitively aware of their surroundings. No pedestrian was injured during the entire eight hours of data collection and there were not any close calls among any of the levels of cell phone use.

This experiment both confirms past studies and shows some interesting findings on how each specific independent variable can affect crossing behavior. Hatfield and Murphy's (2007) study, which found that men who are on a cell phone walk significantly faster than those with no phone, was not confirmed. However, their finding that women walk approximately the same speed with or without a cell phone was confirmed. In Neider et al.'s (2010) semi-immersive environment experiment, they concluded that pedestrians involved in a cell phone call took longer to initiate crossing and crossed more slowly. While only the latter of those conclusions was confirmed by this study, there was no significant difference in speed between the None and Cell Phone groups. As mentioned above in the Results section, the significance was between the Ear Phone and None subgroups. Kotz (2012) and Littelton & Cotton's (2013) conclusion that pedestrians involved in a distracting activity took longer to initiate crossing the street was not confirmed. In fact, this experiment found no interaction between Cell Phone Use and Wait Time.

Limitations

The participants in this study were limited to the pedestrians walking on the campus of Mississippi State University in the morning; therefore some behaviors such as speed may have been agenda driven. Age was not considered in this study, but a large proportion of the participants appeared to be between the ages of 18 – 25. Another limitation of this study was the accuracy of the measurement of the speed and wait time of each pedestrian. The timing of each pedestrian entering and exiting the crosswalk was made difficult by the position of the camera and obstacles occasionally obscuring the pedestrian. The time a pedestrian spent waiting was also difficult to define because some pedestrians simply adjusted their speed just before entering the crosswalk but never actually stopped. These pedestrians were assigned a wait time of zero. In order to obtain more accurate measurement of the time taken to cross the street, two hidden lasers could be used at the entrance and exit of the crosswalk to record the start and stop times. However, due to the price of these lasers and the software needed to operate them, this method was not feasible. The feeling of 'safety' from having more than one pedestrian in the crosswalk must also be considered when making conclusions from these results. Only pedestrians walking alone were considered in this study, but some pedestrians were very close to one another and may be exhibiting different behaviors from a solo crossing.

Opportunities for Future Studies

One opportunity for a future study is to conduct an observational study in a public area where a wider variety of pedestrians can be seen. In this study the experimenters could include age and or ethnicity as an independent variable. Another interesting area of study is the cultural difference on distracted pedestrian crossing behavior. One study could compare the behaviors seen in another country with the findings in this paper and draw conclusions on the effect of cell phones on a larger scale.

CHAPTER VI

CONCLUSION

The distraction caused by cell phones and similar technology clearly has an effect on pedestrians' safety behavior among all types of crosswalks. The use of cell phones in crosswalks or other environments where a pedestrian-vehicle interaction may take place could potentially result in a tragic event. This study shows that several factors such as cell phone use, gender, type of crosswalk, presence of car, density, and time of day, influence pedestrians' safety behaviors. This information can be useful when designing or evaluating crosswalk systems. The results of this study also have implications for the design of autonomous vehicles. The information discovered in this experiment can be used to provide possible scenarios an autonomous vehicle can expect to encounter at a crosswalk. The studying of distracted pedestrian behavior is more important now than it ever has been due to the constant use of cell phones and increasing reliance on technology.

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