Effects of Pedestrian Perceptions of Safety:
An Examination of Pedestrian Crossing Behavior in Marked versus Unmarked Crosswalks

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ABSTRACT

This study examines the relationship between pedestrian perceptions of their right of way in marked versus unmarked crosswalks and the level of caution they exercise when crossing. In a 1972 study, Bruce F. Herms speculated that marking crosswalks leads to a false sense of security and an increased rate of accidents, but this study finds this hypothesis to be unfounded. Survey data collected showed many pedestrians believe they have the right of way only in marked crosswalks. When observing pedestrian behavior in three different crosswalk treatments, however, pedestrians surprisingly showed higher levels of cautiousness in marked crosswalks than unmarked crosswalks. These findings suggest that marked crosswalks do not give pedestrians a false sense of security or correlate with reckless behavior.

Key Terms: *Pedestrian Safety, Crosswalks, Behavior, Complete Streets*

INTRODUCTION

Crosswalks are perhaps the most fundamental, and certainly the most frequently used, devices to promote pedestrian safety. The ongoing scholarly debate over whether they instead promote reckless behavior by instilling a false sense of security in pedestrians prompted this study to explore the relationship between pedestrian perceptions of their rights and their actual behavior when crossing. Comparisons between marked and unmarked crosswalks have led to insights that could prove useful to transportation planners and engineers when making recommendations in the future.

Pedestrian[1] safety has long been an overlooked discipline in the field of transportation planning. Yet while not everyone will drive a car in his or her lifetime, everyone around the world is a pedestrian at one time or another. A recent surge of support for 'complete streets' has brought pedestrian infrastructure and safety back into mainstream discussion as planners work to create streets that give equal priority to all modes of transportation (McCann 2005). As defined by the National Complete Streets Coalition, a complete street is one with safe and equal access provided for pedestrians, cyclists, motorists, and transit riders of all ages and abilities.

Because the greatest risk to pedestrians is posed when they are crossing a street, the impacts of crosswalk markings must be understood in order to minimize pedestrian-motor vehicle injury or fatality accidents. According to the California Department of Motor Vehicles, motorists are required by law to yield the right of way to any pedestrian within a crosswalk at a corner, whether it is marked or unmarked, or within a marked midblock crosswalk. Although pedestrians have equal rights whether the crosswalk they are in is marked or not, their understanding of their rights is different in each of these circumstances. Some incorrectly assume that motorists have the right of way, or may assume that motorists will not yield to a pedestrian despite the pedestrian having the right of way (Zegeer et al. 2005).

When considering what design measures to install to promote pedestrian safety, however, many city staff members and traffic engineers today are still misconstruing a study conducted by Bruce F. Herms in 1972 to justify omitting crosswalk markings (Florido 2011, Zegeer et al. 2005). The study observed a higher number of pedestrian-motor vehicle accidents at crossings with marked crosswalks than at those without markings, and speculated that pedestrians were influenced by the presence of the markings to act more recklessly. This was not an empirically

[1] The California Motor Vehicle Code defines a pedestrian as a person on foot or who uses a conveyance such as roller skates, a skateboard, etc., other than a bicycle. This includes persons in wheelchairs.

derived conclusion, however, and Herms collected no evidence that explored the connection between crosswalk markings and pedestrian behavior. Instead, the idea that marking crosswalks gives pedestrians a false sense of security was a possible explanation suggested for the higher incidence of accidents.

In the study, Herms offers several brief explanations for his results. One suggestion was that the higher incidence of accidents in marked crosswalks was a reflection of pedestrians' lack of caution, but as the study does not present behavioral data it is clear this statement was a musing not intended to be taken as fact. Herms proposes pedestrians may have acted with "a false sense of security," resulting in the increased accident tallies (1972: 12). The research methods used in the study have been widely discredited in the academic community, calling the results into question (Knoblauch et al. 2001, Zegeer et al. 2005). Despite all of this, the phrase 'false sense of security' continues to be cited by city staff and engineers in discussions over potential crosswalk markings.

While subsequent studies have indicated that marking crosswalks in fact reduces the incidence of pedestrian accidents (Knoblauch et al. 2001, Zegeer et al. 2005), none have investigated Herms' supposition that crosswalk markings instill a false sense of security. This study collected survey and behavioral data to answer the following question: do pedestrian perceptions of their right of way in crosswalks affect their cautiousness when crossing?

After a discussion of the relevant literature placing the study in context with the current academic conversation on pedestrian safety, the methodology followed to answer the research question is detailed. Findings from the pedestrian survey and behavioral observations are presented and analyzed. Finally, the implications of this research are considered in the concluding section.

LITERATURE REVIEW

On September 13, 1899, a man named Henry Bliss stepped off a streetcar in Manhattan and was hit by a taxicab. He died the next morning. It was the first recorded vehicle fatality in America (Short and Pinet-Piralta 2010).

Much has changed on American streets since Henry Bliss made tragic history in 1899. At the beginning of the twentieth century, streets were shared equally by a wide variety of users for transportation purposes, as a site for social interaction and for recreation. By 1930, however, automobile interests with their rallying cry of freedom in speed won out over the multitude of other users. Le Corbusier further enchanted the American psyche in the early 1930s with his elevated expressways winding between skyscrapers, monuments to the speed of the automobile, devoid of pedestrian nuisances. Despite the risks of cars and people sharing space, modern cities continue to be designed around the use of potentially threatening motor vehicles, while the vulnerable pedestrians have been shunted to the sidelines (Short and Pinet-Piralta 2010).

In 2000, nearly five thousand pedestrians were killed in accidents in the United States, with nearly eighty thousand more injured. They constituted 11% of all traffic accident fatalities (Sisiopiku 2003). By 2008, the statistics had decreased to just over four thousand killed and seventy thousand injured (Crowley-Koch et al. 2011). This decrease may be due to a general decrease in motorist travel as the American economy declined. A national survey discovered 62% of pedestrians cite danger from motorists as the top reason they feel unsafe while walking (Royal and Miller 2008). Urban transportation concerns revolve primarily around how to move vehicle traffic efficiently and quickly through the city, and when safety concerns are addressed the emphasis is often placed on protecting the safety of drivers and passengers instead of pedestrians (Short and Pinet-Piralta 2010).

Planning paradigms have tended to focus on changing pedestrian behavior, forcing them to adapt to the automobile-dominated streets instead of training motorists to defer to pedestrians. Examination of accident data in North Carolina between vehicles and pedestrians crossing the street found fault assigned to the pedestrian for 81.5% of the accidents, while drivers were found at fault only 13.2% of the time. Even more surprisingly, accidents that occurred when the pedestrian was waiting to cross the street were deemed to be the sole fault of the pedestrian 62% of the time (Ulfarsson et al. 2010). The pedestrian, who was presumably stationary by the side of the road, was blamed for the accident that occurred when he was hit by a moving vehicle.

Other research contradicted this confusing conclusion, finding 90% of pedestrian deaths to be the fault of drivers, with 74% of those resulting from a traffic violation (Surface Transportation Policy Project 1999). With these statistics in mind, it is clear that being a prudent pedestrian—and teaching children to do the same—is not enough to keep people safe. Motorist behavior must also be addressed, and their privilege on the road should be reconsidered.

The Federal Highway Administration has taken steps in recent years to promote bicycle and pedestrian safety, focusing on educating drivers, cyclists, and pedestrians on how to share the road safely, including commissioning studies on crosswalk effects on safety (Redmon and Boodlal 2003, Zegeer et al. 2005). Investigations into design measures that can increase pedestrian safety have also yielded positive results. National opinion is shifting away from the auto-centric streets of the past in favor of streets with more comprehensive designs that allow multiple users to share the space—in other words, complete streets.

In addition to safety concerns, creating complete streets addresses the needs of the aging population in the U.S., improves public health and fitness, reduces our dependence on oil, reduces transportation costs, creates vibrant and livable neighborhoods, and reduces emissions

that contribute to climate change (Smith et al. 2010). Complete streets provide choices in transportation for people of all ages and abilities, and allow them to select a mode that is accessible from every front door, affordable for every family, and healthy for every individual: walking (Burden 2012). Walking is also the most social form of transportation, which helps build social capital and strong communities. As Jonathan Rose points out, "there is a significant difference between running into someone while strolling down a street and running into someone when driving a car" (1994: 145). Promoting pedestrian safety requires more than the haphazard installation of sidewalks and other features, however. It requires an understanding of how pedestrians perceive, negotiate, and navigate their environment.

Pedestrians are more likely to cross at an intersection rather than at a midblock location not marked as a crosswalk if traffic lights and pedestrian signals are installed (Yannis et al. 2007). This may indicate a belief that pedestrians are safer where there are crosswalk markings and traffic controls installed, or a misconception that marked corner crosswalks are the only legal places for pedestrians to cross. Marked crosswalks at unsignalized intersections have been shown to alert drivers to the possible presence of pedestrians, causing them to reduce their speed slightly (Knoblauch et al. 2001). More elaborate mechanisms to enhance crosswalks such as flashing pedestrian beacons, advance stop bars, and flashers embedded in the asphalt have also increased motorist compliance (Do et al. 2011). In light of the scope and volume of more recent data, it is difficult to understand why some planners and engineers still stand by Herms' speculation that pedestrian safety features as fundamental as marked crosswalks lead to a false sense of security and more injury accidents.

In the state of California, pedestrians have the right of way when crossing at any corner or other crosswalk, including marked midblock crosswalks, unless explicitly closed and posted.

This is true whether or not there are traffic lights or stop signs at the corners, and whether or not the crosswalks are marked with painted lines ("Driver Handbook" 2011). Motorists are required to yield the right of way to the pedestrian, and to allow him or her to cross safely. Many people are misinformed about their rights as pedestrians, though. A survey revealed that 61% of pedestrians believe motorists should yield to pedestrians only in marked crosswalks. 31% thought pedestrians should always have priority over motorists, and 7% thought they were always required to yield to motorists (Sisiopiku 2003).

While vehicle traffic volumes themselves do not seem to affect pedestrians' perceptions of how safe they are while walking (Mehta 2008), low vehicle traffic volumes tend to allow motorists to drive faster. Pedestrians therefore tend to be more cautious when crossing a street with low vehicle traffic volumes. Pedestrian traffic volumes, on the other hand, have a significant effect on the level of cautiousness observed. Pedestrians tend to be more cautious when fewer pedestrians are present, and less cautious when they are crossing with a large group. This may be the result of a diffusion of responsibility—assuming other pedestrians in the group will look for oncoming cars—or because of the increased visibility offered by the larger mass of people (Harrell 1991).

Pedestrian perceptions about various crossing options have been shown to influence their decisions when presented with these different options along their route. Marked crosswalks at signalized intersections are seen by some as unsafe because of turning vehicles that fail to yield to pedestrians. Some pedestrians favor midblock crosswalks because they are more convenient and eliminate the threat posed by left-turning vehicles, but others perceive them as unsafe because they feel motorists will only be looking for crossing pedestrians at intersections (Sisiopiku 2003).

While the scope of pedestrian research has broadened, no researcher has yet revisited Herms' 1972 study to examine whether pedestrian perceptions about their rights in marked and unmarked crosswalks affect their cautiousness when crossing. This study will begin to fill this gap in pedestrian safety and behavioral research.

RESEARCH METHODS

In order to answer the question of whether pedestrian perceptions of their right of way in various crossing situations affect their cautiousness, a two-phase research plan was carried out between November 2011 and January 2012 in Davis, California. First, a survey was conducted to gauge pedestrian perceptions of their own right of way in various crossing situations. Second, pedestrian behavior was observed at each of the crossing situations and evaluated for indicators of cautious or reckless behavior. Three different crossing treatments were examined: unmarked corner crosswalks, marked corner crosswalks, and marked midblock crosswalks.

SURVEY METHODOLOGY

To gather information on how pedestrians' perceptions of their right of way changes in marked versus unmarked crosswalks, a survey was conducted. Respondents were systematically selected in downtown Davis—the same area where the observation sites are located. Every third pedestrian passing the survey site was asked to participate in a brief survey on pedestrian rights. They were shown a diagram of each of the three studied crossing treatments and one 'control' diagram of an unmarked midblock crossing where the pedestrian does not legally have the right of way. Respondents answered two questions for each diagram about rights of way and motorist yielding. The responses provide a baseline for the levels of cautiousness expected at each of the crossings. See Appendix A for survey materials and questions.

Conducting a survey facilitated the collection of pedestrian perceptions on their rights. Selecting respondents downtown ensured that the surveyed population was the same as the population observed in the second part of the study. Surveys can be problematic, however. A number of the pedestrians selected for the survey declined to participate, so participation may be slightly skewed towards those who are particularly interested or invested in pedestrian rights.

OBSERVATION METHODOLOGY

Observations of pedestrian crossing behavior were conducted to gather information on the recklessness or cautiousness of pedestrians in the three studied crossing treatments. Four sites were selected for each of the treatments, all in or near downtown Davis. See Figure 1 for a list of sites. A map of study sites and the surrounding pedestrian destinations is included in Appendix B.

Figure 1: Observation Study Sites[2]

Unmarked Corner Crosswalks	Marked Corner Crosswalks	Marked Midblock Crosswalks
5th Street at D Street	2nd Street at C Street	E Street between 2nd and 3rd
A Street at 3rd Street	B Street at 2nd Street	F Street between 2nd and 3rd
C Street at 3rd Street	B Street at 4th Street	F Street between 3rd and 4th
F Street at 7th Street	B Street at 7th Street	G Street between 2nd and 3rd

Streets at all study sites have two vehicle travel lanes, with the exceptions of A Street, which has one lane, and 5th Street, which has four lanes. Bike lanes and on-street parking are present at most of the crosswalks studied as well, with the following exceptions. 5th Street has no on-street parking or bike lanes at D Street. C Street at 3rd Street has both on-street parking and bike lanes, but curb extensions bring the pedestrian farther into the motorist's line of sight

[2] For each study site, the street listed first is the street being crossed by pedestrians, and the second is a cross street to indicate an intersection. Where both parallel crosswalks showed the same crossing treatment, pedestrians in both were recorded. Where only one crosswalk showed the crossing treatment, only that crosswalk was observed.

and thus counteract the visibility limitations created by parked cars. B Street has only bike lanes at 7th Street; there is no on-street parking on the corridor at that location. 2nd Street has on-street parking but no painted bike lanes. Instead, there are shared lane or 'sharrow' markings indicating that cars and cyclists are to share the travel lane equally. The midblock crosswalks on E Street and G Street both have curb extensions as well, and neither has marked bike lanes.

All locations were uncontrolled for traffic at the pedestrian crossings being studied with the exception of A Street at 3rd Street, which has stop signs at both legs. Some studied intersections had traffic controls on legs that were not being studied, but these did not significantly impact the data. Signalized intersections were avoided because they may have influenced the yielding behavior of motorists—at signalized intersections, motorists yield to the signal rather than to pedestrians. If two or more pedestrians crossed at the same time, they were evaluated as a single entity. Individuals may often transfer responsibility to others in the group, trusting that one of their companions has checked for approaching vehicles (Harrell 1991). To avoid misrepresenting the behavior of those pedestrians who trusted their companions to check traffic for them, groups were scored as a unit.

Pedestrian behavior was evaluated across three categories: scanning for oncoming cars, distance from the curb while looking for vehicles, and forcing motorists to yield. In each category, pedestrians were given a score from 1 to 5. A score of 1 was assigned to cautious behaviors—if pedestrians looked carefully in both directions for approaching cars, stood well back from the curb while looking or waiting for cars, or deferred to motorists until traffic cleared or a motorist yielded of their own volition. Conversely, a score of 5 was assigned to assertive behaviors—if pedestrians did not look for cars before crossing, stood off the curb in the street while looking or waiting for cars, or walked in front of oncoming vehicles and forced motorists

to yield. If no cars were approaching when the pedestrian crossed the street, no score was assigned for the third category. Behaviors that fell between these two extremes were scored a 2, 3, or 4. The scores were averaged to arrive at a final behavior score.

Final behavior scores from 1 to 2.3 are considered very cautious scores, and suggest high levels of caution potentially resulting from a misconception about pedestrian rights or perceived unsafe crossing conditions. Scores from 2.5 to 3.7 are moderately cautious scores, indicative of pedestrians who are aware of their rights and assertive in their behavior. Final scores from 4 to 5 suggest reckless crossing behavior with disregard for traffic or other conditions.

A score of 5 on one category alone is not sufficient to indicate reckless behavior—instead, this could mean a pedestrian is expressing a confidence in their rights and asserting their right of way. For example, consider a pedestrian who looked carefully for oncoming cars while standing a safe distance back from the curb and then asserted their right of way by stepping into the street and forcing a motorist to yield. If they did the latter in a safe manner, without forcing a motorist to brake excessively or swerve to avoid them, they could not be considered reckless based solely on that behavior. An average score of 4 or 5 across all categories, however, indicates a pedestrian who is acting with reduced concern for their safety.

Because different numbers of pedestrians were observed at each location, comparing raw values could be misrepresentative of underlying trends. In order to correct for this, the final behavior scores were compared in terms of percentages instead of counts.

Advantages of this methodology include the ease of analysis facilitated by the scoring rubric. Quantifying the observation data allowed clear comparison between the three studied crossing treatments. The rubric also aided in the consistency of behavior evaluations by giving the observer a clear set of guidelines and criteria to apply to pedestrians. The most significant

disadvantage of this method was the time commitment required to complete observations at all twelve study sites, including additional time to conduct pedestrian surveys. Findings from the survey and observations are detailed in the following section.

FINDINGS AND ANALYSIS

Two kinds of data were collected to explore the relationship between pedestrian perceptions of safety and their levels of caution exercised when crossing streets. A survey on pedestrian rights was conducted, and pedestrian crossing behavior was observed in three different crossing situations at a total of twelve study sites. The results of the survey are outlined below, followed by the findings from pedestrian behavior observations.[3]

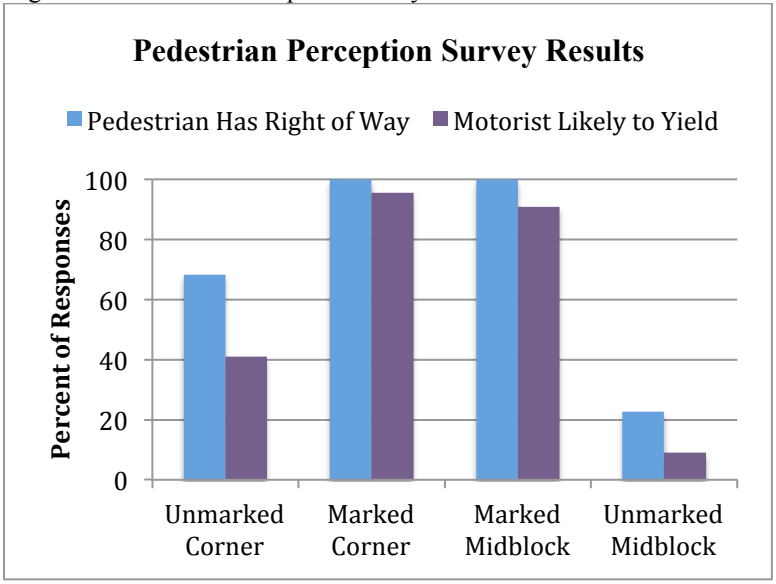
SURVEY FINDINGS

The results from the survey on pedestrian perceptions of their rights at crossings supported the hypothesis that marking crosswalks increases pedestrian confidence. 100% of the 42 survey respondents felt they had the right of way in marked crosswalks, whether they were at a corner or midblock location. They were almost equally sure that a motorist would stop for them under those circumstances—over 95% felt a motorist would yield to them at a marked corner crosswalk, and over 90% felt a motorist would yield at a marked midblock location.

When asked about unmarked crosswalks, responses were more varied. Just over 68% of respondents correctly said they had the right of way at a corner crosswalk, even if it was not marked. Only about 41% felt a motorist would be likely to stop for them at unmarked corner crosswalks. Conversely, just over 23% incorrectly thought pedestrians had the right of way at unmarked midblock locations, and over 9% were optimistic enough to think motorists would

[3] The data presented in the body of this report is a summary of the most salient information. More complete data tables are included in Appendix C. For a full transcript of raw data, please contact the author.

Figure 2: Pedestrian Perception Survey Results



yield to them. These results suggest a connection between the presence of crosswalk markings and the confidence of pedestrians—confidence both that they have the right of way, and that motorists are likely to yield this right of way to them.

OBSERVATION FINDINGS

Final behavior scores at unmarked corner crosswalks are shown in Figure 3. The scores were spread fairly evenly across the scale, with a slight skew towards the left. The average score was 2.9, with a median of 2.5. The outlying pedestrians who received a final behavior score of 5 were all observed at A Street at 3rd Street. A Street is a one-way street that sees relatively low vehicle traffic volumes, so the overly confident behavior of pedestrians observed may be the result of their prior experiences crossing the street without difficulty.

Final behavior scores at marked corner crosswalks were grouped on the lower half of the scale. The average score was 2.1, and the median score was 2. The mode for the dataset was 1, with most of these scores coming from B Street at 2nd Street and 2nd Street at C Street. B Street and 2nd Street are both designed as collector streets for cars moving through downtown, and as a result carry higher vehicle traffic volumes than other study sites. The streets also have fewer

Figure 3: Unmarked Corner Crosswalk Summary

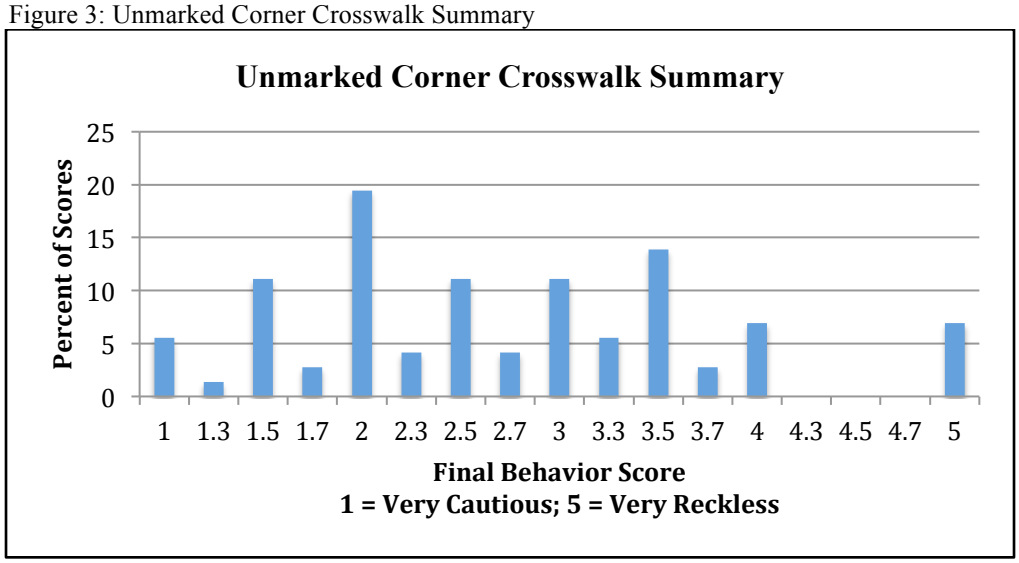


Figure 4: Marked Corner Crosswalk Summary

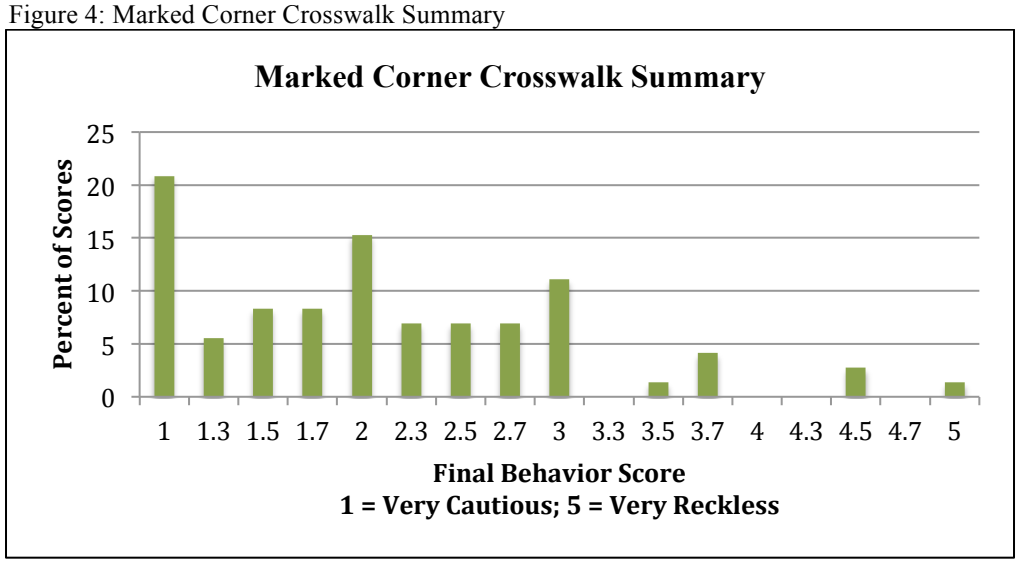
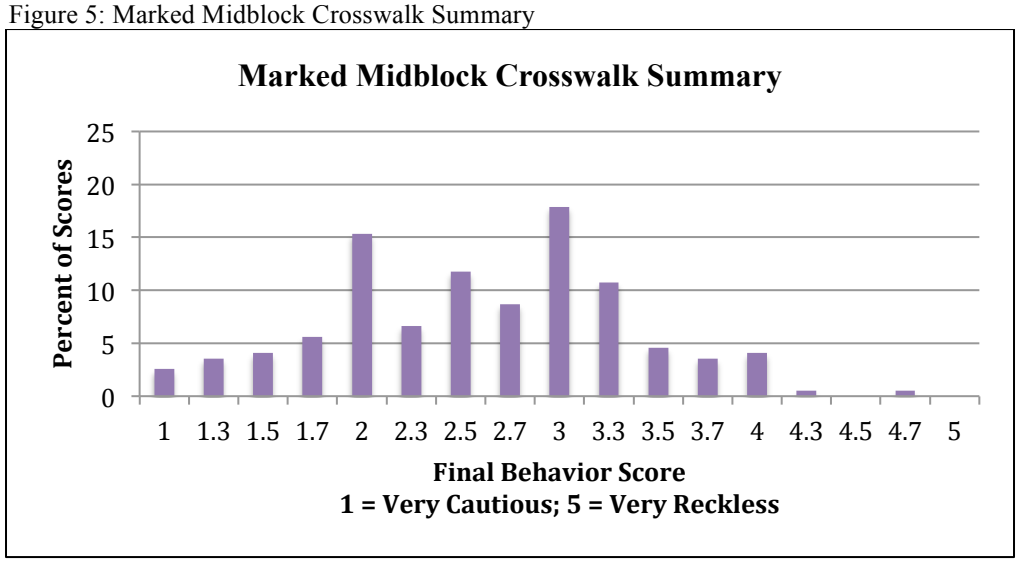


Figure 5: Marked Midblock Crosswalk Summary



traffic controls than others in the downtown area, allowing for increased vehicle speeds. This may have resulted in decreased gaps in traffic for pedestrians to cross, explaining the increased pedestrian caution at these locations.

Observations at marked midblock locations produced final behavior scores grouped near the center of the scale. The average score and median score were the same at 2.6. All four midblock crosswalks observed in the study see very high volumes of pedestrian traffic, which may have contributed to more confident pedestrian behavior than was observed at marked corner locations.

ANALYSIS

This study set out to answer a two-faceted question: whether pedestrians perceived their rights differently in marked and unmarked crosswalks, and whether a sense of security inspired by crosswalk markings correlated with reckless pedestrian behavior. While the results of the pedestrian perception survey showed marking crosswalks increases pedestrian confidence in their rights, the observation data did not show this confidence translating into reckless behavior scores assigned to pedestrians when crossing streets.

Of the three crossing treatments studied, pedestrians surprisingly showed the most caution in marked corner crosswalks. The average final behavior score at marked corner locations was half a point lower than the midblock average, and nearly one point lower than the unmarked corner crosswalk average. While the sample size of this study was not large enough to draw definitive conclusions, this data does not support Herms' 1972 suggestion that marking crosswalks gives pedestrians a false sense of security.

There are a number of possible explanations for these unexpected results. Further research is required to explore each theory and gather evidence before conclusions can be drawn,

however. Until then, the following hypotheses are merely suggestions to explain the patterns observed in this study.

Cautious pedestrian behavior observed at marked corner crosswalks may be the result of preexisting conditions that prompted the marking of the crosswalk initially. Crosswalks markings tend to be used as safety measures at crossings that have historically been points of high conflict between vehicles and pedestrians. In these situations, underlying variables such as high vehicle speeds or low visibility may have a stronger affect on pedestrian crossing behavior than crosswalk markings.

The increased confidence shown by pedestrians at unmarked corner crosswalks may be a way to compensate for the belief that motorists are unlikely to yield despite pedestrians having the right of way. If they are cautious and deferent to motorists, they could end up waiting for minutes at a time before traffic cleared. The final behavior scores from these locations were high enough to indicate confident behavior without being reckless. In order to cross at unmarked locations without unreasonable delays, pedestrians assert their right of way and force motorists to yield to them.

This phenomenon suggests marking crosswalks may actually make pedestrians more cautious, not less. Because of the increased visibility and likeliness of motorists to yield, pedestrians are not forced to assert themselves as they do in unmarked crosswalks. Instead, they trust that motorists would stop for them and wait patiently for a gap instead of stepping into the street. An examination of behavior scores focusing exclusively on the 'forced motorist yield' category supported this hypothesis. As discussed in the methodology section, a high score in a single category does not necessarily denote reckless behavior, but instead can indicate a pedestrian who is confident in their rights.

Figure 6: Forced Motorist Yield at Unmarked Corner Crosswalks

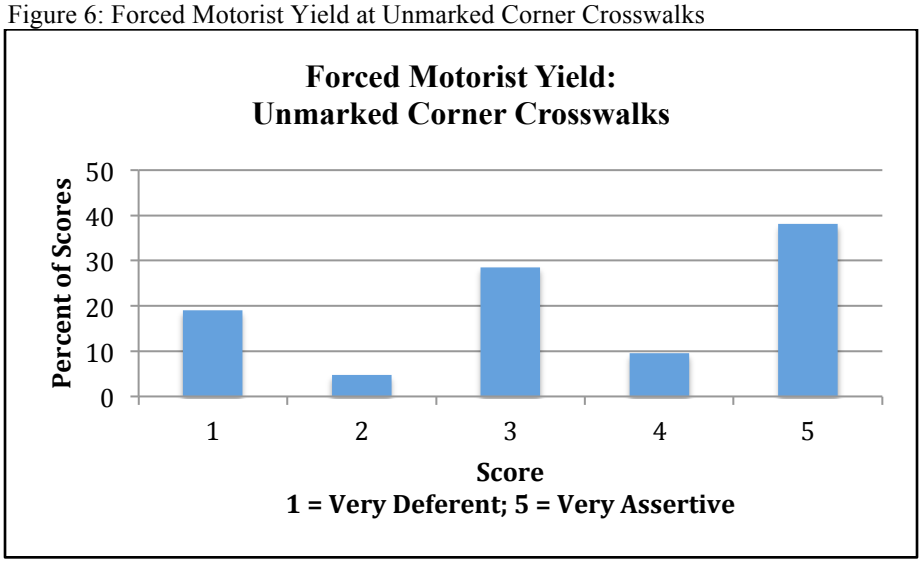


Figure 7: Forced Motorist Yield at Marked Corner Crosswalks

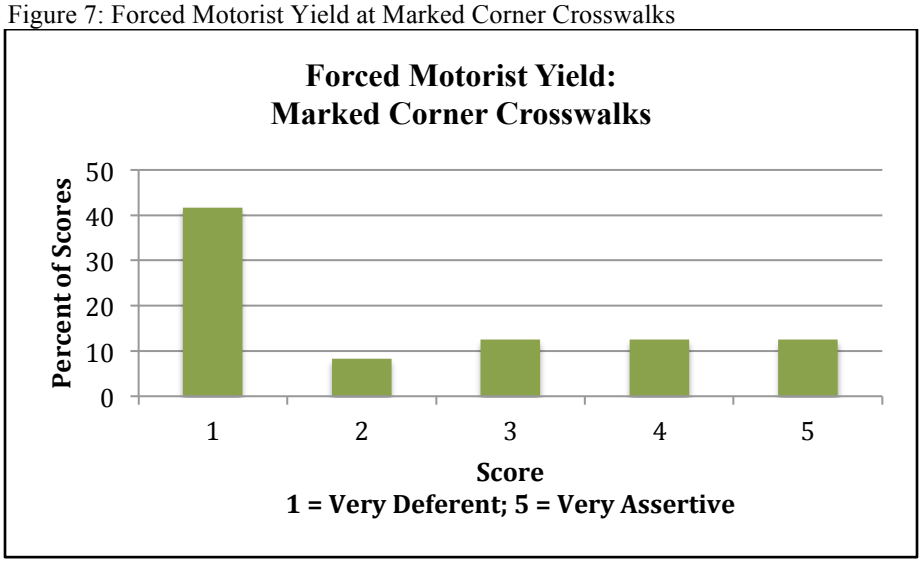


Figure 6 shows the behavior of pedestrians at unmarked corner crosswalk locations. Nearly 40% of pedestrians scored a 5, indicating they were very assertive in forcing motorists to yield to them. Only 19% scored a 1, meaning the pedestrian waited for traffic to clear completely before crossing the street. The mean score at unmarked corner locations was 3.4. Compare this to Figure 7—the difference in behavior at marked corner locations is startling. Only 12.5% of pedestrians scored a 5, while nearly 42% scored a 1. The mean was 2.1, over a full point lower than the mean score at unmarked corner crosswalks. Pedestrians at unmarked

crosswalks were much more assertive and forceful in claiming their right of way over motorists, while pedestrians at marked crosswalks did not take as many risks.

Given the scope of this research study, it is unrealistic to draw definitive conclusions about a causal relationship between crosswalk markings and pedestrian caution. It is clear, however, that marking crosswalks does not correlate with reckless crossing behavior. Herms' hypothesis is therefore unsupported by this evidence. Instead, marking crosswalks may make pedestrians less reckless than their counterparts at unmarked crossing locations.

CONCLUSION

Since Herms speculated in 1972 that marking crosswalks could actually be detrimental to pedestrian safety, city staff and traffic engineers have used his study to justify omitting crosswalk markings (Florido 2011, Zegeer et al. 2005). Because Herms' hypothesis was never empirically tested, this study set out to do just that. The evidence gathered showed that while pedestrians do perceive themselves to be safer in marked crosswalks, this perception does not lead to reckless behavior while crossing at marked locations.

In fact, the opposite turned out to be true—marking crosswalks increased pedestrian confidence that motorists would yield, thereby reducing the need for pedestrians to assert themselves unsafely. It was unmarked crosswalks that inspired incautious behavior in pedestrians, perhaps stemming from a decreased likelihood that motorists would yield the right of way.

It seems, then, that it may be time to stop attempting to reduce accidents by manipulating pedestrian behavior, and instead focus on manipulating motorist behavior. Increasing the visibility of crosswalks with markings on the street, flashing beacons, or other measures has been

shown to encourage motorist yielding and make pedestrians safer. In situations like these, pedestrians are not forced to step out into the roadway to claim their territory. The flashing beacon and white stripes claim it for them, and once the motorist has stopped the pedestrian can proceed safely across the street.

Clearly marking space for different modes of transportation and giving clear signals on when and where yielding must occur makes navigating streets safer and less stressful for everyone. These completed streets move away from the auto-dominated paradigm that has ruled the streets for over a hundred years, and work towards making all modes of transportation equally safe, convenient, and accessible to users of all ages and abilities.

REFERENCES

America Walks. 2012. "Signalized Intersection Enhancements that Benefit Pedestrians." Accessed January 24, 2012. http://americawalks.org/wp-content/upload/America-Walks_Signalized_Intersections_Report_2012.pdf.

Burden, Dan. 2012. "What is a Complete Street?" *AARP Blog*, January 25. Accessed January 25, 2012. http://blog.aarp.org/2012/01/25/what-is-a-complete-street/.

California Department of Motor Vehicles. 2011. "California Driver Handbook – Laws and Rules of the Road: Right of Way Rules." Accessed October 15, 2011. http://dmv.ca.gov/pubs/hdbk/right_of_way.htm.

California Department of Motor Vehicles. 2011. "Motor Vehicle Code Section 21950: Right of Way at Crosswalks." Accessed October 16, 2011. http://dmv.ca.gov/pubs/vctop/d11/vc21950.htm.

Crowley-Koch, Brian J., Ron Van Houten, and Eunyong Lim. 2011. "Effects of Pedestrian Prompts on Motorist Yielding at Crosswalks." *Journal of Applied Behavior Analysis* 44: 121-126.

Do, Ann H., Kay Fitzpatrick, Susan T. Chrysler, Jim Shurbutt, William W. Hunter, and Shawn Turner. 2011. "Safety Strategies Study." *Public Roads* 74: 3.

Duany, Andres, Elizabeth Plater-Zyberk, and Jeff Speck. 2000. *Suburban Nation: The Rise of Sprawl and the Decline of the American Dream*. New York: North Point Press.

Florido, Adrian. 2011. "Making it Easier, But Not Safer, to Cross into Balboa Park." *Voice of San Diego*, August 1. Accessed October 15, 2011. http://www.voiceofsandiego.org/survival/article_5a24b926-bcb2-11e0-9a3e-001cc4c03268.html.

Harrell, W. Andrew. 1991. "Factors Influencing Pedestrian Cautiousness in Crossing Streets." *Journal of Social Psychology* 131: 367-372.

Herms, Bruce F. 1972. "Pedestrian Crosswalk Study: Crashes in Painted and Unpainted Crosswalks." Transportation Research Board: Record No. 406.

Knoblauch, Richard L., Marsha Nitzburg, and Rita F. Seifert. 2001. "Pedestrian Crosswalk Case Studies: Sacramento, California; Richmond, Virginia; Buffalo, New York; Stillwater, Minnesota." Federal Highway Administration: FHWA-RD-00-103.

McCann, Barbara. 2005. "Complete the Streets!" *Planning* 71: 18-23.

Mehta, Vikas. 2008. "Walkable Streets: Pedestrian Behavior, Perceptions and Attitudes." *Journal of Urbanism* 1: 217-245.

National Complete Streets Coalition. 2011. "Complete Streets FAQ." Accessed November 3, 2011. http://www.completestreets.org/complete-streets-fundamentals/complete-streets-faq/.

Redmon, Tamara, and Leverson Boodlal. 2003. "Life in the Crosswalk." *Public Roads* 66: 32-37.

Rose, Jonathan. 1994. "Violence, Materialism, and Ritual: Shopping for a Center." *Modulus 23: Towards a Civil Architecture in America*: 137-151.

Royal, Dawn, and Darby Miller-Steiger. 2008. "National Survey of Bicyclist and Pedestrian Attitudes and Behavior." United States Department of Transportation: DOT-HS-810-971.

Short, John Rennie, and Luis Mauricio Pinet-Piralta. 2010. "No Accident: Traffic and Pedestrians in the Modern City." *Mobilities* 5: 41-59.

Sisiopiku, V.P. 2003. "Pedestrian Behaviors at and Perceptions Towards Various Pedestrian Facilities: An Examination based on Observation and Survey Data." *Transportation Research Part F: Traffic Psychology & Behavior* 6: 249-274.

Smith, Robin, Sharlene Reed, and Shana Baker. 2010. "Street Design: Part 1 – Complete Streets." *Public Roads* 74: 4.

Surface Transportation Policy Project. 1999. "Campaign Connection." *Surface Transportation Policy Project Progress IX.2*: 8.

Ulfarsson, Gudmundur, Sungyop Kim, and Kathleen M. Booth. 2010. "Analyzing Fault in Pedestrian-Motor Vehicle Crashes in North Carolina." *Accident Analysis and Prevention* 42: 1805-1813.

Yannis, George, John Golias, and Eleonora Papadimitriou. 2007. "Modeling Crossing Behavior and Accident Risk of Pedestrians." *Journal of Transportation Engineering* 133: 634-644.

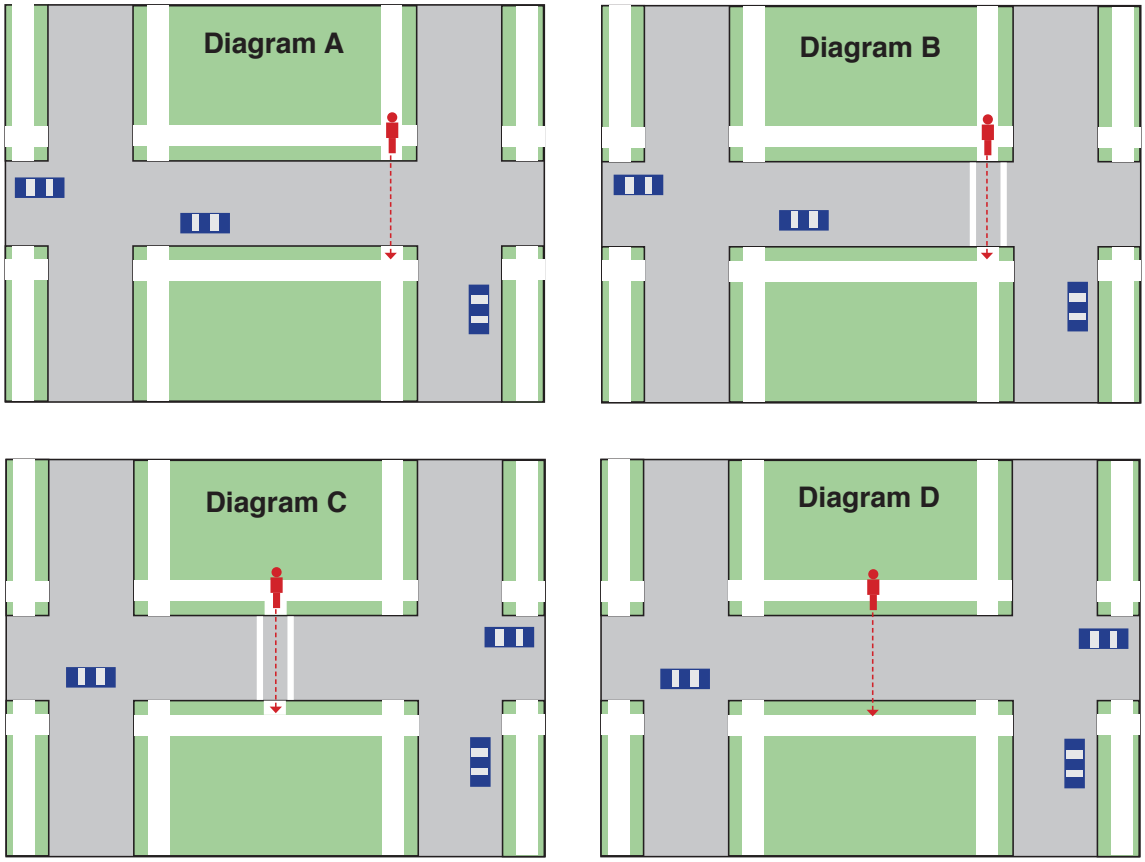
Zacharias, John. 2001. "Pedestrian Behavior and Perception in Urban Walking Environments." *Journal of Planning Literature* 16: 3-18.

Zegeer, Charles V., J. Richard Stewart, Herman H. Huang, Peter A. Lagerwey, John Feaganes, and B.J. Campbell. 2005. "Safety Effects of Marked versus Unmarked Crosswalks at Uncontrolled Locations: Final Report and Recommended Guidelines." Federal Highway Administration: FHWA-HRT-04-100.

Appendix A
Survey Materials

Survey participants were shown a larger version of the following diagrams depicting four different crosswalk situations: a marked corner crosswalk, an unmarked corner crosswalk, a marked midblock crosswalk, and an unmarked midblock crossing.

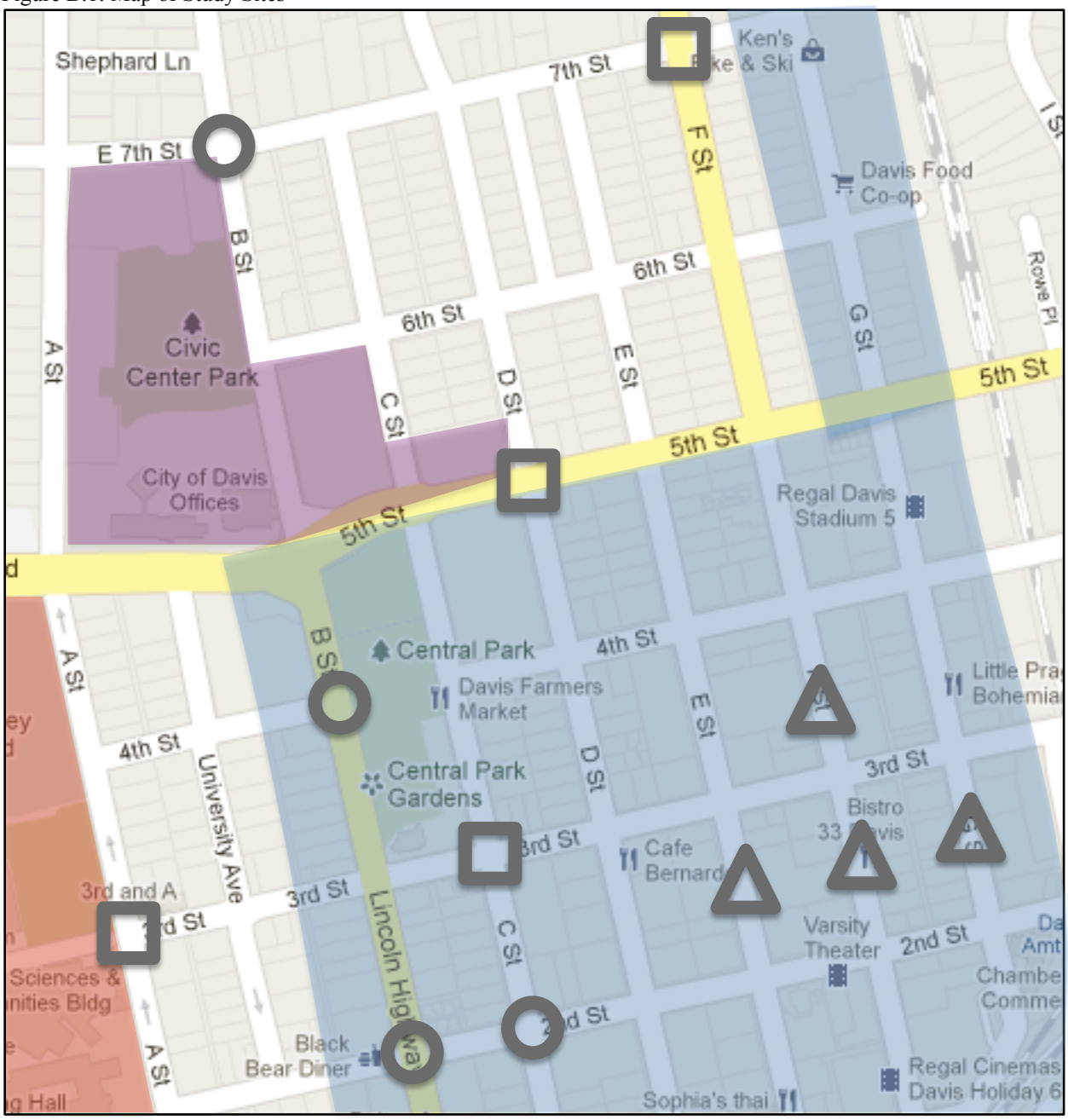
Figure A.1: Survey Crosswalk Diagrams



While looking at the diagrams, participants were asked two questions about each. First, "Under California Motor Vehicle Code, who has the right of way—the motorist or the pedestrian?" Second, "If you were the pedestrian, do you feel a motorist would be likely or unlikely to yield to you?" Their answers were recorded for each of the four diagrams.

Appendix B
Map of Study Sites

Figure B.1: Map of Study Sites



Appendix C
Final Behavior Score Data

Figure C.1: Unmarked Corner Crosswalk Summary

Score	F at 7th	5th at D	A at 3rd	3rd at C	Total	Percent
1	2	0	0	2	4	5.56%
1.3	0	1	0	0	1	1.39%
1.5	1	0	6	1	8	11.11%
1.7	0	1	0	1	2	2.78%
2	2	3	3	6	14	19.44%
2.3	0	1	1	1	3	4.17%
2.5	1	0	5	2	8	11.11%
2.7	0	0	1	2	3	4.17%
3	0	1	3	4	8	11.11%
3.3	0	1	1	2	4	5.56%
3.5	0	0	9	1	10	13.89%
3.7	0	0	1	1	2	2.78%
4	0	1	4	0	5	6.94%
4.3	0	0	0	0	0	0%
4.5	0	0	0	0	0	0%
4.7	0	0	0	0	0	0%
5	0	0	5	0	5	6.94%
Totals	**6**	**23**	**39**	**9**	**72**	**100%**

Figure C.2: Marked Corner Crosswalk Summary

Score	B at 7th	B at 4th	B at 2nd	2nd at C	Total	Percent
1	1	1	8	5	15	20.83%
1.3	0	0	3	1	4	5.56%
1.5	1	1	1	3	6	8.33%
1.7	1	0	5	0	6	8.33%
2	3	2	4	2	11	15.28%
2.3	1	0	4	0	5	6.94%
2.5	3	0	0	2	5	6.94%
2.7	0	1	3	1	5	6.94%
3	0	1	6	1	8	11.11%
3.3	0	0	0	0	0	0%
3.5	0	0	0	1	1	1.39%
3.7	0	1	2	0	3	4.17%
4	0	0	0	0	0	0%
4.3	0	0	0	0	0	0%
4.5	0	0	1	1	2	2.78%
4.7	0	0	0	0	0	0%
5	0	0	1	0	1	1.39%
Totals	**6**	**23**	**39**	**9**	**72**	**100%**

Figure C.3: Marked Midblock Crosswalk Summary

Score	F btwn 3rd/4th	E btwn 2nd/3rd	F btwn 2nd/3rd	G btwn 2nd/3rd	Total	Percent
1	3	0	1	1	5	2.55%
1.3	0	3	1	3	7	3.57%
1.5	0	4	3	1	8	4.08%
1.7	3	4	1	3	11	5.61%
2	3	15	6	6	30	15.31%
2.3	3	5	5	0	13	6.63%
2.5	5	8	3	7	23	11.73%
2.7	1	7	3	6	17	8.67%
3	9	13	8	5	35	17.86%
3.3	4	10	1	6	21	10.71%
3.5	3	2	2	2	9	4.59%
3.7	2	1	0	4	7	3.57%
4	1	3	0	4	8	4.08%
4.3	0	0	1	0	1	0.51%
4.5	0	0	0	0	0	0%
4.7	0	1	0	0	1	0.51%
5	0	0	0	0	0	0%
Totals	**37**	**76**	**35**	**48**	**196**	**100%**