Title

Driver/Pedestrian Understanding and Behavior at Marked and Unmarked Crosswalks

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UNIVERSITY OF CALIFORNIA Berkeley
Traffic Safety Center

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CALIFORNIA PATH

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Final Report for Task Order 6209

UNIVERSITY OF CALIFORNIA Berkeley
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CALIFORNIA PATH

ABSTRACT

Title: Driver and Pedestrian Behavior at Marked and Unmarked Crosswalks

Authors: Meghan Fehlig Mitman
David R. Ragland, Ph.D., MPH

Pedestrian Pedestrian injuries at crosswalk locations represent a significant problem. In 2002, 22.7 percent of US pedestrians involved in collisions were in a crosswalk at the time of the collision, and over 96% of these occurred at an intersection. Almost all crosswalk collisions resulted in pedestrian injury or fatality (98.6 percent), and about one-third resulted in severe or fatal injury (National Automotive Sampling System (NASS) and General Estimates System (GES) 2002).

As the owner of the California State Highway System, Caltrans is responsible for providing access to safe and convenient travel for pedestrians as users of a shared roadway network. Inadequate pedestrian safety in marked crosswalks at unsignalized intersections continues to challenge transportation engineers and planners. Results from thirty years of numerous localized studies have been confirmed by a nationwide study which indicate that marked crosswalks across multi-lane roads with travel volumes exceeding 10,000 average daily traffic (ADT) present a higher accident risk for pedestrians than do unmarked crossings.

Many other agencies around the nation have addressed this by removing marked crosswalks at unsignalized intersections. This approach results in unacceptable pedestrian mobility restrictions and should not be embraced as Caltrans' policy.

The Traffic Safety Center (TSC) at the University of California, Berkeley, recently completed an extensive study of pedestrian and driver knowledge of right-of-way laws. This study focused on identifying potential human factors explanations for the crosswalk dilemma. Several statistically significant differences in marked versus unmarked crosswalks were identified: (1) Pedestrians and drivers lack an accurate knowledge of right-of-way laws related to marked versus unmarked crosswalks at unsignalized intersections. (2) Pedestrians and drivers exhibit different behaviors in marked versus unmarked crosswalks on multi-lane, higher volume roads.

In this report we will present our research and offer recommendations and analyses of countermeasures to improve pedestrian crosswalk safety.

KEYWORDS

Human Factors, Partners for Advanced Transit and Highways California, Pedestrians, Risk Analysis, Safety, Traffic Accidents, Traffic Signals

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RECOMMENDED STATEWIDE STRATEGIC CROSSWALK GUIDELINES

BACKGROUND

As the owner of the California State Highway System, Caltrans has a responsibility to provide for safe and convenient pedestrian travel and embrace pedestrians as legitimate users of a shared roadway network. Marked crosswalks represent one of the most fundamental mechanisms for accommodating pedestrians. However, transportation engineers and planners have been faced with a significant dilemma regarding pedestrian safety in marked crosswalks at uncontrolled intersections.

A nationwide study in 2001 confirmed what smaller, localized studies have observed for more than thirty years[I]: on multi-lane roads with traffic volumes greater than about 12,000 vehicles per day, marked crosswalks without other substantial roadway treatments were associated with higher pedestrian crash rates than having an unmarked crosswalk[II].

Multi-lane, high speed, high volume roads comprise much of the state highway system in California. Thus, there has long been a need for Caltrans to develop strategic safety guidelines to address this dilemma. Additionally, based largely on previous crosswalk studies, as an official or unofficial policy, many cities in California have elected to remove marked crosswalks at uncontrolled intersections, or have tended to resist installing them in the first place. This approach results in unacceptable pedestrian mobility restrictions and should not be embraced as a policy. Instead, Caltrans has the opportunity to take the lead in pedestrian safety and accommodation at uncontrolled intersections by establishing model guidelines for marked crosswalks throughout California.

To inform development of strategic safety guidelines for pedestrian crossings, the Traffic Safety Center (TSC) at the University of California, Berkeley, recently completed a study of pedestrian and driver knowledge of right-of-way laws in a series of focus groups and surveys, as well as observations of pedestrian and driver behavior at a sample of unsignalized, high volume, three- and four-lane intersections in the San Francisco Bay Area. This study focused on identifying potential human factors explanations for the crosswalk dilemma.

The study concluded that pedestrians and drivers have significantly different knowledge of right-of-way laws and crossing/yielding behaviors in marked versus unmarked crosswalks[III,IV]. These findings represent some "missing links" in the marked crosswalk debate and may help to explain the differences in crash risk in marked versus unmarked crosswalks on certain multi-lane roadways. Key insights include the following points:

1. Based on field observations, pedestrians in marked crosswalks were more likely than pedestrians in unmarked crosswalks to have drivers immediately yield the right-of-way to them. Additionally based on surveys and focus groups, drivers were likely to be confused regarding right-of-way laws at unmarked crosswalks. Thus, it seems reasonable that a lower driver yielding (motorist compliance) rate at unmarked crosswalks may be at least partially a result of a lack of knowledge of the pedestrian's right-of-way within unmarked crosswalks.

2. Based on surveys and focus groups, pedestrians were also likely to be confused regarding right-of-way laws at unmarked crosswalks. Taken in combination with the finding that pedestrians in the marked crosswalk were more likely than pedestrians in the unmarked crosswalk to have drivers immediately

yield the right-of-way to them, it seems reasonable that pedestrians exhibit greater caution in unmarked crosswalks because either (1) they do not know motorists must legally yield the right-of-way when they are crossing in unmarked and marked crosswalks, or (2) experience has taught them that drivers are not likely to yield.

3 It is then also plausible that pedestrians exhibit less caution when crossing in marked crosswalks for similar reasons: (1) they are more likely to know that drivers must yield the right-of-way to them, or (2) experience has taught them that drivers are more likely to yield.

4 Another observed paradox is that the higher rate of yielding in marked crosswalks can result in an increased incidence of multiple threat crashes.[1] However, this paradox may have a rational explanation. Even in marked crosswalks, motorist compliance (yielding) rates are not 100 percent, and thus a driver yielding in one lane does not assure a driver will yield in an adjacent lane. Further, the first driver is more likely to yield at a marked crosswalk than at an unmarked crosswalk. Therefore, it is reasonable that there is a greater risk that a pedestrian crossing in a marked crosswalk will be involved in a potential multiple threat scenario than a pedestrian crossing in an unmarked crosswalk, unless other needed treatments are implemented.

RECOMMENDED STRATEGIC SAFETY GUIDELINES

The results of this study should not be interpreted as justification simply to remove marked crosswalks or to fail to install marked crosswalks at appropriate pedestrian crossings. Such an approach does not address the safety and mobility needs of pedestrians.

Instead, these new insights underscore the need for a policy re-prioritization to embrace a broader range of countermeasure treatments and better address the role of human factors in pedestrian collisions. The following guidelines are illustrative components of a more balanced, "3-E" strategy to mitigate crash risk within crosswalks. The three types of countermeasures are envisioned to efficiently work together to encourage safe and lawful behavior by both pedestrians and drivers.

ENGINEERING COUNTERMEASURES

Recognizing the limited funds available for engineering countermeasures and the significant number of potential implementation sites, there is a need for strategic planning to maximize the benefits of countermeasure deployment. It is recommended that Caltrans obtain a full inventory of "at risk" crosswalks using the Seattle model for strategic crosswalk safety planning[V]. Caltrans could complete such as inventory for the State Highway System and establish guidelines (and funding sources) for cities to complete local inventories. By developing a crosswalk inventory, system owners would then be able to prioritize locations for engineering countermeasure installation. At each of the identified treatment locations, appropriate engineering countermeasures should be selected from resources such as:

- Guidelines on Improving Pedestrian Safety at Uncontrolled Crossings (NCHRP/TCRP Report 562, 2006)[VI]
- PEDSAFE Safety Guide and Countermeasure Selection System (FHWA, 2002)[VII]
- AASHTO Guidelines for Reducing Collisions Involving Pedestrians (NCHRP Report 500, Vol. 10, 2004)[VIII]

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1 Multiple-threat crashes occur on multi-lane roads when the driver and pedestrian fail to see each other in time to prevent the collision because their line of sight is blocked by a driver yielding to the pedestrian in an adjacent lane.

EDUCATION COUNTERMEASURES

Engineering countermeasures should be supplemented with education and enforcement at each of the treatment sites selected from the crosswalk inventory. Additionally, broader education and enforcement initiatives can be designed to address crosswalk safety at all locations, not just those prioritized for engineering countermeasure installation.

Specifically, installation of "make eye contact with drivers" warning signs and pedestrian flags is recommended at uncontrolled crosswalks to enhance the visibility of pedestrians across multi-lane, high-volume roads.

It is further suggested that a thorough review and revision of the pedestrian section of the Driver's Handbook be conducted to provide enhanced explanations of right-of-way laws and common risk scenarios[IX].

Finally, opportunities to educate non-driver pedestrians could be explored. A statewide pedestrian safety campaign is recommended to emphasize safe crossing practices (with a message similar to the classic advice of "Stop, Look Left, Look Right") regardless of crosswalk markings or treatments.

ENFORCEMENT COUNTERMEASURES

As with educational measures, it is important that enforcement measures target both pedestrians and drivers. However, it is suggested that education focus on pedestrians and enforcement focus on drivers. Recommended innovative enforcement strategies that seek to enhance pedestrian and driver knowledge of and compliance with right-of-way laws include enforcement "stings," educational warnings in lieu of or in addition to fines, and community enforcement programs. Sustained enforcement efforts can also serve as valuable educational campaigns by incorporating warnings, informational pamphlets, media coverage, and community involvement activities[X]. In this way, road users may learn the right-of-way laws through enforcement of these laws.

CONCLUDING THOUGHTS

Crosswalks at uncontrolled intersections are numerous and widespread. While engineering countermeasures offer significant potential for reducing pedestrian crash risk, not every intersection is in need of an engineering treatment. Prioritizing deployment of engineering countermeasures to the areas with the highest risk and potential for the greatest improvement represents the best use of limited resources. For the other portions of the roadway system, there is a need for a paradigm shift to include broader deployment of education and enforcement countermeasures. These treatments must supplement engineering treatments to provide pedestrian safety benefits for all and ensure walking is embraced as a legitimate and important transportation mode.

While the current study was able to address some of the gaps in the literature, there is still much to be learned regarding motorist and pedestrian interactions and safety. Further research is particularly needed to address the safety effects of many of the treatments that have been proposed for uncontrolled crossings.

It is recognized that the results of this study are based on a limited number of intersections in the San Francisco Bay area and may not necessarily represent conditions or pedestrian and motorist behaviors at other location conditions or in other parts of the U.S. It would be helpful for future research to continue to explore pedestrian and motorist conflicts and behaviors in uncontrolled pedestrian crossings under a wide range of traffic and roadway conditions.

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EXECUTIVE SUMMARY

OVERVIEW

Pedestrian injuries at crosswalk locations represent a significant problem. In 2002, 22.7 percent of US pedestrians involved in collisions were in a crosswalk at the time of the collision, and over 96% of these occurred at an intersection. Almost all crosswalk collisions resulted in pedestrian injury or fatality (98.6 percent), and about one-third resulted in severe or fatal injury (National Automotive Sampling System (NASS) and General Estimates System (GES) 2002).

As the owner of the California State Highway System, Caltrans is responsible for providing access to safe and convenient travel for pedestrians as users of a shared roadway network. Inadequate pedestrian safety in marked crosswalks at unsignalized intersections continues to challenge transportation engineers and planners. Results from thirty years of numerous localized studies have been confirmed by a nationwide study which indicate that marked crosswalks across multi-lane roads with travel volumes exceeding 10,000 average daily traffic (ADT) present a higher accident risk for pedestrians than do unmarked crossings.

Many other agencies around the nation have addressed this by removing marked crosswalks at unsignalized intersections. This approach results in unacceptable pedestrian mobility restrictions and should not be embraced as Caltrans' policy.

The Traffic Safety Center (TSC) at the University of California, Berkeley, recently completed an extensive study of pedestrian and driver knowledge of right-of-way laws. This study focused on identifying potential human factors explanations for the crosswalk dilemma. Several statistically significant differences in marked versus unmarked crosswalks were identified:

- Pedestrians and drivers lack an accurate knowledge of right-of-way laws related to marked versus unmarked crosswalks at unsignalized intersections.
- Pedestrians and drivers exhibit different behaviors in marked versus unmarked crosswalks on multi-lane, higher volume roads.

In this report we will present our research and offer recommendations and analyses of countermeasures to improve pedestrian crosswalk safety.

SECTION 1

CROSSWALK CONFUSION

WHY PEDESTRIAN AND DRIVER KNOWLEDGE OF THE VEHICLE CODE SHOULD NOT BE ASSUMED

AUTHORS: Meghan Fehlig Mitman and David R. Ragland, Ph.D., MPH

INTRODUCTION

Traffic safety researchers have long argued that driver behavior outweighs physical elements as a cause of motor vehicle collisions. In pedestrian-vehicle collisions behavior is also a fundamental cause—both that of the driver and of the pedestrian. One determining factor is whether the driver, the pedestrian, or both, understand the motor vehicle code. Although knowledge does not guarantee compliance, a lack of knowledge could suggest a significant pedestrian safety concern and opportunities for improvement.

We expanded on the results of previous studies by considering driver and pedestrian knowledge of laws specifically related to marked and unmarked crosswalks. The focus on crosswalk markings is warranted by the ongoing debate regarding whether and why collision risk for pedestrians is higher in marked versus unmarked crosswalks.

In Section 1 we present the results of driver and pedestrian intercept surveys and focus groups conducted in the San Francisco Bay Area as a component of the overall study considering driver and pedestrian behavior at marked and unmarked crosswalks. Implications for engineering, education, and enforcement countermeasures are discussed and areas for further research are recommended.

THE VEHICLE CODE

The National Committee on Uniform Traffic Laws and Ordinances (NCUTLO), a private, nonprofit group, has proposed a Uniform Vehicle Code as a set of national traffic laws. Many states have based their traffic regulations on this standard, though the letter and spirit of pedestrian right-of-way laws can vary widely. In California, where original data was collected for this study, the vehicle code regarding pedestrian and driver responsibility states that the driver of a vehicle must yield the right-of-way to a pedestrian crossing the roadway within any marked or unmarked crosswalk at an intersection. The law makes it clear that pedestrians and drivers have a shared responsibility, but also uses ambiguous language which may lead to confusion on the part of both parties.

PREVIOUS STUDIES

Previous studies have shown that both drivers and pedestrians have a limited understanding of right-of-way laws. A key component missing from the previous studies is the examination of pedestrian and driver understanding of right-of-way specifically at marked versus unmarked crosswalks. The Traffic Safety Center (TSC) at the University of California, Berkeley examines for the first time whether drivers and pedestrians exhibit different behavior at marked versus unmarked crosswalks on multi-lane roads. Understanding the extent of driver and pedestrian comprehension of the law in these situations may account for observed differences in behavior, and partially explain the marked-unmarked collision risk phenomenon.

OUR RESEARCH

A component of the TSC crosswalk behavior study included pedestrian and driver intercept surveys and focus groups, which were conducted between September 2005 and June 2006. These original data collection efforts addressed:

- Understanding of right-of-way laws
- Self-reported behavior
- Perceptions of effectiveness of education, enforcement, and engineering countermeasures

We oversampled the pedestrian population, because we were particularly interested in understanding pedestrian behavior. We also oversampled for seniors (people age 65 or older) because of their vulnerability as users of the road. We believe a focus on improving conditions for seniors will result in improved conditions for all.

Survey Results

Intercept surveys were self-administered and were completed by participants under close supervision by the field staff. Pedestrian participants were intercepted immediately after crossing unsignalized intersections in one of four urban pedestrian areas.

The results suggest that most drivers and pedestrians understand the law when the message is clear and simple. When all crossings are marked the pedestrian's right-of-way is mostly understood, as is the concept that unmarked midblock crossing (jaywalking) is illegal. Surprisingly, over 35 percent of driver respondents did not believe that pedestrians have the right-of-way even at marked crosswalks. Overall, pedestrians provided vehicle code-correct responses 63.0 percent of the time and drivers provided correct responses 55.6 percent of the time.

Focus Group Results

We also used focus groups to provide a more interactive discussion of driver and pedestrian knowledge and behavior. Six focus groups were conducted in the San Francisco Bay Area in four different locations and among two different age groups. In Section 1 we present the survey results from the focus groups along with the discussion session comments to provide quantitative and qualitative responses for three different marked and unmarked crosswalk scenarios.

Given the small sample size and anecdotal nature of much of the data, statistics were not computed for the focus group responses. Instead, the overall range of responses to the discussion scenarios is presented in Section 1 along with the percentage of participants providing the correct response for the equivalent survey question. More detail of the focus group comments is presented in Section 4. Overall, the focus group results corroborate data from the intercept surveys and previous research and again suggest that knowledge of the law cannot be assumed, especially in complex situations.

COUNTERMEASURE IMPLICATIONS

There may be a connection between knowledge of pedestrian right-of-way laws and collision risk. Therefore, in addition to physical countermeasures for enhancing safety in marked crosswalks, behavioral countermeasures may also be needed.

The appropriate combination of education, engineering, and enforcement countermeasures, often referred to as the 3-Es of Safety, has been a subject of debate for many decades. We recommend a re-balanced 3-E strategy that would address the demonstrated lack of knowledge of right-of-way laws. Descriptions of these countermeasures and focus group appraisal of their effectiveness is presented in Section 4.

CONCLUDING THOUGHTS

An important, possibly more fundamental, consideration in selecting and balancing pedestrian safety countermeasures is whether the vehicle code itself should first be amended. Perhaps drivers and pedestrians lack knowledge of the law because the law is inherently confusing or unfair. Authors of various studies have made concrete suggestions for how vehicle code amendments should be formulated. The suggestions vary widely in their visions of what would constitute a better driving or walking environment.

We present strategies which offer a proactive approach to pedestrian safety that does not first require the assumption of driver and pedestrian knowledge of the law. The implementation of these balanced countermeasures offers an opportunity to both actively and passively communicate the importance of these laws in maintaining safety for all road users. A change in societal norms may be required before meaningful and sustainable improvements in pedestrian safety can occur. Diagnosing the extent to which drivers and pedestrians know and understand the vehicle code is an important step in this endeavor.

SECTION 2
THE MARKED CROSSWALK DILEMMA
UNCOVERING SOME MISSING LINKS IN A 35-YEAR DEBATE

AUTHORS: Meghan Fehlig Mitman

ABSTRACT

Responding to several landmark safety studies, many agencies across the U.S. have elected to remove marked crosswalks at uncontrolled intersections, or have resisted installing them in the first place. This approach results in unacceptable restrictions of pedestrian mobility, the implications of which are often not considered in policy-making. Therefore, there is a need for roadway system owners to develop strategic safety guidelines to address the marked crosswalk dilemma.

The goal of the TSC's study is to develop a better understanding of driver and pedestrian behavior and safety in both marked and unmarked crosswalks in an effort to recommend more informed crosswalk policies. The study was designed to fill key gaps in the literature by analyzing pedestrian and driver behavior and knowledge of right-of-way laws related to marked and unmarked crosswalks, as well as driver and pedestrian behavior regarding multiple threat scenarios, the most common type of pedestrian collisions at uncontrolled intersections.

INTRODUCTION

Currently the need for more sustainable transportation solutions is critical and a greater focus on non-motorized alternatives to the automobile is clearly warranted and is gaining momentum throughout the United States. It is imperative to consider pedestrian safety in the process of reorienting transportation and land use. Over 35 years of pedestrian safety research has focused on marked and unmarked crosswalks, making this topic one of the most debated in the field.

BACKGROUND

Previous research focusing on uncontrolled crosswalks can generally be grouped in two key areas: (1) safety research regarding collision trends, and (2) behavioral research analyzing driver and pedestrian behavior within crosswalks.

Bruce Herms' famous 1972 study in San Diego found that marked crosswalks were the sites of twice as many crashes as unmarked crosswalks. A 2001 landmark study conducted by Zegeer, *et al*. for the Federal Highway Administration (FHWA) analyzed five years of pedestrian collisions at 1,000 marked crosswalks and 1,000 matched unmarked comparison sites in 30 U.S. cities. The study concluded that there were no meaningful differences in crash risk between marked and unmarked crosswalks on two-lane roads or low-volume multi-lane roads. However, researchers concluded that, particularly on high-speed, high-volume and multi-lane roads, painted white lines are not enough to improve pedestrian safety.

One of the central debates regarding pedestrian behavior in crosswalks is whether pedestrians are less cautious in marked crosswalks than in unmarked crosswalks or non-crosswalk locations. Results from subsequent studies have varied widely, from Herms' 1972 hypothesis that pedestrians' lack of caution may lead to the higher rate of crashes observed in marked crosswalks compared to unmarked crosswalks. However, Knoblauch (2001) and Nitzburg (2001) found no difference in pedestrian assertiveness in marked and unmarked crosswalks, while pedestrian searching behavior (looking left and right for oncoming traffic) actually improved at crossings after they were marked. Others, such as Hauck (1979) have also found that pedestrian behavior improves in well-marked crosswalks compared to unmarked or poorly marked crosswalks.

There have been fewer studies of driver behavior, but it is generally agreed that drivers often fail to yield to pedestrians at both marked and unmarked crosswalks. The effects on driver behavior of marking a crosswalk have remained unclear.

METHODS

Building on the Knoblauch (2001) behavioral research, this study followed a similar methodology, except that this analysis focused primarily on roads with four or more lanes. Utilizing a matched pair approach, driver and pedestrian behavior within marked and unmarked crosswalk pairs at the same intersection were compared. Intersections with matched pairs of marked and unmarked crosswalks were considered desirable because most exogenous factors are held constant, allowing for a direct comparison between the crosswalks.

Previous studies have noted that driver yielding is related to vehicle speeds. All six of our observation locations had speed limits of 25 to 30 MPH in an effort to reduce potential yielding behavior discrepancies based on speed. All six sites are located in the San Francisco Bay Area.

At each of our observation locations, the following study questions were addressed: (1) whether pedestrians use more, less, or the same amount of caution when crossing at a marked crosswalk; (2) whether the age or gender of the pedestrian are correlated with his or her behavior; and (3) whether drivers yield more often to pedestrians in marked crosswalks than unmarked crosswalks.

DATA COLLECTION

For this study, a pilot evaluation of video and clipboard-based data collection methods was conducted to determine the best data collection methodology. The evaluation considered accuracy, reliability, validity, and cost. Clipboard-based (manual) data collection was selected as the best method for the purposes of this study. Data collection occurred during daylight hours on non-rainy days from May to October, 2006. For one of the locations, video footage available from another Traffic Safety Center project was utilized in lieu of in-person observations, with observers using the same data collection form as was used for the field observations.

DATA ANALYSIS

The statistical analysis package SAS was utilized to compare driver and pedestrian behavior observations. This comparison was typically accomplished via a Chi-Squared test, a non-parametric test of statistical significance appropriate for bivariate tables. However, in some instances comparison cells had expected values of less than five. In these cases, the Fisher's Exact Test was used instead of the Chi-Squared test.

In addition to the observation variables included on the data collection form, the following derived variables were analyzed for each observation location: average gap acceptance (lanes); average number of immediate yields (drivers); average vehicle exposure (pedestrians); and multiple threat opportunity.

RESULTS

Unlike previous behavioral studies, in this study differences in pedestrian behavior suggest pedestrians exhibit a greater level of caution when crossing in unmarked crosswalks than in marked crosswalks. Also unlike previous studies which found no significant differences, results from this study suggest that drivers yield more frequently to pedestrians in marked crosswalks compared to unmarked crosswalks. Also consistent with the FHWA study is the finding that potential multiple threat scenarios arise more commonly in marked crosswalks, a critical behavioral variable that has not been considered in the behavioral literature to date.

These observed behavioral differences, in combination with previously reported study findings regarding driver and pedestrian knowledge of right-of-way laws, represent "missing links" in the marked crosswalk debate and may help to explain the differences in crash risk in marked versus unmarked crosswalks on certain multi-lane roadways. Key insights include the following points:

1. Pedestrians in the marked crosswalk were more likely than pedestrians in the unmarked crosswalk to have drivers immediately yield the right-of-way to them and drivers were likely to be confused regarding right-of-way laws at unmarked crosswalks. Thus, it seems reasonable that a lower driver yielding (motorist compliance) rate at unmarked crosswalks may be at least partially a result of a lack of knowledge of the pedestrian's right-of-way within unmarked crosswalks.
2. Pedestrians were also likely to be confused regarding right-of-way laws at unmarked crosswalks. It seems reasonable that pedestrians exhibit extraordinary caution in unmarked crosswalks because either (1) they do not know motorists must legally yield the right-of-way when they are crossing in unmarked and marked crosswalks, or (2) experience has taught them that drivers are not likely to yield, or a combination of both.
3. It is then also plausible that pedestrians exhibit ordinary (as opposed to extraordinary) caution when crossing in marked crosswalks for similar reasons: (1) they are more likely to know that drivers must yield the right-of-way to them, or (2) experience has taught them that drivers are more likely to yield, or a combination of both.
4. Another observed paradox is that the higher rate of yielding in marked crosswalks can result in an increased incidence of multiple threat crashes. However, this paradox may have a rational explanation. Even in marked crosswalks, motorist compliance (yielding) rates are not 100 percent, and thus a driver yielding in one lane does not assure a driver will yield in an adjacent lane. Further, the first driver is more likely to yield at a marked crosswalk than at an unmarked crosswalk. Therefore, it is reasonable that there is a greater risk that a pedestrian crossing in a marked crosswalk will be involved in a potential multiple threat scenario than a pedestrian crossing in an unmarked crosswalk, unless other needed treatments are implemented.

RECOMMENDATIONS

These new insights underscore the need for a policy re-prioritization to embrace a broader range of countermeasure treatments and better address the role of human factors in pedestrian collisions. The following guidelines are illustrative components of a more balanced, "3-E" strategy to mitigate crash risk within crosswalks.

Engineering Countermeasures: It is recommended that system owners obtain a full inventory of "at risk" crosswalks using the Seattle model for strategic crosswalk safety planning. By developing a crosswalk inventory, system owners would then be able to prioritize locations for engineering countermeasure installation.

Education Countermeasures: installation of signs encouraging pedestrians to make eye contact with drivers when crossing should be considered, along with review and revision of the pedestrian section of Driver's Handbooks be conducted to provide enhanced explanations of right-of-way laws and common risk scenarios. Finally, a statewide pedestrian safety campaign is recommended to emphasize safe crossing practices (with a message similar to the classic advice of "Stop, Look Left, Look Right") regardless of crosswalk markings or treatments.

Enforcement Countermeasures: it is important that enforcement measures target both pedestrians and drivers. Recommended innovative enforcement strategies that seek to enhance pedestrian and driver knowledge of and compliance with right-of-way laws include enforcement "stings," educational warnings in lieu of or in addition to fines, and community enforcement programs. Sustained enforcement efforts can also serve as valuable educational campaigns by incorporating warnings, informational pamphlets, media coverage, and community involvement activities. In this way, road users may learn the right-of-way laws through enforcement of these laws.

CONCLUDING THOUGHTS

While engineering countermeasures offer significant potential for reducing pedestrian crash risk, not every intersection is in need of an engineering treatment. Prioritizing implementation of engineering countermeasures to the areas with the highest risk and potential for the greatest improvement represents the best use of limited resources. For the other portions of a roadway system, there is a need for a paradigm shift to include broader deployment of education and enforcement countermeasures. These treatments must supplement engineering treatments to provide pedestrian safety benefits for all and ensure walking is embraced as a legitimate and important transportation mode.

SECTION 3

WHAT THE LITERATURE SAYS

A REVIEW OF PREVIOUS CROSSWALK SAFETY STUDIES

AUTHORS: Emily Johnson

INTRODUCTION

Section 3 reviews the literature related to four key aspects of this study: pedestrian and driver knowledge of crosswalk law, pedestrian crash patterns in crosswalks, pedestrian and driver behavior in marked and unmarked crosswalks, and countermeasures to increase pedestrian safety in crosswalks.

PEDESTRIAN AND DRIVER KNOWLEDGE OF CROSSWALK LAW

Overall, there are few studies that analyze pedestrians' and drivers' understanding of crosswalk laws. One study (Tidwell and Doyle, 1995) found that most people understood that pedestrians must cross at signals or crosswalks and that turning drivers must yield to pedestrians in the crosswalk at intersections. However, that study and others confirm that there is confusion on the part of both pedestrians and drivers about the extent of pedestrians' right of way at crosswalks.

PEDESTRIAN CRASH PATTERNS IN CROSSWALKS

There is a long and influential history of research on the safety impacts of marked and unmarked crosswalks. One of the first and most famous of these is Herms' 1972 study in San Diego, which found that marked crosswalks had twice as many crashes as unmarked crosswalks. Several other studies found similar results (Gibby 1994), but their methodologies have been criticized (Campbell 1997) as having flawed methodology and insufficient data.

A more recent study found no difference between crash rates at unmarked and marked crosswalks at uncontrolled intersections on two-lane roads (Zegeer 2002), but that on high-volume (over 12,000 ADT) multi-lane roads, uncontrolled intersections with a marked crosswalk (and no other treatments) did have higher crash rates than unmarked crosswalks. Zegeer suggests that crossings on these road types should have additional treatments, such as a raised median or pedestrian signal. This debate underscores the importance of controlling for pre-existing contextual factors such as pedestrian volume, vehicle volume, and road design, as well as the importance of analyzing pedestrian and driver behavior to understand crash statistics.

PEDESTRIAN AND DRIVER BEHAVIOR AT MARKED AND UNMARKED CROSSWALKS

One of the central debates about pedestrian behavior in crosswalks is whether pedestrians feel a false sense of security in marked crosswalks that leads them to be less cautious or more aggressive than in unmarked crosswalks or non-crosswalk locations. Early studies, most famously Herms' 1972 analysis, suggested that this leads to a higher rate of crashes in marked crosswalks compared to unmarked crosswalks. However, Knoblauch (2001) and Nitzburg (2001) found no difference in pedestrian aggressiveness in marked and unmarked crosswalks, while others (Hauck 1979) found that pedestrian behavior improves in well-marked crosswalks compared to unmarked or poorly marked crosswalks.

There have been fewer studies of driver behavior, but it is generally agreed that drivers often fail to yield to pedestrians at both marked and unmarked crosswalks. Nasar (2003) observed that many drivers ignored pedestrians in crosswalks, or sped up or swerved to pass them.

There appears to be some dissonance between observed and stated behavior. Varhelyi's (1996) study of motorist behavior at a non-signalized zebra crossing found that in 73 percent of "critical" cases, the vehicle maintained or even increased speed, and in only 27 percent of cases did drivers slow down as required. At the same time, a separate survey found that in 67 percent of the cases, motorists say they "always" or "very often" slow down.

While the results of these studies vary, the idea that crosswalks by themselves cause aggressive behavior or lack of caution is not evident. However, both pedestrians and drivers routinely disobey crosswalk laws, often the result of a desire for more convenient or faster travel. Additionally, beliefs and behaviors appear to be inconsistent, both for drivers and pedestrians.

COUNTERMEASURES TO INCREASE PEDESTRIAN SAFETY IN CROSSWALKS

There are numerous evaluations of engineering and street design countermeasures to improve pedestrian safety in crosswalks, including signage, lighting, and high-visibility striping. Van Houten and Malenfant (1989) found that one series of countermeasures resulted in large increases in the percentage of drivers yielding to pedestrians. Another study by Van Houten (1992) found that adding signs, a stop line, and pedestrian-activated lights increased the percentage of drivers stopping by up to 50% and substantially reduced the number of conflicts.

New video-based pedestrian detection systems can detect not only pedestrians waiting to cross, but can track their progress through the crosswalk and adjust the signal based on their walking speed (NCBW). This not only accommodates slower pedestrians, reducing the number "caught" in the crosswalk, but also reduces delay for vehicles by shortening the pedestrian cycle for faster pedestrians.

Social marketing approaches may also be effective. Educational approaches, while common, are rarely formally evaluated, and there is little evidence that they are effective (Zegeer 2004). Similarly, there are few evaluations of enforcement programs and little evidence of their effectiveness. An evaluation of a public education and enforcement program in Seattle (Britt, Bergman and Moffat 1995), suggests that a very high level of enforcement is necessary to achieve even minor or temporary changes in driver behavior and that environmental and behavioral factors may be more influential than enforcement.

APPENDIX A

FIELD OBSERVATION METHODOLOGY AND RESULTS

PEDESTRIAN AND DRIVER BEHAVIOR IN MARKED VERSUS UNMARKED CROSSWALKS

AUTHORS: Meghan Fehlig Mitman

INTRODUCTION

The environmental, social, health, and economic benefits of walkable communities have become increasingly apparent. At a time when the need for sustainable transportation solutions is critical, a greater focus on pedestrian-oriented alternatives to auto-dependency is clearly warranted. It is imperative to consider pedestrian safety as we re-orient transportation and land use planning. Section 2 documents and interprets field observations of drivers and pedestrians in marked and unmarked crosswalks at unsignalized intersections.

BACKGROUND

One of the central debates about pedestrian behavior in crosswalks is whether pedestrians feel a false sense of security in marked crosswalks that leads them to be less cautious or more aggressive than in unmarked crosswalks or non-crosswalk locations. Thirty years of pedestrian safety research has since considered this fundamental question. Research continues in this field today in two primary areas: clarifying and supplementing recommended engineering countermeasures from an earlier authoritative study (Zegeer, C., et al.: *Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations*), and analyzing the underlying behavioral characteristics that may contribute to pedestrian collisions and may also better inform the selection of countermeasures.

METHODS

instead of repeating studies on 2 and 3-lane roads, our analysis studied mostly roads with 4 or more lanes. Employing a matched pair approach, we compared marked and unmarked crosswalk pairs at the same intersection because all exogenous factors are held constant, allowing for a direct comparison between the crosswalks. We selected six sites for study and considered four different questions regarding pedestrian behavior, including whether pedestrians were more likely to cross within marked crosswalks, whether drivers yielded more often to pedestrians in marked crosswalks than in unmarked crosswalks, and whether pedestrians used more or less caution when crossing at marked crosswalks versus unmarked crosswalks.

DATA COLLECTION AND ANALYSIS

After a pilot test evaluation of video versus clipboard-based (manual) data collection, we selected the clipboard-based method as superior for the purposes of this study. Data collection occurred during daylight hours on non-rainy days from May to October, 2006. For the majority of the study sites, marked and unmarked crosswalk observations were collected concurrently at each site.

We employed a comprehensive quality control process to prepare field data for analysis. The statistical analysis package SAS was then utilized to compare driver and pedestrian behavior observations in marked versus unmarked crosswalks at each of the six observation locations. In addition to the observation variables included on the data collection form, the following derived variables were analyzed for each observation location: average gap acceptance, average number of immediate yields, average vehicle exposure, and multiple threat opportunity.

RESULTS

For each of the six observation sites, we present a detailed summary of the statistical analysis, including photos of each intersection and background characteristics. Statistically significant findings are summarized for each intersection, followed by an overall summary of findings and a discussion of the results.

The following are some of the overall trends we observed in our comparison of pedestrian and driver behavior in unmarked versus marked crosswalks at unsignalized intersections:

- Pedestrians seem to be more assertive and are more likely to "look both ways" in multi-lane unmarked crosswalks
- Pedestrians walk with a faster pace in unmarked crosswalks
- Pedestrians wait for larger gaps in traffic before crossing in unmarked crosswalks
- Drivers yield more frequently to pedestrians in marked crosswalks
- Pedestrians experience somewhat less exposure to vehicles when crossing in multi-lane unmarked crosswalks
- The potential for multiple threat collisions is lower in unmarked crosswalks

Unlike previous behavioral studies, our results show statistically significant differences in driver and pedestrian behavior at marked versus unmarked crosswalks, even for two and three-lane roads. However, these differences appear more pronounced for multi-lane roads. This finding is consistent with the Zegeer (2001) study that illustrated gradients in collision rate differences related to the number of lanes, with the difference in marked versus unmarked becoming significant only for multi-lane roads. Also consistent with the Zegeer study is our finding that multiple threat scenarios arise more commonly in marked crosswalks.

APPENDIX B

FOCUS GROUP RESULTS

BERKELEY, OAKLAND, WALNUT CREEK, AND ALBANY

AUTHORS: Cynthia Sue McCormick

INTRODUCTION

Driver/pedestrian concerns and experiences at crosswalks, understanding of the crosswalk right-of-way laws, and opinions regarding countermeasure effectiveness were explored in five focus groups conducted in Northern California between October 2005 and March 2006. The focus groups were held in three different locations and among two different age groups: adults over the age of 65 (senior) and adults 65 years of age or younger (adult). Section 4 describes the general findings from the focus groups. More detailed information from the focus groups is presented in Appendix D.

PARTICIPANT SURVEY

At the beginning of each focus group a questionnaire was administered that explored the demographic profiles of focus group participants, their primary mode of travel, and their knowledge of the right-of-way at crosswalks. It should be noted that all of the adult participants live in an urban environment, while the seniors live in either a suburban environment (Walnut Creek) or an urban environment (Berkeley). In Section 4 we break down these differences for the more informative categories (income, automobile ownership rates, and travel mode).

There were two questions on the survey to assess knowledge of pedestrian right-of-way at both marked and unmarked crosswalks. The first question asked when pedestrians trying to cross the street have the right-of-way. The second question asked when it is illegal to cross the street in California.

SYNTHESIS OF FOCUS GROUP DISCUSSIONS

Driver/Pedestrian Behavior: Several concerns came up repeatedly in the focus groups including: aggressive/speeding drivers; drivers who don't watch for pedestrians or deliberately ignore the pedestrian (especially when turning, drivers who speed up to make the light, and drivers who are distracted (e.g., music, cell phones). Participants were also concerned about pedestrians who don't make drivers aware of their presence, who fail to look right or left before stepping out into the crosswalk, who over-assert their right-of-way, and who don't recognize the dangers of their actions.

Physical Attributes: Concerns voiced most often by participants were: signals that don't allow enough time for pedestrians to cross the street; potholes/uneven pavement; crosswalk markings that are faded or difficult to see, obstructions that block the driver's view, lack of lights at night, and the inability of drivers to see pedestrians when there are cars in adjacent lanes. Other concerns included lack of multi-lingual signs, lack of in-pavement lights to alert drivers to crosswalks, and lack of police enforcement.

Right-of-Way: While most participants agreed that the pedestrian has the right-of-way in any crosswalk when there are two marked and two unmarked crosswalks, their answers depended on whether or not there was a stop sign and whether or not the pedestrian had already stepped into the intersection. One respondent said that the pedestrian could only cross in an unmarked area when it appeared safe. Approximately one-half of the participants indicated that drivers would typically yield to them in a crosswalk and they discussed driver characteristics and situations which seemed to make drivers more or less likely to yield.

Countermeasures: Section 4 presents detailed responses to the 3E system of countermeasures. Overall, all of the participants understood that the pedestrian has the right-of-way in a marked crosswalk, while approximately half of the participants thought the pedestrian has the right-of-way in an unmarked crosswalk or when there are both marked and unmarked crosswalks in the intersection. At mid-block, 75% of participants felt the pedestrian has the right-of-way in a marked crosswalk, while only 3% thought pedestrians have the right-of-way when there is no marked crosswalk mid-block. However, if there is no signal at the intersection, 81% of participants thought the pedestrian could legally cross the street mid-block without a marked crosswalk. Forty-one percent of participants thought it was illegal for pedestrians to step out in front of a vehicle. Primary concerns of participants were: driver behavior (e.g., aggressive or distracted drivers who don't give pedestrians the right-of-way), and inadequate signal timing to cross the street, especially for the disabled and senior population. Participants felt school campaigns were an effective educational countermeasure, while print ads were thought to be the least effective of those countermeasures presented. Vivid-striping, in-pavement lighting, and the countdown signal were thought to be the most effective engineering countermeasures, while raised crosswalks and advanced yield-marking were thought to be the least effective of those countermeasure presented to participants. Fines were thought to be the most effective enforcement countermeasure.

METHODOLOGY AND STUDY LIMITATIONS

The focus group research methodology allows for detailed, in-depth exploration of relatively new research areas, but its small, non-random sample limits generalizations to the larger population.

Due to lessons learned in the two Walnut Creek focus groups and changes in the scope of the project as requested by the client, there were several changes to both the questionnaire and the protocol for the Berkeley and Oakland focus groups. Additional comments regarding specific methodology for each focus group are included in the relevant focus group summaries, which can be found in Appendix D.

APPENDIX C

STATED BEHAVIOR AT CROSSWALKS

PEDESTRIAN AND DRIVER SURVEY RESPONSES

AUTHORS: Meghan Fehlig Mitman

SUMMARY OF SURVEY RESULTS

A survey research company conducted the intercept surveys, under contract with the TSC. The surveys were self-administered, designed to take approximately ten minutes, and were completed by participants under close supervision by the field staff. Pedestrian participants were intercepted immediately after crossing unsignalized intersections in one of four urban pedestrian areas and drivers were surveyed while purchasing fuel at gas stations or while accessing their vehicles in parking lots. Surveyors screened for local drivers (people who regularly drive locally) before administering the survey.

The survey was completed by 192 people: 133 pedestrians and 59 drivers. Seventy-five percent of the drivers surveyed estimated they spend a majority (50 percent or more) of their local travel time driving as opposed to using other modes. In contrast, only 61 percent of pedestrians surveyed indicated that they drive a majority of the time. Section 5 presents the survey questions and the percent of responses for each answer. Both of the surveys are presented exactly as they appeared to participants at the end of the section.

RESULTS OF PEDESTRIAN SURVEY

Of note is that participants between the ages of 18-19 are more likely to agree to the statement that they usually begin to cross the street regardless of whether the cars are already slowing down. Participants between the ages of 60 and 75 are less likely to report crossing a street outside a marked crosswalk.

RESULTS OF DRIVER SURVEY

One observation is that female participants were more likely than male participants to respond that they often yield to a pedestrian on the curb waiting to cross the street at a crosswalk. Male participants were more likely than female participants to report spending more time walking as a form of travel.

OVERALL RECOMMENDATIONS

Based on the new human factors explanations we identified and detailed in this report, it appears that Caltrans' conventional focus on engineering solutions may be insufficient in addressing a widespread crosswalk safety challenge at unsignalized intersections. To adequately provide for the safety of pedestrians, and encourage walking as a viable means of transportation, there is a need for a policy re-prioritization. A more balanced "3-E" (engineering/education/enforcement) strategy would mitigate accident risk in marked crosswalks at multi-lane, high volume locations:

- **ENGINEERING:** Obtain a full inventory of "at risk" marked crosswalks. Prioritize the crosswalks based on exposure-adjusted crash risk, and select appropriate countermeasures from the NCHRP/TCRP guidelines.
- **EDUCATION:** Revise the pedestrian section of the Driver's Handbook with enhanced explanations of right-of-way laws and common risk scenarios. Conduct a pedestrian safety campaign to emphasize safe crossing practices in both marked and unmarked crosswalks. For all new engineering countermeasures deployed at crosswalks, include warning signs reminding pedestrians to "Cross with Caution."
- **ENFORCEMENT:** Strengthen engineering and education countermeasures through increased enforcement of right-of-way laws by issuing fines and warnings to both drivers and pedestrians. Provide additional funding to enable sustained enforcement efforts.

The use of these balanced guidelines offers an opportunity to both actively and passively communicate the importance of safe and legal behavior for all road users at both marked and unmarked crosswalks.

1. CROSSWALK CONFUSION

WHY PEDESTRIAN AND DRIVER KNOWLEDGE OF THE VEHICLE CODE SHOULD NOT BE ASSUMED

1.1. INTRODUCTION

Traffic safety researchers have long argued that driver behavior outweighs physical elements (such as road design) as a causal factor in motor vehicle collisions[I,II].A fundamental causal component of pedestrian-vehicle collisions is also behavior—that of the driver as well as that of the pedestrian[III,IV]. One determinant of this behavior may be whether the driver, the pedestrian, or both understand the motor vehicle code, which demarcates right-of-way in pedestrian-vehicle interactions. That is, inappropriate or unlawful behavior may occur because the law is not understood or is misunderstood. While knowledge of the law does not guarantee compliance, a lack of knowledge could point to a significant pedestrian safety concern and opportunities for improvement.

Previous studies have shown that drivers and pedestrians have a limited knowledge of pedestrian right-of-way laws[V,VI,VII,VIII]. The research presented in this section expands on these studies by considering driver and pedestrian knowledge of laws specifically related to marked and unstriped, or unmarked, crosswalks. The focus on crosswalk markings is warranted by the long history of debate regarding whether and why collision risk for pedestrians is higher in marked versus unmarked crosswalks [IX]. By considering knowledge of right-of-way laws related to crosswalk markings, the behavioral aspects of this phenomenon may be more fully understood.

In this section we present the results of driver and pedestrian intercept surveys and focus groups conducted in the San Francisco Bay Area as a component of the overall study considering driver and pedestrian behavior at marked and unmarked crosswalks. Implications for engineering, education, and enforcement countermeasures are discussed and areas for further research are recommended.

1.2. THE VEHICLE CODE

In the United States, the legal priority of movement in pedestrian-vehicle interactions is dictated by the traffic code or motor vehicle code of each state. The National Committee on Uniform Traffic Laws and Ordinances (NCUTLO), a private, nonprofit advocacy group, has proposed a Uniform Vehicle Code as a set of national traffic laws. While many states have modeled their traffic regulations on this standard, the letter and spirit of pedestrian right-of-way laws can vary widely[X]. In California, where original data collection was conducted for this study, the vehicle code regarding pedestrian and driver responsibility states[XI]:

- **A** The driver of a vehicle shall yield the right-of-way to a pedestrian crossing the roadway within any marked crosswalk or within any unmarked crosswalk at an intersection, except as otherwise provided…
- **B** This…does not relieve a pedestrian from the duty of using due care for his or her safety. No pedestrian may suddenly leave a curb or other place of safety and walk or run into the path of a vehicle that is so close as to constitute an immediate hazard. No pedestrian may unnecessarily stop or delay traffic while in a marked or unmarked crosswalk.
- **C** The driver of a vehicle approaching a pedestrian within any marked or unmarked crosswalk shall exercise all due care and shall reduce the speed of the vehicle or take any other action relating to the operation of the vehicle as necessary to safeguard the safety of the pedestrian.
- **D** Subdivision (B) does not relieve a driver of a vehicle from the duty of exercising due care for the safety of any pedestrian within any marked crosswalk or within any unmarked crosswalk at an intersection.

The law makes it clear that pedestrians and drivers have a shared responsibility, but also uses vague or ambiguous language such as “unnecessarily stop,” “due care,” and “immediate hazard.”

1.3. PREVIOUS STUDIES

Previous studies have shown drivers and pedestrians have a limited understanding of right-of-way laws. Tidwell and Doyle (1995) found that most people understood that pedestrians must cross at signals or crosswalks and that turning drivers must yield to pedestrians in the crosswalk at intersections. However, there was confusion about the extent of pedestrians' right-of-way at crosswalks. While the Uniform Vehicle Code (UVC) requires motorists to stop or slow only for pedestrians already in a crosswalk, almost 70 percent of respondents thought motorists were required to stop or slow for pedestrians waiting on the curb at a marked crosswalk. Respondents also did not understand pedestrian crossing signals. Tidwell and Doyle concluded that there is a need for pedestrian safety education programs, explanatory signs on pedestrian signals, and enforcement of pedestrian right-of-way laws[V].

A second study (Sisiopiku and Akin, 2003) asked pedestrians, "In your opinion, when should vehicles yield to pedestrians?" Over 60 percent stated that motorists should yield to pedestrians only at designated crosswalks, while 31 percent said pedestrians should always have the right-of-way and 7 percent said motorists should always have the right-of-way. Because this question asked about respondents' opinions, it is unclear if it reveals pedestrians' understanding of right-of-way law or simply their preferences. Additionally, the authors did not ask pedestrians to define "designated crosswalks[VI]."

A survey of drivers in Virginia found that a large majority (75 to 92 percent) were aware of laws requiring them to yield in mid-block crosswalks and to stop before crosswalks at signals (Martinez and Porter, 2004). However, over half incorrectly thought that pedestrians have the right-of-way at all times, including when crossing outside of intersections or crosswalks[VII].

Finally, in a 2004 study by Sarkar and Andreas in San Diego, California 1,587 adult and teenage traffic violators were surveyed at a traffic school. Survey results showed that "many respondents were unaware of California laws related to the pedestrian's rights and duties" based on their assessment of six photograph scenarios[VIII]. The researchers also found that the drivers surveyed were insensitive to pedestrian-driver conflict situations, suggesting, "aggressive acts toward pedestrians need to be included in the definition of aggressive driving so that drivers are made aware of the rights of pedestrians[VIII]."

A key component missing from the previous studies is the examination of pedestrian and driver understanding of right-of-way specifically at marked versus unmarked crosswalks. There is a long and influential history of research on the safety impacts of marked and unmarked crosswalks. The most recent and comprehensive study of this subject (Zegeer, 2002) found that on high-volume (over 12,000 ADT) multi-lane roads, uncontrolled intersections with a marked crosswalk (and no other treatments) had higher collision rates than unmarked crosswalks[IX].

Recent research conducted by the Traffic Safety Center (TSC) at the University of California, Berkeley (on behalf of Caltrans) examines for the first time whether drivers and pedestrians exhibit different behavior at marked versus unmarked crosswalks on multi-lane roads. Understanding the extent of driver and pedestrian knowledge of the law in these situations may account for observed differences in behavior, and partially explain the marked-unmarked collision risk phenomenon.

1.4. ORIGINAL RESEARCH

As a component of the TSC crosswalk behavior study, pedestrian and driver intercept surveys and focus groups were conducted between September 2005 and June 2006. These original data collection efforts addressed:

- Understanding of right-of-way laws
- Self-reported behavior
- Perceptions of effectiveness of education, enforcement, and engineering countermeasures

The study sample is not representative of the general population in several important ways. First, we oversampled the pedestrian population, because we were particularly interested in understanding pedestrian behavior. Second, we also oversampled for seniors (people age 65 or older). We chose to focus on seniors because of their vulnerability as road users and their unique challenges when crossing the street. Further, we believe a focus on improving conditions for seniors will result in improved conditions for all. Third, the study was not conducted randomly; rather, participants were approached on a convenience basis. Last, not everyone who was approached for the study chose to participate, and those who did choose to participate may hold very different opinions than those who did not.

Despite the potential atypical characteristics of the survey and focus group participants, their answers were very informative, and may truly portray the beliefs of a large segment of the California population.

1.4.1 INTERCEPT SURVEYS

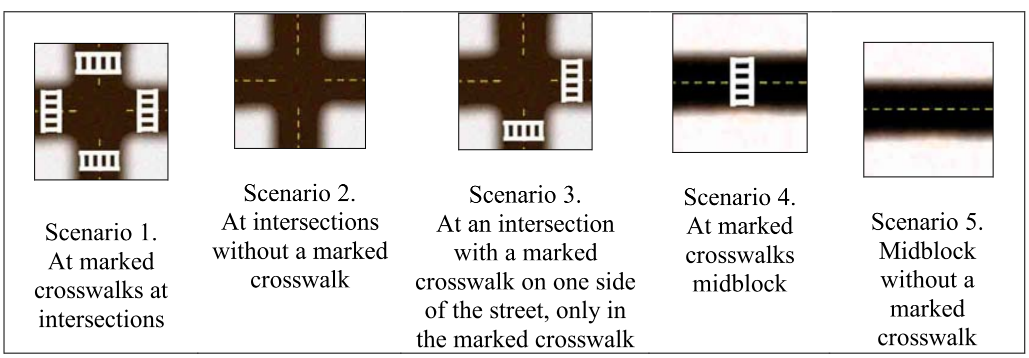
A survey research company conducted the intercept surveys, under contract with the TSC. The surveys were self-administered, designed to take approximately ten minutes, and were completed by participants under close supervision by the field staff. Pedestrian participants were intercepted immediately after crossing unsignalized intersections in one of four urban pedestrian areas. Two of the areas were highly frequented by elderly residents, and the other two areas were associated with high alternative mode-share. The census tracts targeted were:

- Elderly Urban: Census tract 4030 (Alameda County) and census tract 114 (San Francisco)
- Urban High Alternative (Non-auto) Mode-share: Census tracts 115 and 176 (San Francisco)

Drivers were surveyed while purchasing fuel at gas stations or while accessing their vehicles in parking lots in Census Tract 4088 (Alameda County). Surveyors screened for local drivers (people who regularly drive locally) before administering the survey.

Figure 1

RIGHT-OF-WAY LAWS CROSSWALK SURVEY SCENAR OS



The survey was completed by 192 people, comprising 133 pedestrians and 59 drivers. Seventy-five percent of the drivers surveyed estimated they spend a majority (50 percent or more) of their local travel time driving as opposed to using other modes. In contrast, only 61 percent of pedestrians surveyed drive a majority of the time. The median driver and pedestrian age range was 30 to 39. Driver respondents were 64 percent male and pedestrian respondents were 54 percent male.

The scenarios related to right-of-way at marked and unmarked crosswalks were presented as shown in Figure 1.

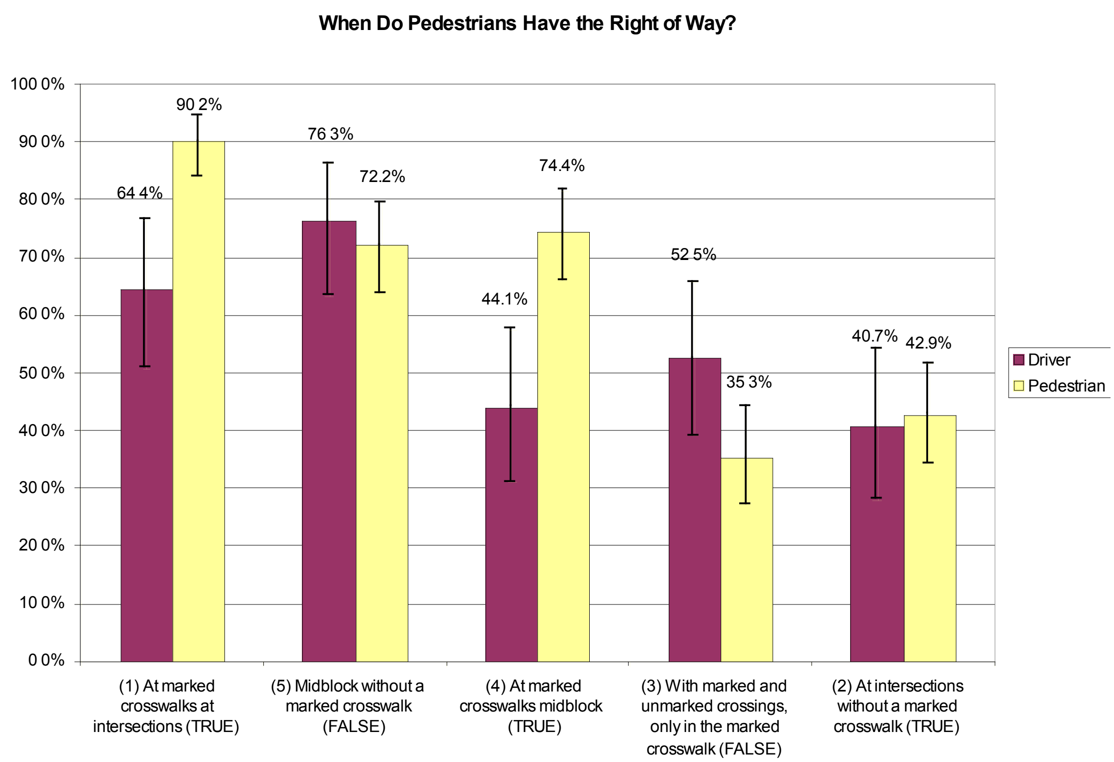
Based on the California Vehicle Code, in Scenarios 1, 2, and 4 of Figure 1 the pedestrian has the right-of-way as stated. In Scenario 5, the pedestrian does not have the right-of-way. For the case of the marked and unmarked crossings (Scenario 3), the pedestrian has the right-of-way at all four crossings (making the statement here false).

SURVEY RESULTS

Survey responses were designated as correct or incorrect based on whether the response agreed or disagreed with the California Vehicle Code. Figure 2 presents a comparison of the percent of correct responses for each scenario for the driver and pedestrian surveys. The results suggest that most drivers and pedestrians understand the law when the message is clear and simple. That is, when all crossings are marked (Scenario 1), the pedestrian's right-of-way is mostly understood. Likewise, for unmarked midblock crossings, most respondents knew that "jaywalking" is illegal, and thus the pedestrian does not have the right-of-way at these locations (Scenario 5). Nonetheless, it is noteworthy that over 35 percent of driver respondents did not believe that pedestrians have the right-of-way even at marked crosswalks (Scenario 1).

Figure 2

SURVEY RESULTS IN ORDER OF SCENARIOS OF INCREASING COMPLEXITY



For scenarios of increasing complexity, both pedestrians and drivers exhibited a lower level of understanding of the vehicle code, as illustrated by the clear gradient in Figure 2. Marked differences can be seen between driver and pedestrian responses to individual scenarios. For the two cases where the 95 percent confidence intervals do not overlap (Scenarios 1 and 4), pedestrians demonstrate better knowledge than drivers. Overall, pedestrians provided correct responses 63.0 percent of the time and drivers provided correct responses 55.6 percent of the time.

Figure 3

FOCUS GROUP SLIDES FOR PEDESTRIAN RIGHT-OF-WAY LAWS DISCUSSION

4 Marked Crossings

Scenario A. The Pedestrian Has the Right-of-way in All Crossings (Correct response: True)

4 Unmarked Crossings

Scenario B. The Pedestrian Has the Right-of-way in All Crossings (Correct response: True)

Mixed marked and unmarked crossings

Scenario C. The Pedestrian Has the Right-of-way in the Marked Crossing Only (Correct response: False; The Pedestrian has the Right-of-Way at All Crossings)

1.4.2. FOCUS GROUPS

The TSC study also used focus groups to provide a more interactive discussion of driver and pedestrian knowledge and behavior. Six focus groups, each comprising 10 to 12 participants, were conducted in the San Francisco Bay Area in four different locations and among two different age groups. The six groups were:

- Senior pedestrians (with walking as their primary mode of transport) in the suburban community of Walnut Creek, CA
- Senior drivers (with driving as their primary mode of transport) in Walnut Creek
- Non-seniors in urban Oakland, CA (mixed drivers and pedestrians)
- Seniors in urban Berkeley, CA (mixed drivers and pedestrians)
- Non-seniors in Berkeley (mixed drivers and pedestrians)
- Seniors in suburban Albany, CA (mixed drivers and pedestrians)

In total, 65 people participated in the six groups. Sixty-four percent of the participants were seniors (over age 65). Forty-three of the participants were women and 22 were men. Seventy-eight percent of participants had a college education (associate's degree or higher). The median household income of participants was between $20,000 and $49,999. Finally, 33 percent of participants were married, 36 percent were single, 14 percent were widowed, and 17 percent were divorced.

RIGHT-OF-WAY QUESTIONS

At the beginning of each focus group session, participants were asked to complete a background and demographics survey, which included the right-of-way question from the intercept survey (as presented in Figure 1). A subsample of three of the survey scenarios, as illustrated in Figure 3, was then presented to focus group participants for an interactive discussion. In the focus group results, the survey results have been combined with the discussion session comments to provide quantitative and qualitative responses for the three scenarios.

FOCUS GROUP RESULTS

Given the small sample size and anecdotal nature of much of the data, statistics were not computed for the focus group responses. Instead, the range of responses to the discussion scenarios is presented along with the percent of participants proving the correct response for the equivalent survey question. Because of time constraints during the session, only the survey portion of the right-of-way questions was included in the Oakland focus groups; thus, no discussion comments are provided from that session.

FOUR MARKED CROSSWALKS (SCENARIO A)

Based on the survey results, all focus group participants correctly responded that the pedestrian has the right-of-way at all crossings in this scenario. Comments during the discussion session, some of which qualify the survey responses, included:

Berkeley Non-Seniors:

- "The driver would have the right-of-way if completing a left turn."

Albany Seniors:

- "Marked crosswalks give the indication that a driver has to stop."
- "Pedestrians have the right-of-way but they can't always trust drivers to stop."

FOUR UNMARKED CROSSWALKS (SCENARIO B)

Figure 4 presents the surveys results for Scenario B. In a considerable change from Scenario A, on average only 50 percent of participants provided the correct response that the pedestrian has the right-of-way at all crossings. The number and range of discussion session comments are illustrative of the participants' relative lack of knowledge regarding pedestrian right-of-way in this situation. These comments included:

Walnut Creek Pedestrians:

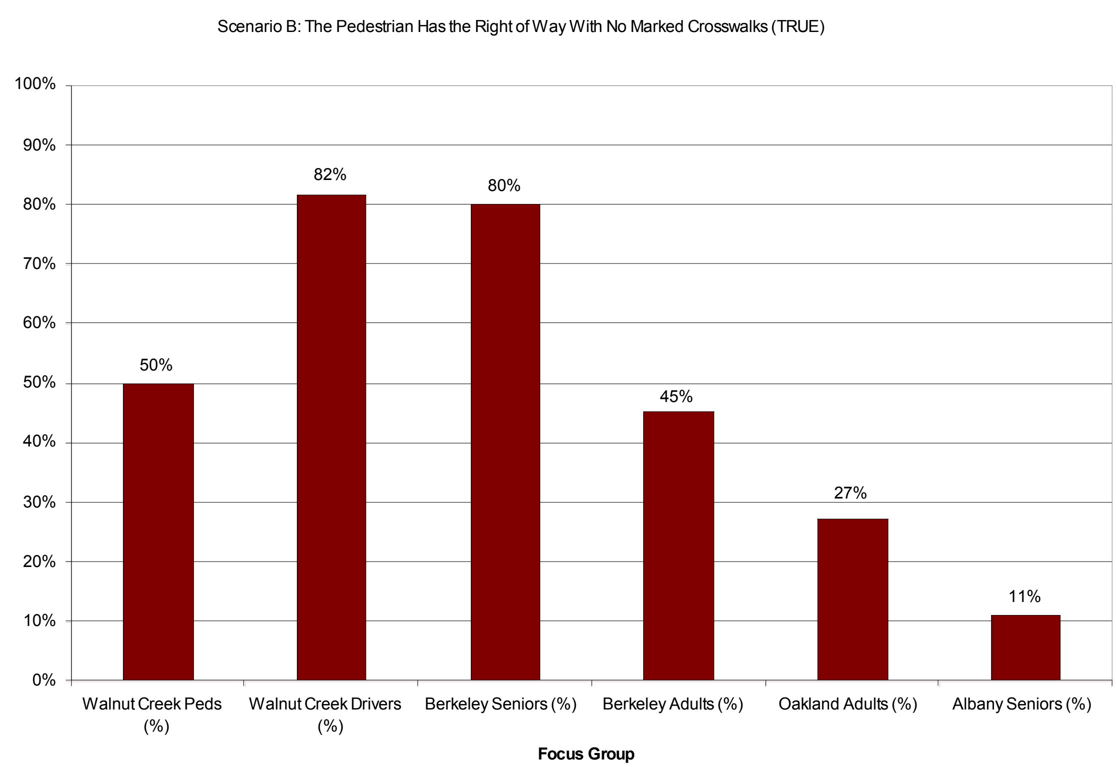
- "Pedestrians have the right-of-way no matter what."
- "Drivers should have the courtesy to stop."
- "Pedestrians have to initiate the action."
- "Pedestrians should make eye contact with the driver."
- "A person is not considered a pedestrian unless he makes a move to cross."

Berkeley Seniors:

- "If the pedestrian is in the street or within view of the vehicle then the pedestrian has the right-of-way."
- "If it is obvious the pedestrian wants to cross, then the driver must yield."
- "The pedestrian has to make a signal that he wants to cross, such as stepping into the street or making eye contact with the driver."

Figure 4

SCENARIO B: PERCENT OF CORRECT RESPONSES BY FOCUS GROUP



Berkeley Non-Seniors:

Although pedestrian right-of-way is not contingent on the presence of stop signs, participants in this group requested information regarding stop signs at the intersection in this scenario. When participants were told there were stop signs at all four approaches, all 11 participants said the pedestrian would have the right-of-way in the unmarked crossings. However, only eight participants thought the pedestrian would have the right-of-way if there were no stop signs at this type of intersection.

Albany Seniors:

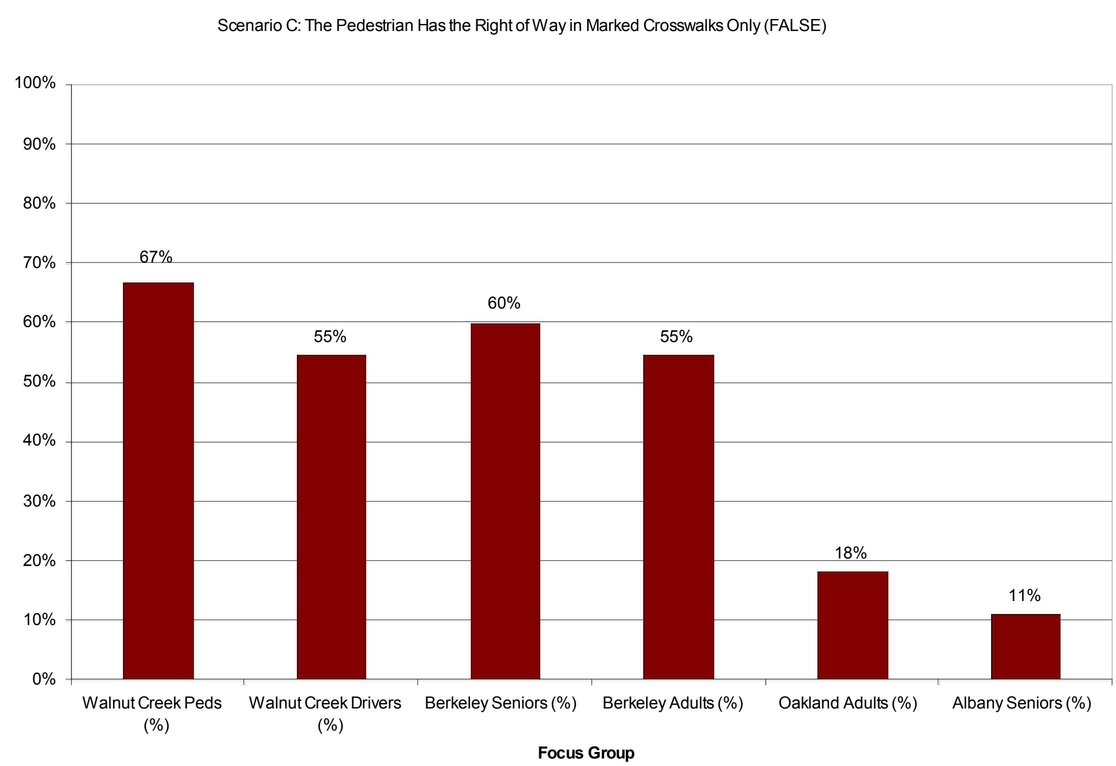
- "Whether there is a crosswalk marking or not, the pedestrian should always have the right-of-way."
- "Pedestrians should go to the next block or marked crosswalk for safety."
- "It is illegal for drivers not to stop for pedestrians even if there's no marking."

MARKED AND UNMARKED CROSSWALKS (SCENARIO C)

Figure 5 illustrates the percent of correct survey responses for this scenario in each focus group. As with Scenario B, a lack of driver and pedestrian knowledge in both age groups is evident. Overall, only 45 percent of focus group participants provided the correct response for Scenario C.

Figure 5

SCENARIO C: PERCENT OF CORRECT RESPONSES BY FOCUS GROUP



Again, the comments provide insight into the confusion associated with this complex situation:

Walnut Creek Pedestrians:

- "Pedestrians should not cross anywhere other than the marked section of the intersection."

Walnut Creek Senior Drivers:

If the pedestrian had already stepped into the intersection, all the participants felt the pedestrian had the right-of-way. However, if the pedestrian had not yet stepped off the sidewalk, only three participants felt the pedestrian had the right-of-way within this type of intersection.

Berkeley Seniors:

- "The unmarked crosswalk indicates that pedestrian crossings are not allowed."
- "The DMV booklet states that the motorist has to yield to a pedestrian whether there is or is not a crosswalk."
- "The pedestrian must take responsibility in this situation."
- "I would only cross in a marked crosswalk."

Participants in this focus group were also asked a follow-up question to explore stated behavior in this type of situation. When given a hypothetical origin and destination that would have the unmarked crosswalk in the direct path, four persons said they would go out of their way to cross in the marked crosswalk and six said they would cross in the unmarked crosswalk.

Berkeley Non-Seniors:

- "The pedestrian only has the right-of-way if there is a stop sign."
- "The pedestrian can't step out in front of a car, but can cross in an unmarked area when it is safe."

SUMMARY

The results of the focus group surveys and discussion sessions demonstrate that road users tend to understand the pedestrian right-of-way laws when the message is clear and simple (as in Scenario A). In the six focus groups, all participants felt the pedestrian has the right-of-way in the intersection with four marked crosswalks (although some qualified this answer during the discussion session). However, for the other scenarios of increasing complexity, both pedestrians and drivers, young and old, urban and suburban, exhibited a lower level of understanding of the vehicle code.

Figure 6 presents a comparison of correct focus group survey responses between seniors and non-seniors. For both Scenarios B and C, seniors displayed a greater knowledge of right-of-way laws.

Figure 7 presents a comparison of correct focus group survey responses between senior pedestrians and drivers in Walnut Creek. Overall, senior drivers had a slightly better knowledge of the laws.

In a comparison of correct focus group survey responses among urban (Berkeley and Oakland) and suburban (Walnut Creek and Albany) participants, suburban residents (all of whom were seniors) had a slightly greater knowledge of the law in Scenario C only (and an equal level of knowledge) as urban residents in the other scenarios.

There are a number of possible reasons for these differences, including level of education or socio-economic status, personal walking experience, generational or neighborhood walkability differences, how the law is advertised in each city, or—quite possibly—chance.

Figure 6

COMPARISON OF SENIOR AND NON-SENIOR KNOWLEDGE OF THE LAW

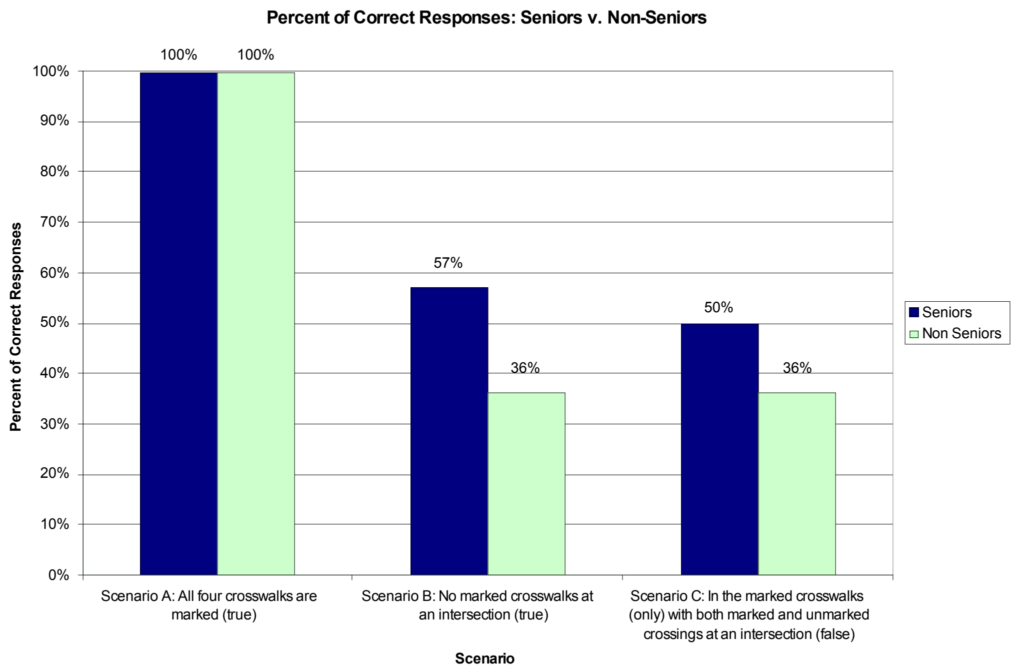
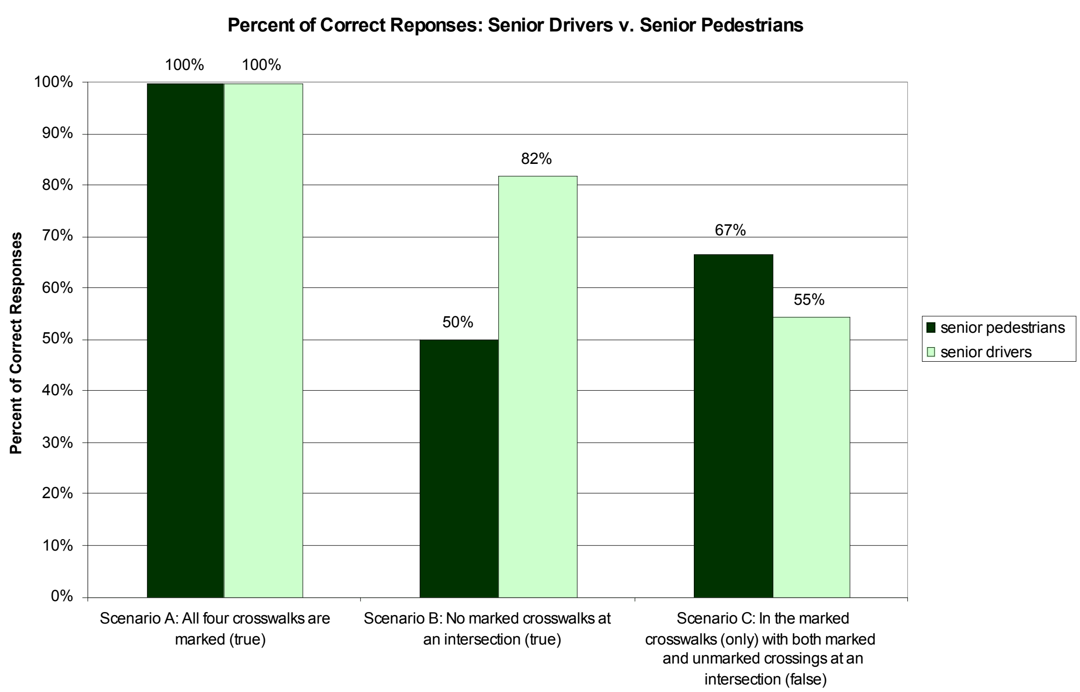


Figure 7

COMPARISON OF WALNUT CREEK SENIOR DRIVER AND PEDESTRIAN KNOWLEDGE OF THE LAW



Overall, the focus group results corroborate data from the intercept surveys and previous research and again suggest that knowledge of the law cannot be assumed, especially in complex situations.

1.5. COUNTERMEASURE IMPLICATIONS

There may be a connection between knowledge of pedestrian right-of-way laws and collision risk. While knowledge of the law does not necessarily result in compliance, a lack of knowledge is unlikely to result in improved yielding behavior—especially in the case of multi-lane roads. This connection is an appropriate subject for further study. If the widespread lack of accurate knowledge regarding right-of-way laws is indeed found to be a significant contributing factor in pedestrian-vehicle collisions, a re-prioritizing of pedestrian safety countermeasures may be required. Thus, in addition to the physical countermeasures for enhancing safety in marked crosswalks suggested by Zegeer[IX], behavioral countermeasures may be needed.

The appropriate combination of education, engineering, and enforcement countermeasures, often referred to as the 3-Es of Safety, has been a subject of debate for many decades[XII,XIII]. The following countermeasures are illustrative components of a re-balanced 3-E strategy that would address the demonstrated lack of knowledge of right-of-way laws.

ENGINEERING

Using context sensitive design (CSD) options, pedestrian facilities can actively communicate the right-of-way to drivers and pedestrians, whether or not they know their legal responsibilities. As defined by the Federal Highway Administration (FHWA), CSD "is an approach that considers the total context within which a transportation improvement project will exist[XIV]." The CSD philosophy, in "thinking beyond the pavement," embraces the appropriate use of traffic calming devices such as bulbouts, raised intersections, pedestrian refuge islands, and raised crosswalks, among others, that communicate expected behavior to road users.

In a before-and-after study of traffic-calming devices in several US cities, Huang and Cynecki (2001) found that motorist and pedestrian compliance with the vehicle code increased, suggesting that these devices "have the potential for improving the pedestrian environment." The researchers also emphasize, however, that "these devices by themselves do not guarantee that motorists will slow down or yield to pedestrians[XV]."

In cases where traffic calming may be inappropriate or infeasible, Zegeer (2002) notes that traffic and pedestrian signals and other more substantive countermeasures, such as pedestrian overpasses, should be considered[IX]. These engineering measures, although costly, would also preclude the need for accurate knowledge of the law.

EDUCATION

The impact of education and mass media imaging changes on smoking cessation in the US, for example, offers evidence that public health concerns can be significantly addressed through educational campaigns[I]. However, pedestrian safety education efforts are currently less prevalent than engineering countermeasures.

Knowledge of the right-of-way laws in a state's vehicle code is typically transmitted as a component of driver education. Drivers are expected to demonstrate knowledge of the laws when passing a driver's license exam. Notably, such exams do not require perfect scores for licensure and are typically administered only when a driver first receives his license.

Sarkar, Van Houten, and Moffatt (1999) reviewed drivers' manuals from 32 states based on the premise that "along with enforcement and engineering, quality education can be very important in improving driver behavior and providing a better understanding of the vulnerability of pedestrians[XVI]." The researchers concluded that while state driver licensing manuals can play a key role in education, manuals need significant improvements. They note that better manuals, with "well-written, well-illustrated information on pedestrian conflicts associated with different traffic regulations" are increasingly important with the gradual phasing out of driver education in schools[XVI].

There is no analogous licensing exam or manual for non-driver pedestrians. Parents, teachers and the media are expected to convey pedestrian right-of-way laws to non-drivers. Some efforts, such as Safe Routes to School programs, have demonstrated considerable success with pedestrian safety education of children. Holtz et al. (2004) evaluated the effectiveness of a Safe Routes to School program, the WalkSafe program, for elementary school children in Miami, Florida. The study concluded, "The WalkSafe program implemented in a single high-risk district was shown to improve the pedestrian safety knowledge of elementary school children. The observational data demonstrated improved crossing behaviors from pre-test to post-testing conditions[XVII]."

However, similar programs for seniors, immigrants, and other groups of non-driver pedestrians are not as prevalent. Additional opportunities to educate non-driver pedestrians should be explored, as well as refresher programs or educational campaigns for licensed drivers.

ENFORCEMENT

Innovative enforcement strategies that focus on enhancing pedestrian and driver knowledge of and compliance with the laws include enforcement "stings", educational warnings in lieu of or in addition to fines, and community enforcement programs. In a study of an enforcement sting in Miami Beach, Florida, Van Houten and Malenfant (2004) found that "the percentage of drivers yielding to pedestrians increased following the introduction of the enforcement operation in each corridor[XVIII]." They note, "these increases were sustained for a period of a year with minimal additional enforcement, and that the effects generalized to untreated crosswalks in both corridors as well as crosswalks with traffic signals[XVIII]."

Sustained enforcement efforts, targeted at both drivers and pedestrians, can also serve as valuable educational campaigns by incorporating warnings, informational pamphlets, media coverage, and community involvement activities. In this way, road users may learn the right-of-way laws through enforcement of these laws.

1.6. CONCLUDING THOUGHTS

An important, possibly more fundamental, consideration in selecting and balancing pedestrian safety countermeasures is whether the vehicle code itself should first be amended. Perhaps drivers and pedestrians lack knowledge of the law because the law is inherently confusing or unfair. It may be that a significant number of right-of-way violations occur because laws are counterintuitive, or because they are perceived as inappropriate for the local driving culture. Further, there are some scenarios in which it is legally ambiguous or unclear who has the right-of-way.

Several authors have made concrete suggestions for how vehicle code amendments should be formulated. The suggestions vary widely in their visions of what would constitute a better driving or walking environment.

Evans (2004) suggests that laws should be strengthened such that the default responsibility for a pedestrian-vehicle collision would be placed only on the driver because the driver has the potential to cause greater harm (1). In contrast, proponents of the Shared Space or "Naked Streets" philosophy (Hans Moderman and others) argue that "artificial" traffic regulations should be removed and replaced instead by "natural human interaction," as can be encouraged by traffic calming street designs[XIX].

As suggested by the National Committee on Uniform Traffic Laws and Ordinances (NCUTLO), any such revisions to the current law should also include efforts to create more uniform laws on pedestrian right-of-way across agency and state boundaries so that the laws are not only intuitive, but also consistent[X].

Another important concern many pedestrian safety experts raise is that unless 100 percent compliance with the law is achieved, increasing driver-yielding behavior could actually be detrimental to pedestrian safety if it leads to a pedestrian expectation that all drivers will yield, and thus a lower level of vigilance when crossing. In this event, the consequence of even one driver failing to yield may be much greater than the consequence of many drivers not yielding under current conditions. Again, this point further emphasizes the need to develop a three-pronged program of not only engineering but also education and enforcement to address the responsibilities of both the pedestrian and driver as users of the shared roadway.

The strategies presented here offer a proactive approach to pedestrian safety that does not first require the assumption of driver and pedestrian knowledge of the law. The use of these balanced countermeasures offers an opportunity to both actively and passively communicate the importance of these laws in maintaining safety for all road users.

Analogous to the successful Mothers Against Drunk Driving (MADD) campaign to reduce driving under the influence (DUI), a change in societal norms may be required before meaningful and sustainable improvements in pedestrian safety can occur. Diagnosing the extent to which drivers and pedestrians know and understand the vehicle code is an important step in this endeavor.

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2. THE MARKED CROSSWALK DILEMMA:

UNCOVERING SOME MISSING LINKS IN A 35-YEAR DEBATE

2.1. ABSTRACT

Largely in response to several landmark safety studies, as an official or unofficial policy, many agencies across the U.S. have elected to remove marked crosswalks at uncontrolled intersections, or have shown resistance to installing them in the first place. This approach results in unacceptable pedestrian mobility restrictions, yet such restrictions are often not considered in policy-making. Therefore, there is a need for roadway system owners to develop strategic safety guidelines to address the marked crosswalk dilemma.

Since 2005, the UC Berkeley Traffic Safety Center, in a study funded by the California Department of Transportation (Caltrans), has focused on developing a better understanding of driver and pedestrian behavior and safety in both marked and unmarked crosswalks in an effort to recommend more informed crosswalk policies. The study was designed to fill key gaps in the literature by analyzing pedestrian and driver behavior and knowledge of right-of-way laws related to marked and unmarked crosswalks. The study also focused on driver and pedestrian behavior with regard to multiple threat scenarios, the most common type of pedestrian collisions at uncontrolled intersections.

This section summarizes results from field observations of driver and pedestrian behavior at marked and unmarked crosswalks on low speed, two-lane and multi-lane roads. The behavioral observations are interpreted in light of findings reported by Mitman and Ragland (2007) from surveys and focus groups regarding driver and pedestrian knowledge of right-of-way laws. The section concludes with recommendations for a comprehensive crosswalk safety policy to strategically address crash risk at uncontrolled crosswalks.

2.2. INTRODUCTION

At a time when the need for more sustainable transportation solutions is critical, a greater focus on non-motorized alternatives to the automobile is clearly warranted and is gaining momentum throughout the United States. Considering pedestrian safety in the process of reorienting transportation and land use is imperative. As Zegeer, *et al.* (2001) and others have argued, "Pedestrians have a right to cross roads safely and, therefore, planners and engineers have a professional responsibility to plan, design, and install safe crossing facilities[I]."

In an effort to provide a greater understanding of pedestrian crash risk, and in doing so encourage the facilitation of safe and convenient pedestrian crossings, this section documents and discusses field observations of drivers and pedestrians at uncontrolled marked and unmarked crossings. The behavioral observations are then interpreted as they relate to recent findings from surveys and focus groups regarding driver and pedestrian knowledge of right-of-way laws[II].

More than 35 years of pedestrian safety research has focused on marked and unmarked crosswalks, making this topic one of the most debated in the field. Thus, it is instructive to begin with a summary of the background for this debate.

2.3. BACKGROUND

Previous research focusing on uncontrolled crosswalks can generally be grouped in two key areas: (1) safety research regarding collision trends, and (2) behavioral research analyzing driver and pedestrian behavior within crosswalks.

2.3.1 SAFETY RESEARCH AT UNCONTROLLED CROSSWALKS

There is a long and influential history of research about the safety impacts of marked and unmarked crosswalks. Herms' famous 1972 study in San Diego found that marked crosswalks were the sites of twice as many crashes as unmarked crosswalks, controlling for pedestrian volume[III]. Several other studies found similar results (Gibby, 1994), but their methodologies have been criticized (Campbell, 1997)[IV,V].

A landmark study conducted by Zegeer, *et al*. in 2001 for the Federal Highway Administration (FHWA) analyzed five years of pedestrian collisions at 1,000 marked crosswalks and 1,000 matched unmarked comparison sites in 30 U.S. cities. The study concluded that no meaningful differences in crash risk exist between marked and unmarked crosswalks on two-lane roads or low-volume multi-lane roads. However, researchers found that on multi-lane roads with traffic volumes greater than about 12,000 vehicles per day, marked crosswalks without other substantial roadway treatments were associated with higher pedestrian crash rate than having an unmarked crosswalk. The study concluded that, particularly on high-speed, high-volume and multi-lane roads, painted white lines are not enough to improve pedestrian safety[I].

A recent research effort jointly sponsored by the Transit Cooperative Research Program (TCRP) and the National Cooperative Highway Research Program (NCHRP) and conducted by the Texas Transportation Institute (TTI) focused on determining the effectiveness of many of the pedestrian safety engineering countermeasures for uncontrolled crossings recommended in the 2001 FHWA study. As a result of this study, specific engineering guidelines for selecting effective pedestrian crossing treatments for uncontrolled intersections and midblock locations are now available and are based on key input variables such as: pedestrian volume, street crossing width, and traffic volume. The study also suggested modifications to the pedestrian traffic signal warrant in the *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD)[VI].

2.3.2 BEHAVIORAL RESEARCH AT UNCONTROLLED CROSSWALKS

One of the central debates regarding pedestrian behavior in crosswalks is whether pedestrians are less cautious in marked crosswalks than in unmarked crosswalks or non-crosswalk locations. Herms' 1972 analysis hypothesized that this "lack of caution" may lead to the higher rate of crashes observed in marked crosswalks compared to unmarked crosswalks[III].

More recently, however, Knoblauch, *et al*. (2001) measured the effects of crosswalk markings on driver and pedestrian behavior at uncontrolled intersections on two- and three-lane roads[VII]. Knoblauch (2001) and Nitzburg (2001) found no difference in pedestrian assertiveness in marked and unmarked crosswalks, while pedestrian searching behavior (looking left and right for oncoming traffic) actually improved at crossings after they were marked[VII,VIII]. Others (for example, Hauck, 1979) have also found that pedestrian behavior improves in well-marked crosswalks compared to unmarked or poorly marked crosswalks[IX].

There have been fewer studies of driver behavior, but it is generally agreed that drivers often fail to yield to pedestrians at both marked and unmarked crosswalks. The effects on driver behavior of marking a crosswalk have remained unclear.

In a before-after study, Knoblauch (2001) found that marking a crosswalk had no effect on driver yielding. However, he found a slight reduction in speed by drivers approaching a pedestrian in a marked crosswalk compared to a crossing that is unmarked[VII].

Nitzburg (2001) found strong differences between day and nighttime driver behavior. Nitzburg's study also found differences in both driver and pedestrian behavior when the pedestrian was in the second half of the crosswalk compared to the first half[VIII].

2.3.3 THIS STUDY'S CONTRIBUTION

In recent years, many agencies have elected to remove marked crosswalks at uncontrolled intersections, or have shown resistance to installing them in the first place. This approach results in unacceptable pedestrian mobility restrictions and should not be embraced as policy. Instead, streets need to be more-pedestrian friendly, and new traffic control options should be developed to allow pedestrians more crossing opportunities along a street

Since 2005, the UC Berkeley Traffic Safety Center, in a study funded by the California Department of Transportation (Caltrans), has focused on developing a better understanding of driver and pedestrian behavior in both marked and unmarked crosswalks in an effort to recommend more informed crosswalk policies. Specifically, the study was designed to fill key gaps in the literature by:

- Analyzing pedestrian and driver behavior in marked and unmarked crosswalks on multi-lane roads—the critical road type identified by safety studies but not considered in previous behavioral studies
- Analyzing pedestrian and driver knowledge of the law as relates to right-of-way in marked and unmarked crosswalks—a factor which may at least partially explain behavioral patterns

In an earlier paper from this study, Mitman and Ragland (2007) presented the results of intercept surveys and focus groups which assessed driver and pedestrian knowledge of right-of-way laws. Previous studies have shown that both drivers and pedestrians have a limited knowledge of pedestrian right-of-way laws. Mitman and Ragland expanded on these studies by specifically considering knowledge of right-of-way laws related to marked and unmarked crosswalks. Results confirmed that a substantial level of confusion exists with respect to pedestrian right-of-way laws. This confusion was exacerbated by intersections with unmarked crosswalks[II].

This paper summarizes results from field observations of driver and pedestrian behavior at marked and unmarked crosswalks on multi-lane roads and interprets these results in light of the previously reported findings regarding knowledge of right-of-way laws.

2.4. METHODS

Building on the Knoblauch (2001) behavioral research, this study followed a similar methodology, except that instead of repeating studies on two and three-lane roads, this analysis focused primarily on roads with four or more lanes. Utilizing a matched pair approach, driver and pedestrian behavior within marked and unmarked crosswalk pairs at the same intersection were compared. Intersections with matched pairs of marked and unmarked crosswalks were considered desirable because most exogenous factors are held constant, allowing for a direct comparison between the crosswalks.

Table 1

FIELD OBSERVATION SITES

2 Lanes	3 Lanes	4+ Lanes	
Cedar St. and Walnut St., Berkeley	16th St. and Capp St., San Francisco	*No Median*	*Median*
		International Blvd. and 37th Ave., Oakland	University Ave. and Walnut St., Berkeley
		Telegraph Ave. and 41st/63rd St., Oakland	Sacramento St. and Blake St., Berkeley

Six sites were selected for the purposes of the study. The locations were chosen with the following guidelines:

- One matched pair of crosswalks at an intersection on a two-lane major road
- One matched pair of crosswalks at an intersection on a three-lane major road
- Four matched pairs of crosswalks at intersections on four- to five-lane major roads

Previous studies have noted that driver yielding is related to vehicle speeds. All six observation locations had speed limits of 25 to 30 MPH in an effort to reduce potential yielding behavior discrepancies based on speed. Of the multi-lane sites, two locations with medians and two locations without medians were selected. The sites with two- and three-lanes were selected to allow for comparison with previous studies and with multi-lane crossings. Table 1 presents these sites by major road type. All six sites are located in the San Francisco Bay Area.

At each of our observation locations, the following study questions were addressed:

- Whether pedestrians use more, less, or the same amount of caution when crossing at a marked crosswalk (as compared to an unmarked crosswalk) — by recording the pedestrian's "looking behavior" and waiting location (curb or street) when using a marked versus unmarked crosswalk.
- Whether the age or gender of the pedestrian are correlated with his or her behavior — by recording the gender and approximate age of the pedestrian observed.
- Whether drivers yield more often to pedestrians in marked crosswalks than unmarked crosswalks — by recording whether or not the driver yielded when encountering a pedestrian in the crosswalk.

2.5. DATA COLLECTION

For this study, a pilot evaluation of video and clipboard-based data collection methods was conducted to determine the best data collection methodology. The evaluation considered accuracy, reliability, validity, and cost. Clipboard-based (manual) data collection was selected as the best method for the purposes of this study.

Data collection occurred during daylight hours on non-rainy days from May to October, 2006. Marked and unmarked crosswalk observations were collected concurrently at each site, except at International and 37th, where they were collected in series. Observers included professional field data collectors from Population Research Systems (PRS), selected based on inter-rater reliability tests from the pilot evaluation, as well as undergraduate work-study students from UC Berkeley who completed a one-hour training course tailored to this project.

For the 16th and Capp three-lane intersection in San Francisco, video footage available from another Traffic Safety Center project was utilized in lieu of in-person observations. Trained field observers completed the video observations in the office using QuickTime® video-playback software. When collecting data from the video, observers used the same data collection form as was used for the field observations.

2.6. DATA ANALYSIS

The statistical analysis package SAS was utilized to compare driver and pedestrian behavior observations in marked versus unmarked crosswalks at each of the six observation locations. This comparison was typically accomplished via a Chi-Squared test, a non-parametric test of statistical significance appropriate for bivariate tables. However, in some instances comparison cells had expected values of less than five. In these cases, the Fisher's Exact Test was used instead of the Chi-Squared test.

In addition to the observation variables included on the data collection form, the following derived variables were analyzed for each observation location:

- **Average Gap Acceptance (lanes):** This variable measures the number of times that no vehicle was present in a lane encountered during a pedestrian's crossing. The maximum number of gaps is equal to the number of lanes across which the crosswalk extends. The average number of gaps for pedestrians in marked versus unmarked crosswalks was compared in the statistical analysis for each site.

- **Average Number of Immediate Yields (drivers):** This variable is the sum of the number of times the first driver encountered by a pedestrian in each lane yielded (as opposed to not yielding and trapping the pedestrian on the curb or within the street). The average number of immediate yields for pedestrians in marked versus unmarked crosswalks was compared in the statistical analysis for each site.

- **Average vehicle exposure (pedestrians):** This variable is the sum of the total number of vehicles encountered by a pedestrian during a crossing. The average exposure for pedestrians in marked versus unmarked crosswalks was compared in the statistical analysis for each site.

- **Multiple Threat Opportunity:** This variable measures for each pedestrian the number of times in which a driver yielded in one lane (the first encountered in the crossing direction) while a driver in the adjacent lane of the same direction of travel (the next encountered) did not yield. The incidence of multiple threat opportunities was applicable only for the crosswalks across the multi-lane intersections. For the four- and five-lane intersections, two pairs of multiple threat opportunities were considered, the first set of same direction lanes encountered in a crossing and the second set. The incidence of multiple threat opportunities for pedestrian crossings in marked versus unmarked crosswalks was compared in the statistical analysis for each site.

Multiple threat scenarios were specifically addressed in this analysis because the 2001 FHWA study noted, "The greatest difference in pedestrian crash types between marked and unmarked crosswalks involved 'multiple-threat' crashes[i]." Multiple-threat crashes occur on multi-lane roads when the pedestrian and/or driver's line of sight is blocked by a driver yielding to the pedestrian in an adjacent lane.

2.7. RESULTS

This section presents general characteristics and the statistical analysis results for behavior observations at a representative sample of two study sites, followed by a summary of the overall trends identified across the six observation sites. The two sites were selected for this paper to provide a comparison of our results for a two lane and multi-lane location. The multi-lane site presented here yielded the most robust results across the observation variables. Reported p-values are for the statistical test of each variable (age, sex, etc.) in marked versus unmarked crosswalks.

2.7.1. SITE 1: CEDAR AND WALNUT, BERKELEY

SITE CHARACTERISTICS:

- **Number of Lanes Main Road (Cedar):** 2

- **Peak Pedestrian Volume:** 19 pedestrians/hour (marked), 4 pedestrians/hour (unmarked)

- **Surrounding Land Uses:** Mostly residential and churches with restaurants, a grocery store, and a pharmacy within 1 block

- **Speed Limit Main Road (Cedar):** 25 MPH
- **Distance from Nearest Traffic Signal:** 1 block (320 feet) on Main Road
- **Note:** Cedar is on a slight grade, sloping downhill from east to west. This topography may affect driver and pedestrian behavior.

DESCRIPTIVE CHARACTERISTICS:

Table 2

PEDESTRIAN CHARACTERISTICS BY CROSSWALK TYPE, CEDAR AND WALNUT

	Unmarked n (column %)	**Marked** n (column %)	**Total** N (column %)	***p*-value**
Pedestrians	206	639	845	
Age				0.9094
Child	0 (0.0)	1 (0.2)	1 (0.1)	
Teen	1 (0.5)	6 (0.9)	7 (0.8)	
Young adult	89 (43.6)	291 (45.7)	380 (45.2)	
Older adult	97 (47.5)	292 (45.8)	389 (46.3)	
Elderly	17 (8.3)	47 (7.4)	64 (7.6)	
Sex				0.0451
Male	109 (52.9)	286 (44.9)	395 (46.9)	
Female	97 (47.1)	351 (55.1)	448 (53.1)	

SUMMARY OF STATISTICALLY SIGNIFICANT FINDINGS, CEDAR AND WALNUT

- Pedestrians in the marked crosswalk were more likely than pedestrians in the unmarked crosswalk to be female.
- Pedestrians in the unmarked crosswalk were more likely than pedestrians in the marked crosswalk to run when crossing.
- Pedestrians in the unmarked crosswalk were more likely than pedestrians in the marked crosswalk to wait for larger gaps in traffic before crossing.
- Pedestrians in the marked crosswalk were more likely than pedestrians in the unmarked crosswalk to have drivers immediately yield the right-of-way to them.

ANALYSIS RESULTS:

Table 3

PEDESTRIAN AND DRIVER BEHAVIOR BY CROSSWALK TYPE, CEDAR AND WALNUT

	Unmarked n (column %)	Marked n (column %)	Total N (column %)	*p*-value
Pedestrian Behavior				
Waiting Location/ Behavior				0.1977
Waited on curb	77 (37.7)	209 (33.0)	286 (34.1)	
Waited on street	56 (27.5)	222 (35.0)	278 (33.2)	
Did not wait	71 (34.8)	201 (31.7)	272 (32.5)	
Forced driver to yield	0 (0.0)	2 (0.3)	2 (0.2)	
Looking				0.3166
Didn't look	4 (2.0)	13 (2.1)	17 (2.0)	
Looked one way	34 (17.0)	126 (20.0)	160 (19.3)	
Looked both ways	127 (63.5)	413 (65.5)	540 (65.0)	
Looked more than 2 times	35 (17.5)	79 (12.5)	114 (13.7)	
Pace				0.0003
Slow	1 (0.5)	1 (0.2)	2 (0.2)	
Normal	177 (85.9)	586 (92.0)	763 (90.5)	
Fast	5 (2.4)	13 (2.0)	18 (2.1)	
Ran	23 (11.2)	37 (5.8)	60 (7.1)	

Driver Behavior / Traffic	Unmarked	Marked	Total	*p*-value
Average gap acceptance (lanes)	1.1	0.9	1.0	0.0005
Average number of immediate yields (drivers)	0.4	0.7	0.6	<0.0001
Average vehicle exposure (pedestrians)	1.4	1.4	1.4	0.5381

2.7.2. SITE 2: INTERNATIONAL BLVD. AND 37TH AVE., OAKLAND

SITE CHARACTERISTICS:

- **Number of Lanes Main Road (International):** 5
- **2-Way Traffic Volume Main Road (International):** 30,000/day
- **Peak Pedestrian Volume** 30 pedestrians/hour (marked), 4 pedestrians/hour (unmarked)
- **Surrounding Land Uses:** Restaurants, Nail Salon, Apartments, Clothing Stores
- **Speed Limit Main Road (International):** 30 MPH
- **Distance from Nearest Traffic Signal:** 1 Block (320 feet) on Main Road
- **Notes:** There was a large sample size for this site, making the analysis particularly robust. This site is in a low-income neighborhood with a large Hispanic population, and pedestrians and drivers in this area may have different characteristics and cultural norms than those observed at other study locations.

DESCRIPTIVE STATISTICS:

Table 4

PEDESTRIAN CHARACTERISTICS BY CROSSWALK TYPE, INTERNATIONAL AND 37TH

	Unmarked n (column %)	Marked n (column %)	Total N (column %)	*p*-value
Pedestrians	186	153	339	
Age				0.0004
Child	0 (0.0)	0 (0.0)	0 (0.0)	
Teen	29 (15.6)	6 (3.9)	35 (10.3)	
Young adult	72 (38.7)	78 (51.0)	150 (44.2)	
Older adult	85 (45.7)	67 (43.8)	152 (44.8)	
Elderly	0 (0.0)	2 (1.3)	2 (0.6)	
Sex				<0.0001
Male	148 (80.0)	80 (52.3)	228 (67.5)	
Female	37 (20.0)	73 (47.7)	110 (32.5)	

SUMMARY OF STATISTICALLY SIGNIFICANT FINDINGS, INTERNATIONAL AND 37TH:

- Pedestrians in the unmarked crosswalk were more likely than pedestrians in the marked crosswalk to be teens, while pedestrians in the marked crosswalk were more likely than pedestrians in the unmarked crosswalk to be young adults or elderly.
- Pedestrians in the marked crosswalk were more likely than pedestrians in the unmarked crosswalk to be female.
- Pedestrians in the unmarked crosswalk were more likely than pedestrians in the marked crosswalk to be assertive, waiting in the street instead of on the curb before crossing.
- Pedestrians in the unmarked crosswalk were more likely than pedestrians in the marked crosswalk to look both ways before crossing.
- Pedestrians in the unmarked crosswalk were more likely than pedestrians in the marked crosswalk to run when crossing.
- Pedestrians in the marked crosswalk, in both the first and second halves of their crossings, were more likely than pedestrians in the unmarked crosswalk to be involved in potential multiple threat scenarios.
- Pedestrians in the unmarked crosswalk were more likely than pedestrians in the marked crosswalk to wait for larger gaps in traffic before crossing.
- Pedestrians in the marked crosswalk were more likely than pedestrians in the unmarked crosswalk to have drivers immediately yield the right-of-way to them.
- Pedestrians in the marked crosswalk had a higher exposure to vehicles when crossing than pedestrians in the unmarked crosswalk.

Table 5

PEDESTRIAN AND DRIVER BEHAVIOR BY CROSSWALK TYPE, INTERNATIONAL AND 37TH

	Unmarked N (column %)	**Marked** n (column %)	**Total** (N column %)	***p*-value**
Pedestrian Behavior				
Waiting Location/ Behavior				0.0283
Waited on curb	25 (14.0)	38 (25.0)	63 (19.1)	
Waited on street	97 (54.5)	67 (44.1)	164 (49.7)	
Did not wait	56 (31.5)	46 (30.3)	102 (30.9)	
Forced driver to yield	0 (0.0)	1 (0.7)	1 (0.3)	
Looking				<0.0001
Didn't look	0 (0.0)	4 (2.6)	4 (1.2)	
Looked one way	72 (40.9)	110 (72.4)	182 (55.5)	
Looked both ways	104 (59.1)	38 (25.0)	142 (43.3)	
Pace				<0.0001
Slow	5 (2.7)	1 (0.7)	6 (1.8)	
Normal	98 (52.7)	137 (89.5)	235 (69.3)	
Fast	13 (7.0)	9 (5.9)	22 (6.5)	
Ran	70 (37.6)	6 (3.9)	76 (22.4)	

	Unmarked N (column %)	**Marked** n (column %)	**Total** (N column %)	***p*-value**
Driver Behavior / Traffic				
Multiple Threat				
First ½ of crossing pair				0.0211
No	176 (94.6)	134 (87.6)	310 (91.4)	
Yes	10 (5.4)	19 (12.4)	29 (8.6)	
Second ½ of crossing pair				<0.0001
No	154 (82.8)	96 (62.8)	250 (73.7)	
Yes	32 (17.2)	57 (37.3)	89 (26.3)	

	Unmarked	**Marked**	**Total**	***p*-value**
Average gap acceptance (lanes)	3.4	2.7	3.1	<0.0001
Average number of immediate yields (drivers)	0.9	1.6	1.2	<0.0001
Average vehicle exposure (pedestrians)	2.7	3.5	3.1	0.0174

2.7.3 SUMMARY OF STATISTICALLY SIGNIFICANT RESULTS ACROSS ALL STUDY LOCATIONS

Several overall trends are evident from the study's comparison of pedestrian and driver behavior at six uncontrolled, matched pair intersections. These trends are summarized in Table 6 and discussed in detail below.

AGE

Age was a statistically significant variable at the International Blvd. and 37th Ave. observation site. The large sample size at this location in comparison to other observation sites may have contributed to this result. At this intersection, pedestrians in the unmarked crosswalk were more likely than pedestrians in the marked crosswalk to be teens, while pedestrians in the marked crosswalk were more likely than pedestrians in the unmarked crosswalk to be young adults or elderly.

GENDER

Gender was a statistically significant variable at three of the observation sites, including both sites with five lanes and no median refuge. At all three locations, pedestrians in the marked crosswalk were more likely than pedestrians in the unmarked crosswalk to be female.

WAITING BEHAVIOR

Pedestrian waiting behavior was a statistically significant variable only at the International Blvd. and 37th Ave. observation site. As with pedestrian age, the large sample size at this location may have contributed to this result. Assertive crossing behavior may also be associated with the socio-economic or cultural norms of pedestrians at this location. At this intersection, pedestrians in the unmarked crosswalk were more likely than pedestrians in the marked crosswalk to be assertive, waiting in the street instead of on the curb before crossing.

LOOKING BEHAVIOR

Pedestrian looking behavior was a statistically significant variable at the 16th and Capp and International Blvd. and 37th Ave. observation sites. At both locations pedestrians in the unmarked crosswalk were more likely than pedestrians in the marked crosswalk to look both ways before crossing. Both sites are multi-lane roads with no median refuge.

PACE

Pedestrian pace (walking speed) was a statistically significant variable at four of the observation sites. At all four locations, pedestrians in the unmarked crosswalk were more likely than pedestrians in the marked crosswalk to run when crossing. This finding was consistent across all road types.

GAP ACCEPTANCE

Average gap acceptance was a statistically significant variable at five of the observation sites. At all five locations, pedestrians in the unmarked crosswalk were more likely than pedestrians in the marked crosswalk to wait for larger gaps in traffic before crossing. This finding was consistent across all road types.

DRIVER YIELDING

Driver yielding behavior was a statistically significant variable at all six observation sites. For all road types, pedestrians in the marked crosswalk were more likely than pedestrians in the unmarked crosswalk to have drivers immediately yield the right-of-way to them.

Table 6

SUMMARY OF ANALYSIS RESULTS — UNMARKED CROSSWALKS COMPARED TO MARKED CROSSWALKS

	Intersection	Cedar/ Walnut	16th/ Capp	Sacramento/ Blake	University/ Walnut	International/ 37th	Telegraph/ 41st
	Lanes	2	3	4	4	5	5
	Speed Limit	25 MPH	25 MPH	30 MPH	25 MPH	30 MPH	25 MPH
	Hourly Pedestrian Volume (Unmarked/Marked)	4/19	8/29	2/3	5/32	4/30	4/20
	Median	None	None	Grass Median	Concrete Median	None	None
	Number of Observations (Unmarked/Marked)	206/639	70/383	84/150	61/712	186/153	38/536
Factors	Age					More Teens	
Factors	Gender	More Males				More Males	More Males
Factors	Waiting					More Assertive	
Factors	Looking		More Looking			More Looking	
Factors	Pace	Faster Pace			Faster Pace	Faster Pace	Faster Pace
Factors	Gap	More Gaps	More Gaps		More Gaps	More Gaps	More Gaps
Factors	Yield	Less Yielding	Less Yielding	Less Yielding	Less Yielding	Less Yielding	Less Yielding
Factors	Exposure		Fewer Vehicles Encountered			Fewer Vehicles Encountered	
Factors	Multiple Threat	N/A		Lower Threat	Lower Threat	Lower Threat	

PEDESTRIAN EXPOSURE

Average pedestrian exposure to vehicles was a statistically signif cant variable at two of the observation sites. At both locations, pedestrians in the marked crosswalk had a higher exposure to vehicles when crossing than pedestrians in the unmarked crosswalk. Both sites are multi-lane roads with no median refuge.

MULTIPLE THREAT

The incidence of multiple threat opportunities was a statistically significant variable at three of the five multi-lane observation sites, including three of the four sites with four or more lanes, and both sites with median refuges. The small sample size at Telegraph and 41st Street may be associated with the lack of statistical significance at this location, as a similar trend is present. At all three locations, pedestrians in the marked crosswalk were more likely than pedestrians in the unmarked crosswalk to be involved in a potential multiple threat scenario.

2.7.4 DISCUSSION AND INTERPRETATION OF FINDINGS

Unlike previous behavioral studies, differences in pedestrian behavior in this study suggest pedestrians exhibit a greater level of caution (looking both ways, waiting for gaps in traffic, and hurrying across the street) when crossing in unmarked crosswalks than in marked crosswalks. This finding is particularly robust in terms of pace and gap acceptance, although it is also evident regarding looking behavior; whereas previous studies on two- and three-lane roads found looking behavior improved in marked crosswalks.

Also unlike previous studies which found no significant differences, results from this study suggest that drivers do yield more frequently to pedestrians in marked crosswalks compared to unmarked crosswalks.

These study results generally apply to two- and three-lane roads as well as four- and five-lane roads. However, the differences in marked versus unmarked crosswalks do appear more pronounced across several variables for multi-lane roads, with International and 37th being the most significant example. This finding is consistent with the 2001 FHWA study, which illustrated gradients in crash rate differences related to the number of lanes, with the difference in marked versus unmarked crosswalks becoming significant only for multi-lane roads[l]. Also consistent with the FHWA study is the finding that potential multiple threat scenarios arise more commonly in marked crosswalks, a critical behavioral variable that has not been considered in the behavioral literature to date[l].

These observed behavioral differences, in combination with previously reported study findings regarding driver and pedestrian knowledge of right-of-way laws, represent "missing links" in the marked crosswalk debate and may help to explain the differences in crash risk in marked versus unmarked crosswalks on certain multi-lane roadways. Key insights include the following points:

1. Based on field observations, pedestrians in the marked crosswalk were more likely than pedestrians in the unmarked crosswalk to have drivers immediately yield the right-of-way to them. Additionally based on surveys and focus groups, drivers were likely to be confused regarding right-of-way laws at unmarked crosswalks. Thus, it seems reasonable that a lower driver yielding (motorist compliance) rate at unmarked crosswalks may be at least partially a result of a lack of knowledge of the pedestrian's right-of-way within unmarked crosswalks.

2. Based on surveys and focus groups, pedestrians were also likely to be confused regarding right-of-way laws at unmarked crosswalks. Taken in combination with the finding that pedestrians in the marked crosswalk were more likely than pedestrians in the unmarked crosswalk to have drivers immediately yield the right-of-way to them, it seems reasonable that pedestrians exhibit extraordinary caution in unmarked crosswalks because either (1) they do not know motorists must legally yield the right-of-way when they are crossing in unmarked and marked crosswalks, or (2) experience has taught them that drivers are not likely to yield, or a combination of both.

3. It is then also plausible that pedestrians exhibit ordinary (as opposed to extraordinary) caution when crossing in marked crosswalks for similar reasons: (1) they are more likely to know that drivers must yield the right-of-way to them, or (2) experience has taught them that drivers are more likely to yield, or a combination of both.

4. Another observed paradox is that the higher rate of yielding in marked crosswalks can result in an increased incidence of multiple threat crashes. However, this paradox may have a rational explanation. Even in marked crosswalks, motorist compliance (yielding) rates are not 100 percent, and thus a driver yielding in one lane does not assure a driver will yield in an adjacent lane. Further, the first driver is more likely to yield at a marked crosswalk than at an unmarked crosswalk. Therefore, it is reasonable that there is a greater risk that a pedestrian crossing in a marked crosswalk will be involved in a potential multiple threat scenario than a pedestrian crossing in an unmarked crosswalk, unless other needed treatments

are implemented. For example, there may be a need to consider installing advance stop lines or yield lines with the sign "Stop Here (or Yield Here) for Pedestrians," improving nighttime lighting, installing traffic signals with pedestrian signals (if warranted), and/or installing raised median islands to provide a safer pedestrian crossing.

2.8. RECOMMENDATIONS

The results of this study should not be interpreted as justification to simply remove marked crosswalks or to fail to install marked crosswalks at appropriate pedestrian crossings. Such an approach does not address the safety and mobility needs of pedestrians.

Instead, these new insights underscore the need for a policy re-prioritization to embrace a broader range of countermeasure treatments and better address the role of human factors in pedestrian collisions. The following guidelines are illustrative components of a more balanced, "3-E" strategy to mitigate crash risk within crosswalks.

2.8.1 ENGINEERING COUNTERMEASURES

Recognizing the limited funds available for engineering countermeasures and the significant number of potential implementation sites, there is a need for strategic planning to maximize the benefits of countermeasure deployment. It is recommended that system owners obtain a full inventory of "at risk" crosswalks using the Seattle model for strategic crosswalk safety planning[X]. By developing a crosswalk inventory, system owners would then be able to prioritize locations for engineering countermeasure installation. At each of the identified treatment locations, appropriate engineering countermeasures should be selected from resources such as:

- *Guidelines on Improving Pedestrian Safety at Uncontrolled Crossings* (NCHRP/TCRP Report 562, 2006)
- *PEDSAFE Safety Guide and Countermeasure Selection System* (FHWA, 2002)
- *AASHTO Guidelines for Reducing Collisions Involving Pedestrians* (NCHRP Report 500, Vol. 10, 2004)[IV,XIV,XV]

A potential treatment for multi-lane roads is the new HAWK or "Pedestrian Beacon" technique that is under consideration in the next edition to the Manual on Uniform Traffic Control Devices (MUTCD). This traffic control device has been demonstrated as an effective treatment for reducing pedestrian collisions[VI].

2.8.2 EDUCATION COUNTERMEASURES

Engineering countermeasures should be supplemented with education and enforcement at each of the treatment sites. Additionally, broader education and enforcement initiatives can be designed to address crosswalk safety at all locations, not just those prioritized for engineering countermeasure installation.

Specifically, installation of "make eye contact with drivers" warning signs and pedestrian flags is recommended at uncontrolled crosswalks to enhance the visibility of pedestrians across multi-lane, high-volume roads.

It is further suggested that a thorough review and revision of the pedestrian section of Driver's Handbooks be conducted to provide enhanced explanations of right-of-way laws and common risk scenarios. Sarkar, Van Houten, and Moffatt (1999) concluded that while state driver licensing manuals can play a key role in education, manuals need significant improvements. They note that better manuals, with "well-written, well-illustrated information on pedestrian conflicts associated with different traffic regulations" are increasingly important with the gradual phasing out of driver education in schools[XII].

Finally, opportunities to educate non-driver pedestrians should be explored. A statewide pedestrian safety campaign is recommended to emphasize safe crossing practices (with a message similar to the classic advice of "Stop, Look Left, Look Right") regardless of crosswalk markings or treatments.

2.8.3 ENFORCEMENT COUNTERMEASURES

As with educational measures, it is important that enforcement measures target both pedestrians and drivers. Recommended innovative enforcement strategies that seek to enhance pedestrian and driver knowledge of and compliance with right-of-way laws include enforcement "stings," educational warnings in lieu of or in addition to fines, and community enforcement programs. In a study of an enforcement sting in Miami Beach, Florida, Van Houten and Malenfant (2004) found that "the percentage of drivers yielding to pedestrians increased following the introduction of the enforcement operation in each corridor[XIII]." They note, "These increases were sustained for a period of a year with minimal additional enforcement, and that the effects generalized to untreated crosswalks in both corridors as well as crosswalks with traffic signals[XIII]."

Sustained enforcement efforts can also serve as valuable educational campaigns by incorporating warnings, informational pamphlets, media coverage, and community involvement activities. In this way, road users may learn the right-of-way laws through enforcement of these laws.

2.9. CONCLUDING THOUGHTS

Crosswalks at uncontrolled intersections are numerous and widespread. While engineering countermeasures offer significant potential for reducing pedestrian crash risk, not every intersection is in need of an engineering treatment. Prioritizing implementation of engineering countermeasures to the areas with the highest risk and potential for the greatest improvement represents the best use of limited resources. For the other portions of a roadway system, there is a need for a paradigm shift to include broader deployment of education and enforcement countermeasures. These treatments must supplement engineering treatments to provide pedestrian safety benefits for all and ensure walking is embraced as a legitimate and important transportation mode.

While the current study was able to address some of the gaps in the literature, there is still much to be learned regarding motorist and pedestrian interactions and safety. Further research is particularly needed to address the safety effects of many of the treatments that have been proposed for uncontrolled crossings.

It is recognized that the results of this study are based on a limited number of low speed intersections in the San Francisco Bay Area and may not necessarily represent conditions or pedestrian and motorist behaviors at other location conditions or in other parts of the U.S. It would be helpful for future research to continue to explore pedestrian and motorist conflicts and behaviors in uncontrolled pedestrian crossings under a wide range of traffic and roadway conditions.

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3. WHAT THE LITERATURE SAYS

A REVIEW OF PREVIOUS CROSSWALK SAFETY STUDIES

3.1. INTRODUCTION

Pedestrian injuries at crosswalk locations represent a significant problem. In 2002, 22.7 percent of US pedestrians involved in collisions were in a crosswalk at the time of the collision, and over 96% of these occurred at an intersection. Almost all crosswalk collisions resulted in pedestrian injury or fatality (98.6 percent), and about one-third resulted in severe or fatal injury (National Automotive Sampling System (NASS) and General Estimates System (GES) 2002).

A great number of pedestrian injures and deaths are due to the failure of both drivers and pedestrians to follow the vehicle code, which states that 1) The driver of a vehicle shall yield the right-of-way to a pedestrian crossing the roadway within any marked crosswalk or within any unmarked crosswalk at an intersection and 2) Every pedestrian upon a roadway at any point other than within a marked crosswalk or within an unmarked crosswalk at an intersection shall yield the right of way to all vehicles upon the roadway so near as to constitute an immediate hazard. The failure of both drivers and pedestrians to follow this code may be due to lack of knowledge of the law, especially with regard to unmarked crosswalks; knowledge of the law but perception that it is not enforced and is, therefore, routinely ignored; or regardless of knowledge of the law, inattention and speed.

In order to reduce pedestrian injury, we need to better understand driver and pedestrian knowledge of the law and behavior in both marked and unmarked crosswalks. This will enable us to develop recommendations for countermeasures and strategies to increase driver and pedestrian compliance of the vehicle code at crosswalks and to mitigate danger when violations occur.

This section reviews the literature related to four key aspects of this study: pedestrian and driver knowledge of crosswalk law, pedestrian crash patterns in crosswalks, pedestrian and driver behavior in marked and unmarked crosswalks, and countermeasures to increase pedestrian safety in crosswalks.

3.2. PEDESTRIAN AND DRIVER KNOWLEDGE OF CROSSWALK LAW

Overall, there are few studies that analyze pedestrians' and drivers' understanding of crosswalk laws. One study (Tidwell and Doyle, 1995) found that most people understood that pedestrians must cross at signals or crosswalks and that turning drivers must yield to pedestrians in the crosswalk at intersections. However, there was confusion about the extent of pedestrians' right of way at crosswalks. While the Uniform Vehicle Code (UVC) requires motorists to stop or slow only for pedestrians already in a crosswalk, almost 70% of respondents thought motorists were required to stop or slow for pedestrians waiting on the curb at a marked crosswalk. Respondents also did not understand pedestrian crossing signals. Tidwell and Doyle conclude that there is a need for pedestrian safety education programs, explanatory signs on pedestrian signals, and enforcement of pedestrian right of way laws.

A second study (Sisiopiku and Akin, 2003) asked pedestrians "In your opinion, when should vehicles yield to pedestrians?" Over 60% stated that motorists should yield to pedestrians only at designated crosswalks, while 31% said pedestrians should always have the right of way and 7% said motorists should always have the right of way. Because this question asked about opinions, it is unclear if it reveals pedestrians' understanding of right of way law or simply their preferences. Additionally, the authors did not ask pedestrians to define "designated crosswalks."

Finally, a survey of drivers in Virginia found that a large majority (75-92%) were aware of laws requiring them to yield in mid-block crosswalks and to stop before crosswalks at signals (Martinez and Porter 2004). However, over half incorrectly thought that pedestrians have the right of way at all times, including when crossing outside of intersections or crosswalks.

We did not find any studies of pedestrian and driver understanding of marked versus unmarked crosswalks.

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3.3. PEDESTRIAN CRASH PATTERNS IN CROSSWALKS

According to police report data, approximately 70,000 pedestrians are injured and 5,000 die in traffic crashes in the United States each year (NHTSA 2003). An analysis of pedestrian crash types shows that about one-third of all crashes occur in or near an intersection. Of these, 30% involve a turning vehicle, over 20% involve a pedestrian running across or darting into the intersection, and 16% involve a driver violation such as failure to yield the right of way (Pedestrian and Bicycle Information Center).

There is a long and influential history of research on the safety impacts of marked and unmarked crosswalks. One of the first and most famous of these is Herms' 1972 study in San Diego, which found that marked crosswalks had twice as many crashes as unmarked crosswalks, controlling for pedestrian volume. Several other studies found similar results (Gibby 1994), but their methodologies have been criticized (Campbell 1997). Campbell raises three main concerns with the Herms study: first, the study does not describe how the crosswalks were selected; second, while Herms suggests that the higher crash rate is due to pedestrians' lack of caution, the study did not collect any behavioral data; and finally, the study can not separate the effect on crashes of striping a crosswalk from the pre-existing conditions (infrequent gaps, accident history, speed, intersection design, etc.) that led to the crosswalk being striped. He concludes that "the accident data do not necessarily indicate anything adverse about pedestrian behavior or any negative effect of the painted crosswalks themselves."

Zegeer also notes that the decision to mark a crosswalk is based in part on pedestrian volume and crash history. Like Campbell, he suggests that the higher rate of crashes that Herms found at marked crosswalks is likely a reflection of the conditions that led to them being marked in the first place (Zegeer 2004).

A more recent study found no difference between crash rates at unmarked and marked crosswalks at uncontrolled intersections on two-lane roads (Zegeer 2002). However, the study found that on high-volume (over 12,000 ADT) multi-lane roads, uncontrolled intersections with a marked crosswalk (and no other treatments) did have higher crash rates than unmarked crosswalks. Zegeer suggests that crossings on these road types should have additional treatments, such as a raised median or pedestrian signal. This debate underscores the importance of controlling for pre-existing contextual factors such as pedestrian volume, vehicle volume, and road design, as well as the importance of analyzing pedestrian and driver behavior to understand crash statistics.

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3.4. PEDESTRIAN AND DRIVER BEHAVIOR AT MARKED AND UNMARKED CROSSWALKS

One of the central debates about pedestrian behavior in crosswalks is whether pedestrians feel a sense of security in marked crosswalks that leads them to be less cautious or more aggressive than in unmarked crosswalks or non-crosswalk locations. Early studies, most famously Herms' 1972 analysis, posited that this "lack of caution" or "false sense of security" leads to a higher rate of crashes in marked crosswalks compared to unmarked crosswalks. However, Knoblauch (2001) and Nitzburg (2001) found no difference in pedestrian aggressiveness in marked and unmarked crosswalks, while others (Hauck 1979) found that pedestrian behavior improves in well-marked crosswalks compared to unmarked or poorly marked crosswalks.

A survey by Sisiopiku and Akin (2003) found that pedestrians appreciate the flexibility of midblock, unsignalized intersections. Almost one-third of respondents said they typically cross at unsignalized and midblock crosswalks, while 23% cross at signalized crosswalks, 5% at any kind of crosswalk, and 41% at any convenient location. A crosswalk's location relative to the pedestrian's destination was the most influential factor in where pedestrians chose to cross, followed by time savings. There were no significant differences in responses by gender or age. The authors conclude that pedestrians prefer unsignalized midblock crosswalks.

According to a survey in Virginia, over two-thirds of pedestrians reported crossing at crosswalks or intersections most of the time or always. Those who crossed outside of crosswalks did so because they were in a hurry, the road was clear, or the nearest crosswalk was too far away (Martinez and Porter 2004).

Yagil (2000) explains pedestrian compliance with crosswalk laws in three ways. The first is the health belief model, which states that behavior is influenced by cognitive factors including cues to action, perceived threats and benefits, and barriers. The second is motives, both "instrumental" (gains or losses related to compliance) and "normative" (personal values). Third are situational factors, such as the presence and behavior of other pedestrians, mood, and the physical environment. Yagil's survey in Israel found that normative motives, namely, an obligation to obey the law, were the strongest predictor of crossing behavior. Situational factors (i.e., high traffic volume) were also influential. There were also strong differences by gender: women's behavior was more motivated by perceived danger and the social environment, while men's behavior was more influenced by the physical environment.

There have been fewer studies of driver behavior, but it is generally agreed that drivers often fail to yield to pedestrians at both marked and unmarked crosswalks. Nasar (2003) observed that many drivers ignored pedestrians in crosswalks, or sped up or swerved to pass them. Out of 100 drivers observed at a stop sign, most rolled through the stop sign, never coming to a complete stop. When a pedestrian was in the crosswalk, 43% of the drivers did not stop. While self-reported data is often unreliable, it has been used to gauge driver behavior at crosswalks. In a survey of drivers in Virginia, over 80% stated that they "always" or "most of the time" yielded to pedestrians in a mid-block crosswalk, though less than 64% responded that they always yield to pedestrians when making a left turn (Martinez and Porter 2004). Pedestrians' perceptions of drivers' behavior paints a different picture. In a survey by Sisiopiku and Akin (2003), less than half of the respondents (45%) stated that drivers typically yield to pedestrians in designated locations (midblock and intersection crosswalks). Half of the respondents said that drivers turning on red do not yield to pedestrians crossing on green. The authors recommend that additional surveys be conducted to examine differences between drivers' and pedestrians' perceptions of right of way at intersections.

The effects on driver behavior of marking a crosswalk are unclear. In a before and after study, Knoblauch (2001) found that marking a crosswalk had no effect on driver yielding. However, he found a slight reduction in speed by drivers approaching a pedestrian in a marked crosswalk compared to one that is unmarked.

Nitzburg (2001) found strong differences between day and night-time driver behavior. During the day, over 40% of drivers yielded to pedestrians in the high-visibility crosswalks, 20% yielded to pedestrians in a marked mid-block crosswalk, and less than 3% yielded to pedestrians in an unmarked crosswalk. At night, these percentages fell to 25% in the high-visibility crosswalk and 17% in the marked mid-block crosswalk.

Nitzburg's study also found differences in both driver and pedestrian behavior when the pedestrian was in the second half of the crosswalk compared to the first half. At unmarked crosswalks, no drivers yielded to pedestrians in the first half, but over 11% yielded to pedestrians in the second half. Similarly, at a marked midblock crosswalk, 6% of drivers yielded to pedestrians in the first half while 54% yielded to pedestrians in the second half. Pedestrians using the mid-block crosswalk became more assertive in the second half of the crossing, forcing the right of way over 15% of the time, compared to about 8% of the time in the first half of the crossing.

There appears to be some dissonance between observed and stated behavior. Varhelyi's (1996) study of motorist behavior at a non-signalized zebra crossing (diagrammed in the paper as a crosswalk marked by a series of broad horizontal stripes; this is often called a "continental" or "ladder" crosswalk) found that in 73 percent of "critical" cases, the vehicle maintained or even increased speed, and in only 27 percent of cases did they slow down as required. At the same time, a separate survey found that in 67 percent of the cases, motorists say they "always" or "very often" slow down.

While the results of these studies vary, the notion that crosswalks by themselves induce aggressive behavior or lack of caution is not supported. At the same time, both pedestrians and drivers routinely disobey crosswalk laws. It appears that this behavior is often the result of a desire for more convenient or faster travel. Other factors such as time of day and location in the crosswalk also affect driver yielding. Finally, beliefs and behaviors appear to be inconsistent, both for drivers and pedestrians.

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3.5. COUNTERMEASURES TO INCREASE PEDESTRIAN SAFETY IN CROSSWALKS

There are many evaluations of engineering or street design countermeasures to improve pedestrian safety in crosswalks, including signage, lighting, and high-visibility striping. Van Houten and Malenfant (1989) found that a series of countermeasures including pavement markings, feedback to pedestrians, warning signs for motorists, and enforcement resulted in large increases in the percentage of drivers yielding to pedestrians. Another study by Van Houten (1992) found that adding signs, a stop line, and pedestrian-activated lights increased the percentage of drivers stopping by up to 50% and substantially reduced the number of conflicts. Similarly, a study of high visibility crosswalks with ladder striping, overhead lighting and signage found more driver yielding, and no increase in pedestrian aggressiveness, running, or vehicle-pedestrian conflicts compared to unmarked control crosswalks (Knoblauch 2001).

Pedestrian detection is a new approach to improving pedestrian safety in crosswalks. New video-based systems can detect not only pedestrians waiting to cross, but can track their progress through the crosswalk and adjust the signal based on their walking speed (NCBW). This not only accommodates slower pedestrians, reducing the number "caught" in the crosswalk, but also reduces delay for vehicles by shortening the pedestrian cycle for faster pedestrians. An Australian study found that using this "puffin" (Pedestrian User-Friendly INtelligent) crossing system resulted in increased pedestrian compliance and a significant reduction in pedestrians crossing before the green, as well as a 40% reduction in vehicle delay (Catchpole 1996, cited in Cairney 1999). A similar system known as a Pussycat (Pedestrian Urban Safety SYstem and Comfort At Traffic signals) crossing includes a mat or infrared detector at the curb and infrared sensors to detect pedestrians in the crossing. This is being tested in the Netherlands, Britain, and France (Levelt 1992, cited in Hummel 1999).

Social marketing approaches may also be effective. Nasar (2003) studied the effectiveness of hand-held signs to get drivers to stop for pedestrians in a crosswalk. He found a significant increase in stopping, both at the treatment crosswalk and at a downstream non-treatment crosswalk. However, long-term effects were not evaluated.

Educational approaches, while common, are rarely formally evaluated, and there is little evidence that they are effective (Zegeer 2004). A safety campaign in downtown Auckland, New Zealand used a combination of visual media (banners, billboard, road markings), chastisement (whistle-blowing and finger-pointing by a "footpath mime") and rewards (pens, notepads, sweets, and letters mailed to yielding drivers) to reduce the number of pedestrians crossing on a red light and to encourage left-turning drivers to yield to pedestrians (Harre and Wrapson 2004). While pedestrian crossings on red decreased by half, there was no effect on driver behavior, and no change in pedestrian or driver attitudes towards pedestrian safety. Just over half of those surveyed were aware that the campaign had occurred.

Similarly, there are few evaluations of enforcement programs and little evidence of their effectiveness. Britt et al's evaluation of a public education and enforcement program in Seattle was unable to demonstrate that law enforcement efforts significantly or consistently improve driver yielding (Britt, Bergman and Moffat 1995). They suggest that a very high level of enforcement is necessary to achieve even minor or temporary changes in driver behavior and that environmental and behavioral factors may be more influential than enforcement.

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APPENDIX A:

FIELD OBSERVATION METHODOLOGY AND RESULTS

PEDESTRIAN AND DRIVER BEHAVIOR IN MARKED VERSUS UNMARKED CROSSWALKS

INTRODUCTION

The environmental, social, health, and economic benefits of walkable communities have become increasingly apparent. Especially at a time when the need for sustainable transportation solutions is critical, a greater focus on pedestrian-oriented alternatives to auto-dependency is clearly warranted. The pedestrian advocacy community has long argued for such a focus, emphasizing the legitimacy of pedestrians as shared users of the public roadways. Considering pedestrian safety as we re-orient transportation and land use planning to the pedestrian is imperative. As Zegeer, et al. (2001) and others have argued, "Pedestrians have a right to cross roads safely and, therefore, planners and engineers have a professional responsibility to plan, design, and install safe crossing facilities[I]."

This section addresses pedestrian safety with regard to crosswalks at unsignalized intersections. In California, the study area for the original data collection presented in this report, from 2000 to 2004 approximately 8 percent of statewide pedestrian collisions (5,680 of 73,310) occurred at unsignalized intersections. Ninety-five percent of these collisions (5,388) resulted in a pedestrian injury or fatality (yielding an average of almost 1,100 injuries or fatalities annually at unsignalized intersections in California)[II].

This section documents and interprets field observations of drivers and pedestrians in marked and unmarked crosswalks at unsignalized intersections. Other sections of the report present findings from surveys, focus groups, and literature reviews to address driver and pedestrian knowledge of right-of-way laws[III] and stated behavior, also in the context of marked versus unmarked crosswalks.

BACKGROUND

Crosswalks at unsignalized intersections have been the subject of numerous studies over the past 30 years. Specifically, the differences in collision risk at marked (striped) versus unmarked crosswalks[1] have been well documented. However, most of these studies have leapt from identifying collision patterns to recommending engineering solutions without addressing the underlying causal factors of collisions. As illustrated by the classic Haddon Matrix for injury prevention and analysis (Table 1), many factors must be considered to fully deconstruct collision risk and select appropriate and effective countermeasures.

Table 1

THE HADDON MATRIX

Phases/ Factors	Human Factors	Agent or Vehicle	Physical Environment	Socio-cultural Environment
Pre-Crash	This study's focus		Conventional focus	This study's focus
Crash	This study's focus		Conventional focus	This study's focus
Post-Crash				

[1] According to the California Vehicle Code, a legal crosswalk is defined as the extension of the sidewalk across a road, regardless of painting/striping designation.

Traffic safety researchers have long argued that driver behavior is a key causal factor in roadway collisions[IV,V]. Thus, to strategically improve pedestrian safety, we fundamentally need to understand driver and pedestrian behavior, which may be more closely associated with the human factors or socio-cultural environment cells of the Haddon Matrix, and thus not completely addressed through conventional engineering practice focusing on the physical environment.

One of the central debates about pedestrian behavior in crosswalks is whether pedestrians feel a sense of security in marked crosswalks that leads them to be less cautious or more aggressive than in unmarked crosswalks or non-crosswalk locations. Early studies, most famously Herms' 1972 analysis, suggested that this "lack of caution" may have led to the observed higher rate of collisions in marked crosswalks compared to unmarked crosswalks[VI].

Thirty years of pedestrian safety research has since considered this fundamental question. More recently, Knoblauch, *et al.* (2001) measured the effect of crosswalk markings on driver and pedestrian behavior at unsignalized intersections on two and three-lane roads[VII]. Knoblauch (2001) and Nitzburg (2001) found no difference in pedestrian assertiveness in marked and unmarked crosswalks, while pedestrian searching behavior actually improved at crossings after they were marked[VII,VIII]. Others, for example, Hauck, 1979, have found that pedestrian behavior improves in well-marked crosswalks compared to unmarked or poorly marked crosswalks[IX].

There have been fewer studies of driver behavior but it is generally agreed that drivers often fail to yield to pedestrians at both marked and unmarked crosswalks. The effects on driver behavior of marking a crosswalk have remained unclear.

Figure 1

VOLUME, LANE, AND SPEED LIMIT-BASED GUIDELINES FOR CROSSWALK INSTALLATION

Roadway Type (Number of Travel Lanes and Median Type)	Vehicle ADT ≤ 9,000			Vehicle ADT >9000 to 12,000			Vehicle ADT >12,000 - 15,000			Vehicle ADT > 15,000		
	Speed Limit**											
	≤ 30 mi/h	35 mi/h	40 mi/h	≤ 30 mi/h	35 mi/h	40 mi/h	≤ 30 mi/h	35 mi/h	40 mi/h	≤ 30 mi/h	35 mi/h	40 mi/h
2 Lanes	C	C	P	C	C	P	C	C	N	C	P	N
3 Lanes	C	C	P	C	P	P	P	P	N	P	N	N
Multi-Lane (4 or More Lanes) With Raised Median***	C	C	P	C	P	N	P	P	N	N	N	N
Multi-Lane (4 or More Lanes) Without Raised Median	C	P	N	P	P	N	N	N	N	N	N	N

* These guidelines include intersection and midblock locations with no traffic signals or stop signs on the approach to the crossing. They do not apply to school crossings. A two-way center turn lane is not considered a median. Crosswalks should not be installed at locations that could present an increased safety risk to pedestrians, such as where there is poor sight distance, complex or confusing designs, a substantial volume of heavy trucks, or other dangers, without first providing adequate design features and/or traffic control devices. Adding crosswalks alone **will not** make crossings safer, nor will they necessarily result in more vehicles stopping for pedestrians. Whether or not marked crosswalks are installed, it is important to consider other pedestrian facility enhancements (e.g., raised median, traffic signal, roadway narrowing, enhanced overhead lighting, traffic-calming measures, curb extensions), as needed, to improve the safety of the crossing. **These are general recommendations; good engineering judgment should be used in individual cases for deciding where to install crosswalks.**

** Where the speed limit exceeds 40 mi/h (64.4 km/h) marked crosswalks alone should not be used at unsignalized locations.

C = **Candidate sites for marked crosswalks**. Marked crosswalks must be installed carefully and selectively. Before installing new marked crosswalks, an engineering study is needed to determine whether the location is suitable for a marked crosswalk. For an engineering study, a site review may be sufficient at some locations, while a more in-depth study of pedestrian volume, vehicle speed, sight distance, vehicle mix, etc. may be needed at other sites. It is recommended that a minimum of 20 pedestrian crossings per peak hour (or 15 or more elderly and/or child pedestrians) exist at a location before placing a high priority on the installation of a marked crosswalk alone.

P = **Possible increase in pedestrian crash risk may occur if crosswalks are added without other pedestrian facility enhancements.** These locations should be closely monitored and enhanced with other pedestrian crossing improvements, if necessary, before adding a marked crosswalk.

N = **Marked crosswalks alone are insufficient, since pedestrian crash risk may be increased due to providing marked crosswalks alone. Consider using other treatments, such as traffic-calming treatments, traffic signals with pedestrian signals where warranted, or other substantial crossing improvement to improve crossing safety for pedestrians.**

*** The raised median or crossing island must be at least 4 ft (1.2 m) wide and 6 ft (1.8 m) long to adequately serve as a refuge area for pedestrians in accordance with MUTCD and American Association of State Highway and Transportation Officials (AASHTO) guidelines.

Source: Zegeer, 2001.

In a before and after study, Knoblauch (2001) found that marking a crosswalk had no effect on driver yielding. However, he found a slight reduction in speed by drivers approaching a pedestrian in a marked crosswalk compared to one that is unmarked.

Nitzburg (2001) found strong differences between day and nighttime driver behavior. During the day, over 40% of drivers yielded to pedestrians in the high-visibility crosswalks, 20% yielded to pedestrians in a marked mid-block crosswalk, and less than 3% yielded to pedestrians in an unmarked crosswalk. At night, these percentages fell to 25% in the high-visibility crosswalk and 17% in the marked mid-block crosswalk. Nitzburg's study also found differences in both driver and pedestrian behavior when the pedestrian was in the second half of the crosswalk compared to the first half. At unmarked crosswalks, no drivers yielded to pedestrians in the first half, but over 11% yielded to pedestrians in the second half. Similarly, at a marked midblock crosswalk, 6% of drivers yielded to pedestrians in the first half while 54% yielded to pedestrians in the second half. Pedestrians using the mid-block crosswalk became more assertive in the second half of the crossing, forcing the right of way over 15% of the time, compared to about 8% of the time in the first half of the crossing[VII,VIII].

Importantly, these previous studies of driver and pedestrian behavior share a common focus on crosswalks across only two and three-lane, low volume roads. This may explain why no clear behavioral differences between marked and unmarked crosswalks have been observed. The now accepted authority on the unmarked/marked crosswalk collision phenomenon, a 2001 study by Zegeer, et al., suggests no meaningful collision risk differences occur on two-lane roads or on low-volume multi-lane roads[I]. According to Zegeer, crosswalks across multi-lane roads (roads with 3 or more lanes) with travel volumes exceeding 12,000 average daily traffic (ADT) are the only scenarios in which the increased collision risk of installing a marked crosswalk at an uncontrolled intersection is statistically significant. This conclusion was based on an analysis of 5 years of pedestrian collisions at 1,000 marked crosswalks and 1,000 matched unmarked comparison sites in 30 U.S. cities.

Zegeer's key study results included:

- The presence of a marked crosswalk alone was associated with no difference in pedestrian collision rate on two-lane roads and low-volume multi-lane roads.
- On multi-lane roads with traffic volumes above about 12,000 vehicles per day, having a marked crosswalk alone (e.g., without raised median or other substantial treatment) was associated with a higher pedestrian collision rate.
- On multi-lane roads, having raised medians provided significantly lower pedestrian collision rates, compared to having no raised median.
- Older pedestrians had high relative collisions for their crossing exposure[I].

Figure 1 summarizes Zegeer's safety enhancement recommendations for crosswalk facilities based on variables including number of lanes, traffic volume (vehicle ADT), speed limit, and presence of median.

Research continues in this field today in two primary areas: clarifying and supplementing the recommended engineering countermeasures from the Zegeer study, and analyzing the underlying behavioral characteristics that may contribute to pedestrian collisions and better inform the selection of countermeasures.

In the first area, a recent research effort jointly sponsored by TCRP and NCHRP and conducted by the Texas Transportation Institute (TTI) focused on determining the effectiveness[2] of pedestrian safety engineering countermeasures for unsignalized crossings. As a result of this study, specific guidelines for selecting effective pedestrian

[2] Effectiveness was defined as motorist compliance (yielding). An important concern many pedestrian safety experts raise is that unless 100 percent compliance with the law is achieved, increasing driver-yielding behavior could actually be detrimental to pedestrian safety if it leads to a pedestrian expectation that all drivers will yield, and thus a lower level of vigilance when crossing. In this event, the consequence of even one driver failing to yield may be much greater than the consequence of many drivers not yielding under current conditions.

crossing treatments for unsignalized intersections and midblock locations are now available based on key input variables (such as pedestrian volume, street crossing width, and traffic volume). The study also suggested modifications to the pedestrian traffic signal warrant in the *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD)[X].

Figure 2

MARKED / UNMARKED CROSSWALKS PAIR

Table 2

FIELD OBSERVATION SITES

2 Lanes	3 Lanes	4+ Lanes	
		No Median	Median
Cedar St. and Walnut St., Berkeley	16th St. and Capp St., San Francisco	International Blvd. and 37th Ave., Oakland	University Ave. and Walnut St., Berkeley
		Telegraph Ave. and 41st/63rd St., Oakland*	Sacramento St. and Blake St., Berkeley

* Field observations occurred at both Telegraph Ave. and 41st St. and Telegraph Ave. and 63rd St. in this category.

Falling within the second area of current research, this section summarizes results from field observations of driver and pedestrian behavior at marked and unmarked crosswalks. Following sections present the results of intercept surveys and focus groups conducted to assess driver and pedestrian knowledge of right-of-way laws related to marked and unmarked crosswalks. Results from the surveys and focus groups demonstrate that a substantial level of confusion exists with respect to pedestrian right-of-way laws. This confusion was exacerbated by intersections which had unmarked crosswalks[III].

In the conclusion to this report, we present recommendations which combine results from both areas of current research.

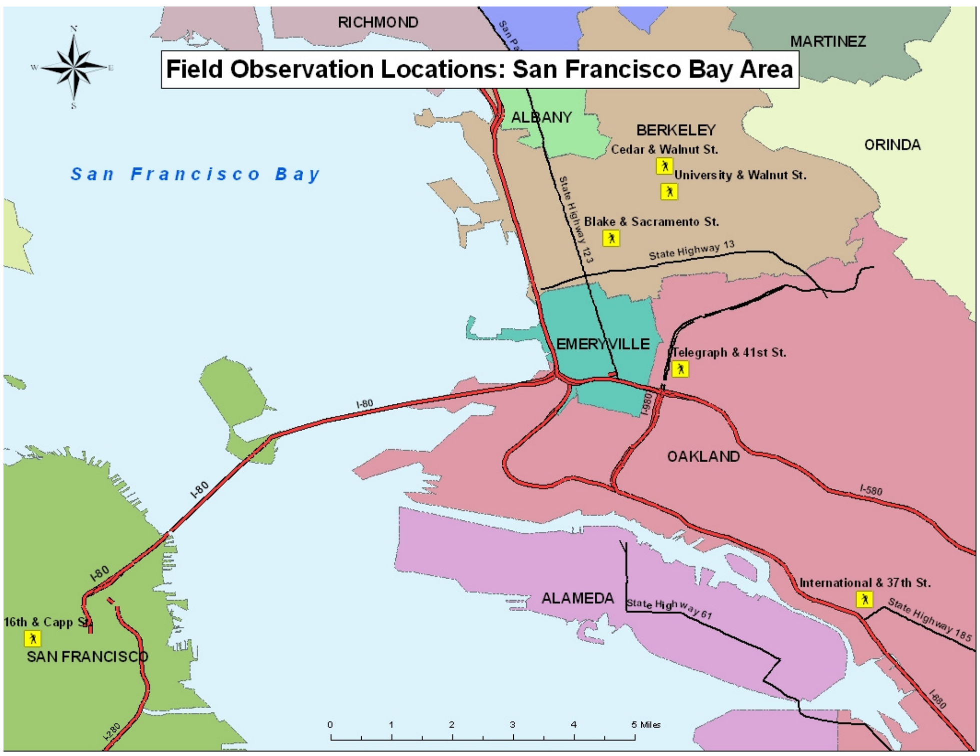
METHODS

Directly responding to Zegeer's call for further research on driver and pedestrian behavior, the field data collection effort for this study focused on the "N and P" cells in Figure 1. A better understanding of any behavioral differences exhibited in these scenarios was sought in an effort to inform best practices in pedestrian safety countermeasures.

Building on the Knoblauch (2001) study, we followed a similar research methodology, except that instead of repeating studies on 2 and 3-lane roads, this analysis studied mostly roads with 4 or more lanes. Utilizing a matched pair approach, we compared marked and unmarked crosswalk pairs at the same intersection, as illustrated in the aerial photograph in Figure 2. Intersections with matched pairs of marked and unmarked crosswalks were considered desirable because all exogenous factors are held constant, allowing for a direct comparison between the crosswalks.

Figure 3

FIELD OBSERVATION LOCATIONS, SAN FRANCISCO BAY AREA



Six sites were selected for the purposes of this study. The locations were chosen with the following guidelines:

- One matched pair of crosswalks at an intersection on a two-lane major road
- One matched pair of crosswalks at an intersection on a three-lane major road
- Four matched pairs of crosswalks at intersections on four to five lane major roads. Of these sites we selected:
  - Two locations with medians
  - Two locations without medians

One 2-lane intersection was selected to allow for comparison with previous studies and then to compare with multi-lane crossings. Table 2 presents these sites, all of which are located in the San Francisco Bay Area. Figure 3 displays the relative geographic locations of the sites.

At each of our matched pair locations, we considered the following study questions:

- **Whether pedestrians use more, less, or the same amount of caution when crossing at a marked crosswalk, as compared to an unmarked crosswalk**—by recording the pedestrian's "looking behavior" and level of assertiveness when using a marked versus unmarked crosswalk.
- **Whether the age or gender of the pedestrian are correlated with his or her behavior**—by recording the gender and approximate age of the pedestrian observed.[3]
- **Whether drivers yield more often to pedestrians in marked crosswalks than unmarked crosswalks**—by recording whether or not the driver yielded when encountering a pedestrian in the crosswalk.[4]
- **Whether pedestrians are more likely to cross a street within a marked crosswalk**—by recording "crosswalk capture," or a circuitous crossing in favor of the marked crosswalk.

DATA COLLECTION

For this study, a pilot evaluation of video and clipboard-based data collection methods was conducted to determine the best data collection methodology. The evaluation considered accuracy, reliability, validity, and cost. Results from this evaluation are presented in Appendix A. Clipboard-based (manual) data collection was selected as the best method for the purposes of this study.

Figure 4

FIELD DATA COLLECTION FORM

Intersection: International and 37th   Crossing Observed: Unmarked   observer station 4

Data Collected by: ______________________   Start Time: __________

Data Collected on: ______________________   End Time: __________

	LEAD/ ISOLATED PEDESTRIAN			DRIVERS					LEAD/ ISOLATED PEDESTRIAN				
Event #	Time Ped Arrived	PED LEVEL ASSERT 0=wait on curb 1=wait on street 2=no wait 3=force driver to yield	PED LOOK BEHAVIOR 0=did not look 1=look 1 direction 2=look both directions 3=look more times	Lane NB1 Driver U=driver unable to yield Y=driver 1 yielded Wn=ped had to wait for n cars 0=no car	Lane NB2 Driver Y=driver 1 yielded Wn=ped had to wait for n cars 0=no car	Lane C Driver Y=driver 1 yielded Wn=ped had to wait for n cars 0=no car	Lane SB2 Driver Y=driver 1 yielded Wn=ped had to wait for n cars 0=no car	Lane SB1 Driver Y=driver 1 yielded Wn=ped had to wait for n cars 0=no car	AGE C=<13, T=13-18, YA=19-35, OA=36-64, E=65+	GENDER M=male F=female	PED GAIT S=slow N=normal F=fast R=ran	Time Ped Finished Crossing	Notes (note if ped is disabled, parent with child, unusual walking behavior, etc.)
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													

[3] Socioeconomic standing is also likely correlated with behavior. However, the observational (anonymous) study design did not permit the collection of this type of data.

[4] Previous studies have noted that driver yielding is related to vehicle speeds. All six observations locations had speed limits of 25 to 30 MPH in an effort to reduce potential yielding behavior discrepancies based on speed.

Data collection occurred during daylight hours on non-rainy days from May to October, 2006. Marked and unmarked crosswalk observations were collected concurrently at each site, except for International and 37th, where they were collected in series. Observers included professional field data collectors from Population Research Systems (PRS), selected based on inter-rater reliability tests from the pilot evaluation, as well as undergraduate work-study students from UC Berkeley who completed a one-hour training course tailored to this project.

Figure 4 presents the field data collection form developed for this project. Data entry fields were rearranged and additional observation categories were added to enhance the usability and efficiency of the form based on the debriefing comments and results of the pilot test.

For the 16th and Capp 3-lane intersection in San Francisco, video footage available from another Traffic Safety Center project was utilized in lieu of in-person observations. Trained field observers completed the video observations in the office using QuickTime® video-playback software. When collecting data from the video, observers used the same data collection form as was used for the field observations.

DATA ANALYSIS

A comprehensive quality control process was employed to prepare field data for data analysis. The field observers entered data from their clipboard forms into an Excel spreadsheet. This data was then cross-checked by another field observer and signed and dated. Finally, all data received a quality review by the project manager before being formatted as an analysis input file.

The statistical analysis package SAS was then utilized to compare driver and pedestrian behavior observations in marked versus unmarked crosswalks at each of the six observation locations. This comparison was accomplished via a Chi-Squared test, a non-parametric test of statistical significance appropriate for bivariate tables.[5] The determination of statistical significance was based on a p-value of less than or equal to 0.05. Summary tables from this analysis are included in the subsequent sections of this report. Detailed output from the analysis is provided in Appendix B.

In addition to the observation variables included on the data collection form, the following derived variables were analyzed for each observation location:

- **AVERAGE GAP ACCEPTANCE (LANES):** This variable measures the number of times that no vehicle was present in a lane encountered during a pedestrian's crossing. The maximum number of gaps is equal to the number of lanes across which the crosswalk extends. The average number of gaps for pedestrians in marked versus unmarked crosswalks was compared in the statistical analysis for each site.
- **AVERAGE NUMBER OF IMMEDIATE YIELDS (DRIVERS):** This variable is the sum of the number of times the first driver encountered by a pedestrian in each lane yielded (as opposed to not yielding and trapping the pedestrian on the curb or within the street). The average number of immediate yields for pedestrians in marked versus unmarked crosswalks was compared in the statistical analysis for each site.
- **AVERAGE VEHICLE EXPOSURE (PEDESTRIANS):** This variable is the sum of the total number of vehicles encountered by a pedestrian during a crossing. The average exposure for pedestrians in marked versus unmarked crosswalks was compared in the statistical analysis for each site.

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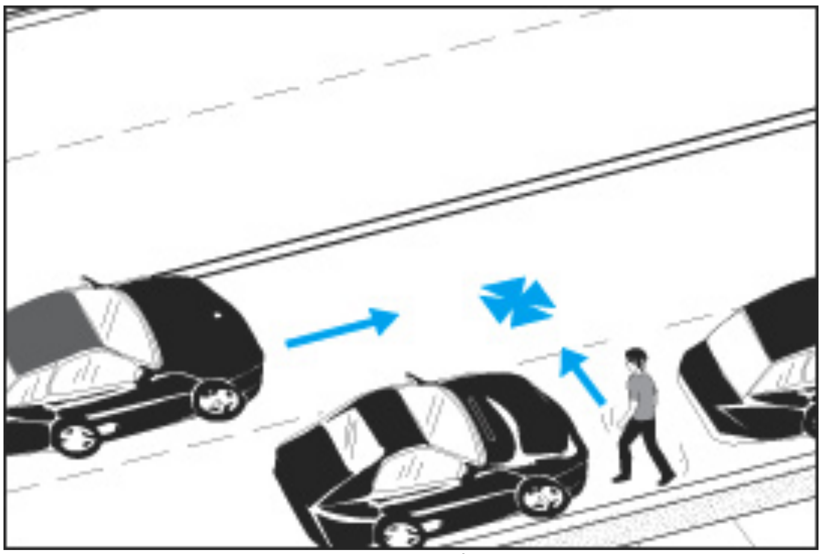
[5] In some instances, as noted in the Appendix output tables, cells had expected counts less than 5 and the Chi-Square may not be a valid test. In these cases, the Fisher's Exact Test was used.

- **MULTIPLE THREAT OPPORTUNITY:** This variable measures for each pedestrian the number of times in which a driver yielded in one lane (the first encountered in the crossing direction) while a driver in the adjacent lane of the same direction of travel (the next encountered) did not yield. The incidence of multiple threat opportunities was applicable only for the crosswalks across the 3, 4, and 5-lane intersections (i.e., not Cedar and Walnut). For the 4 and 5-lane intersections, two pairs of multiple threat opportunities were considered, the first set of same direction lanes encountered in a crossing and the second set.[6] The incidence of multiple threat opportunities for pedestrian crossings in marked versus unmarked crosswalks was compared in the statistical analysis for each site.

Multiple threat scenarios were specifically addressed in our analysis because the Zegeer study noted, "The greatest difference in pedestrian collision types between marked and unmarked crosswalks involved 'multiple-threat' collisions[l]". Multiple-threat collisions occur on multi-lane roads when the driver and pedestrian fail to see each other in time to prevent a collision because their line of sight is blocked by a driver yielding to the pedestrian in an adjacent lane (as illustrated in Figure 5).

Figure 5

MULTIPLE-THREAT COLLISION TYPE



Source: http://www.walkinginfo.org/pedsafe/images/collisiontype_c710m.gif

A1.6. RESULTS

On the following pages we present a summary of the statistical analysis for the six observation sites. Photos of each intersection and background characteristics are also provided as context.

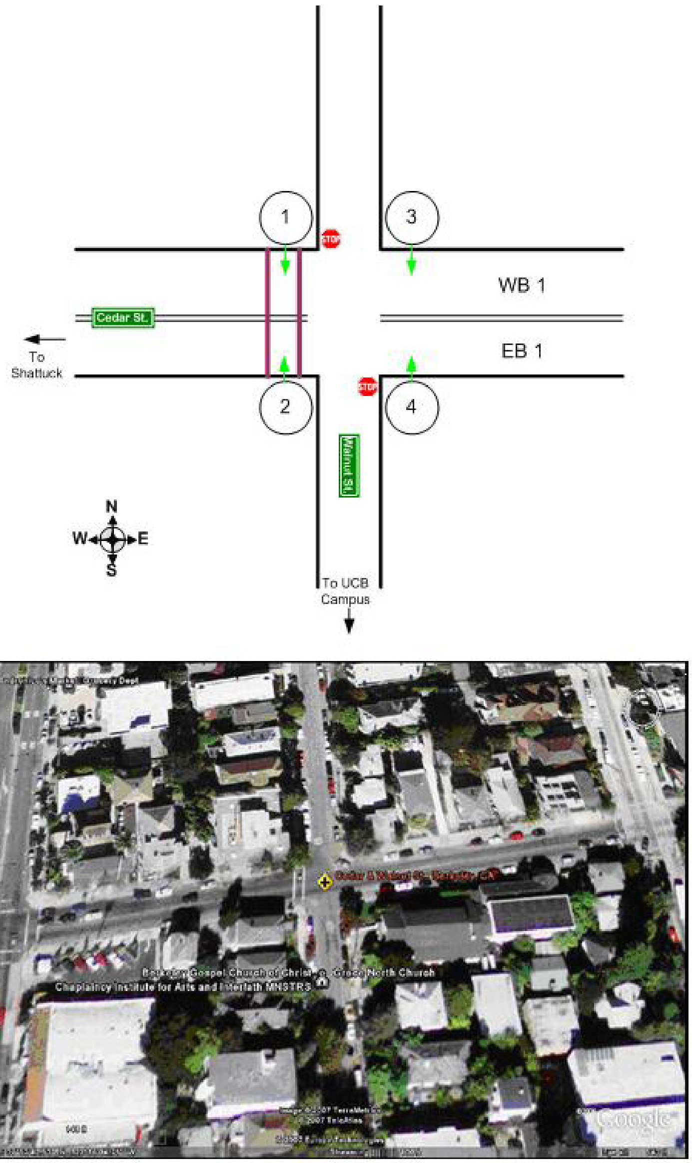
Statistically significant findings are summarized for each intersection, followed by an overall summary of findings and a discussion of the results.

[6] These pairs were analyzed separately because we believe driver behavior may be affected by the amount of time the pedestrian has been in the crossing (and thus the amount of lead time for a reaction from the driver).

SITE 1: CEDAR AND WALNUT

Figure 6

SITE 1: CEDAR AND WALNUT
DIAGRAM AND AERIAL PHOTOGRAPH



BACKGROUND CHARACTERISTICS:

- **Peak Pedestrian Volume:**
  19 pedestrians/hour (marked),
  4 pedestrians/hour (unmarked)
- **Surrounding Land Uses:**
  Mostly residential and churches with restaurants, a grocery store, and a pharmacy within 1 block
- **Speed Limit Main Road:**
  (Cedar) 25 MPH
- **Distance from Nearest Traffic Signal:** 1 block (320 feet) on Main Road
- **Important Note for This Intersection:**

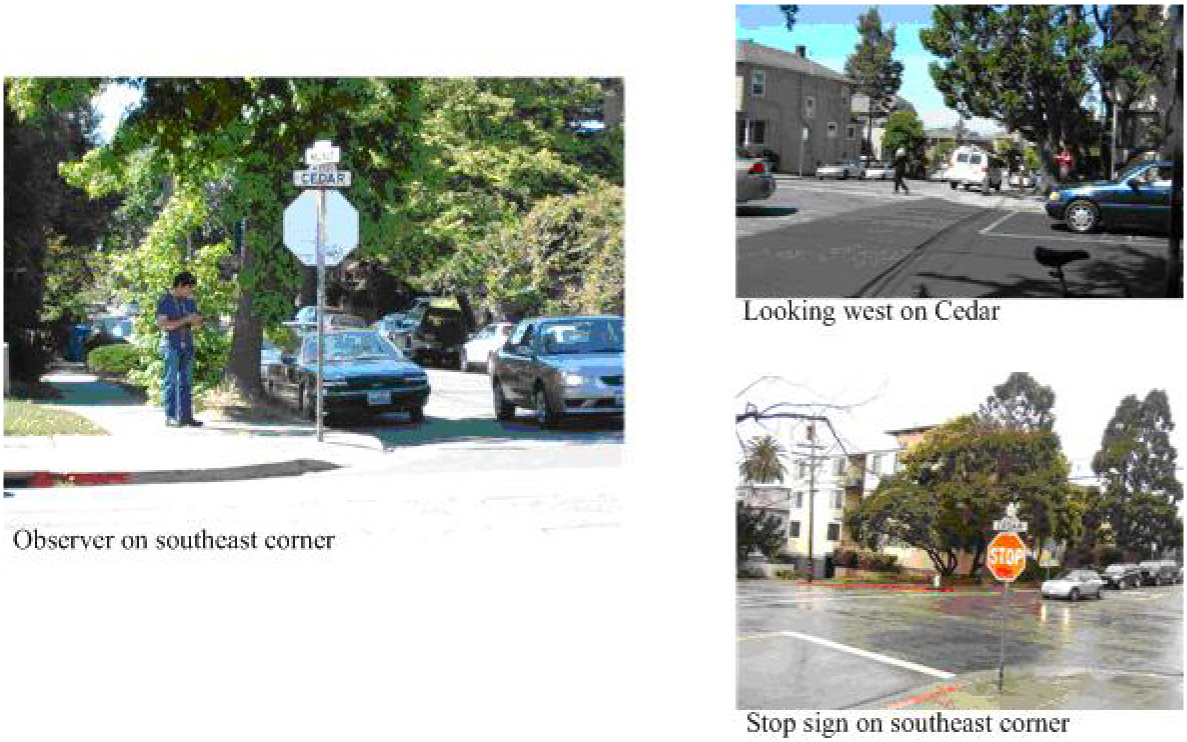
  Cedar is on a slight grade, sloping downhill from east to west. This topography may affect driver and pedestrian behavior.

SUMMARY OF STATISTICALLY SIGNIFICANT FINDINGS, CEDAR AND WALNUT:

- Female pedestrians are more likely to use the marked crosswalk.
- Pedestrians in the unmarked crosswalk are more likely to run when crossing.
- Pedestrians in the unmarked crosswalk are more likely to wait for larger gaps in traffic before crossing.
- Drivers are more likely to yield to pedestrians in the marked crosswalk.

Figure 7

SITE 1 PHOTOGRAPHS: CEDAR AND WALNUT



Observer on southeast corner

Looking west on Cedar

Stop sign on southeast corner

DESCRIPTIVE STATISTICS:

Table 3

SITE 1: CEDAR AND WALNUT
PEDESTRIAN CHARACTERISTICS BY CROSSWALK TYPE

	Unmarked n (column %)	**Marked** n (column %)	**Total** N (column %)	***p*-value**[d]
Pedestrians	206	639	845	
Age				0. 9094
Child	0 (0.0)	1 (0.2)	1 (0.1)	
Teen	1 (0.5)	6 (0.9)	7 (0.8)	
Young adult	89 (43.6)	291 (45.7)	380 (45.2)	
Older adult	97 (47.5)	292 (45.8)	389 (46.3)	
Elderly	17 (8.3)	47 (7.4)	64 (7.6)	
Sex				0.0451
Male	109 (52.9)	286 (44.9)	395 (46.9)	
Female	97 (47.1)	351 (55.1)	448 (53.1)	

ANALYSIS RESULTS:

Table 4

SITE 1: CEDAR AND WALNUT
PEDESTRIAN AND DRIVER BEHAVIOR BY CROSSWALK TYPE

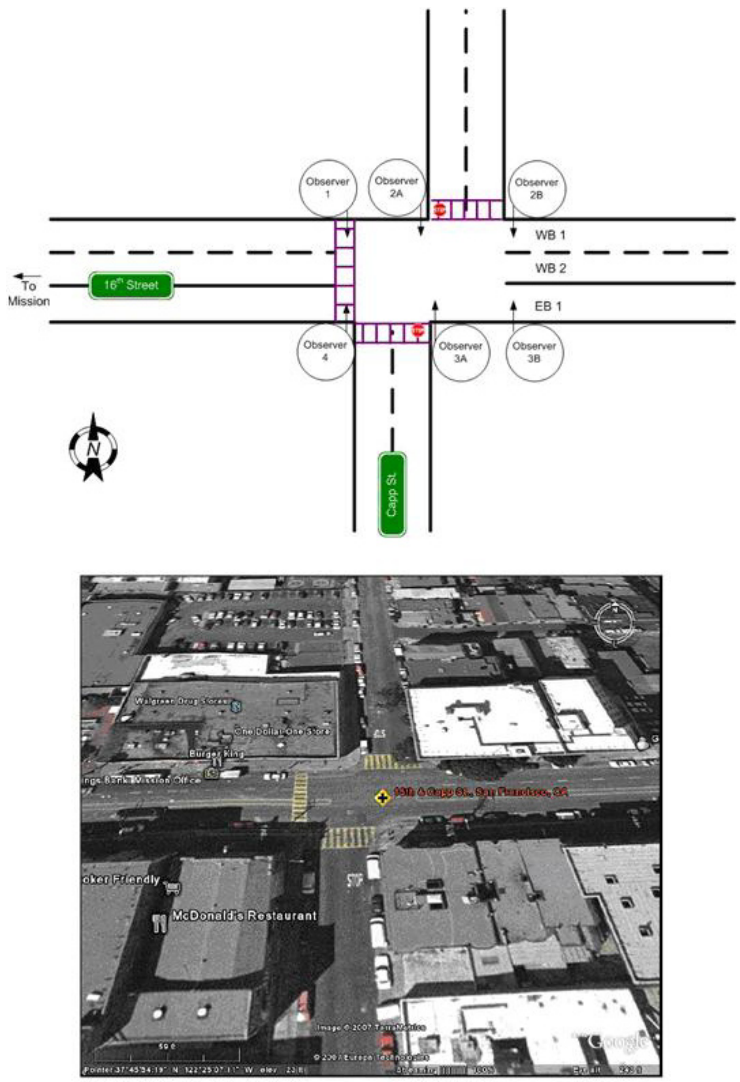
	Unmarked n (column %)	Marked n (column %)	Total N (column %)	*p*-value
Pedestrian Behavior				
Assertiveness				0.1977
Waited on curb	77 (37.7)	209 (33.0)	286 (34.1)	
Waited on street	56 (27.5)	222 (35.0)	278 (33.2)	
Did not wait	71 (34.8)	201 (31.7)	272 (32.5)	
Forced driver to yield	0 (0.0)	2 (0.3)	2 (0.2)	
Looking				0.3166
Didn't look	4 (2.0)	13 (2.1)	17 (2.0)	
Looked one way	34 (17.0)	126 (20.0)	160 (19.3)	
Looked both ways	127 (63.5)	413 (65.5)	540 (65.0)	
Looked more than 2 times	35 (17.5)	79 (12.5)	114 (13.7)	
Pace				0.0003
Slow	1 (0.5)	1 (0.2)	2 (0.2)	
Normal	177 (85.9)	586 (92.0)	763 (90.5)	
Fast	5 (2.4)	13 (2.0)	18 (2.1)	
Ran	23 (11.2)	37 (5.8)	60 (7.1)	

Driver Behavior / Traffic	**Unmarked**	**Marked**	**Total**	***p*-value**
Average gap acceptance (lanes)	1.1	0.9	1.0	0.0005
Average number of immediate yields (drivers)	0.4	0.7	0.6	<0.0001
Average vehicle exposure (pedestrians)	1.4	1.4	1.4	0.5381

SITE 2: 16TH ST. AND CAPP ST., SAN FRANCISCO

Figure 8

SITE 2: 16TH AND CAPP
DIAGRAM AND AERIAL PHOTOGRAPH



BACKGROUND CHARACTERISTICS:

- **2-Way Traffic Volume Main Road:** (16th Street) 8,700/day
- **Peak Pedestrian Volume:** 71 pedestrians/hour (marked and unmarked crosswalks)
- **Surrounding Land Uses:** Restaurants, Bars, Food Markets, Apartments
- **Speed Limit Main Road:** (16th Street) 25 MPH
- **Distance from Nearest Traffic Signal:** Signal: 1 Block (280 feet) on Main Road
- **Important Note for This Intersection:**

  The Capp St. approaches to the intersection are offset, which may affect pedestrian and driver behavior.

SUMMARY OF STATISTICALLY SIGNIFICANT FINDINGS, 16TH AND CAPP:

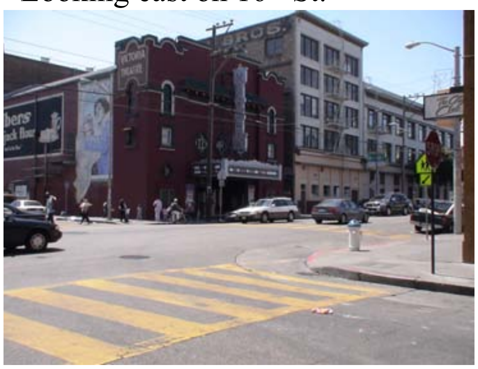
- Pedestrians in the unmarked crosswalk are more likely to look both ways before crossing.
- Pedestrians in the unmarked crosswalk are more likely to wait for larger gaps in traffic before crossing.
- Drivers are more likely to yield to pedestrians in the marked crosswalk.
- Pedestrians in the marked crosswalk likely have a higher exposure to vehicles when crossing.

Figure 9

SITE 2 PHOTOGRAPHS: 16TH AND CAPP

Looking east on 16th St.

Looking east on 16th St.



At northerly crosswalk looking southwest

At southerly crosswalk looking northwest

DESCRIPTIVE STATISTICS:

Table 5

SITE 2: 16TH AND CAPP
PEDESTRIAN CHARACTERISTICS BY CROSSWALK TYPE

	Unmarked n (column %)	**Marked** n (column %)	**Total** N (column %)	***p*-value**
Pedestrians	70	383	453	
Age				0.6313
Child	0 (0.0)	1 (0.3)	1 (0.3)	
Teen	0 (0.0)	1 (0.3)	1 (0.3)	
Young adult	34 (48.6)	131 (42.7)	165 (43.8)	
Older adult	32 (45.7)	162 (52.8)	194 (51.5)	
Elderly	4 (5.7)	12 (3.9)	16 (4.2)	
Sex				0.9789
Male	49 (70.0)	268 (70.2)	317 (70.1)	
Female	21 (30.0)	114 (29.8)	135 (29.9)	

ANALYSIS RESULTS:

Table 6

SITE 2: 16TH AND CAPP
PEDESTRIAN AND DRIVER BEHAVIOR BY CROSSWALK TYPE

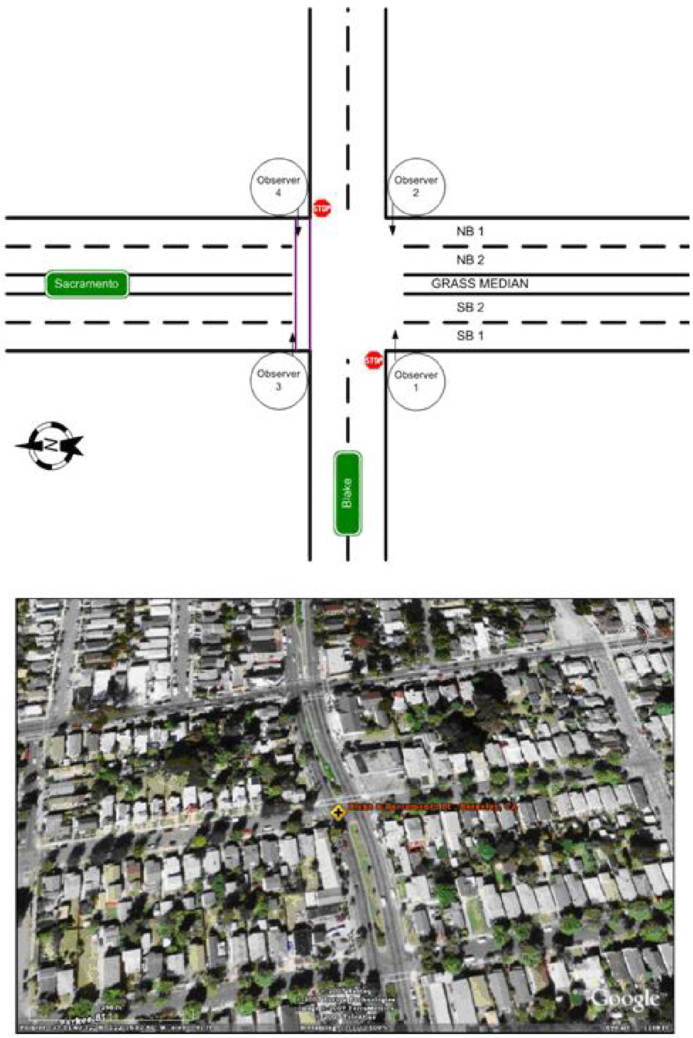
	Unmarked n (column %)	Marked n (column %)	Total N (column %)	*p*-value
Pedestrian Behavior				
Assertiveness				0.1968
Waited on curb	8 (15.4)	42 (11.0)	50 (11.5)	
Waited on street	22 (42.3)	124 (32.4)	146 (33.6)	
Did not wait	22 (42.3)	207 (54.0)	229 (52.6)	
Forced driver to yield	0 (0.0)	10 (2.6)	10 (2.3)	
Looking				0.0242
Didn't look	0 (0.0)	8 (2.1)	8 (1.9)	
Looked one way	18 (35.3)	207 (54.9)	225 (52.6)	
Looked both ways	15 (29.4)	82 (21.8)	97 (22.7)	
Looked more than 2 times	18 (35.3)	80 (21.2)	98 (22.9)	
Pace				0.5444
Slow	6 (8.6)	26 (6.8)	32 (7.1)	
Normal	48 (68.6)	288 (75.2)	336 (74.2)	
Fast	9 (12.9)	31 (8.1)	40 (8.8)	
Ran	7 (10.0)	38 (9.9)	45 (9.9)	
Capture				
None	216 (56.5)			
Partial	151 (39.5)			
Complete	15 (3.9)			
Driver Behavior / Traffic				
Multiple Threat (MT)				
WB1 and WB2 lanes pair				0.2873
No MT Scenario during crossing (peds)	62 (96.9)	354 (92.4)	416 (93.1)	
MT Scenario during crossing (peds)	2 (3.1)	29 (7.6)	31 (6.9)	

	Unmarked	Marked	Total	*p*-value
Average gap acceptance (lanes)	2.2	1.9	2.0	0.0262
Average number of immediate yields (drivers)	0.3	0.7	0.6	0.0001
Average vehicle exposure (pedestrians)	1.0	1.4	1.4	0.0165

SITE 3: SACRAMENTO AND BLAKE, BERKELEY

Figure 10

SITE 3: SACRAMENTO AND BLAKE
DIAGRAM AND AERIAL PHOTOGRAPH



BACKGROUND CHARACTERISTICS:

- **2-Way Traffic Volume Main Road:** (Sacramento) 19,500/day
- **Peak Pedestrian Volume:** 3 pedestrians/hour (marked), 2 pedestrians/hour (unmarked)
- **Surrounding Land Uses:** Residential
- **Speed Limit Main Road:** (Sacramento) 30 MPH
- **Distance from Nearest Traffic Signal:** 1 Block (370 feet) on Main Road
- **Important Note for This Intersection:**

  The wide grass median on Sacramento may affect pedestrian and driver behavior by creating two independent crossings as opposed to one continuous crossing with a center median.

SUMMARY OF STATISTICALLY SIGNIFICANT FINDINGS, SACRAMENTO AND BLAKE:

- Pedestrians in the marked crosswalk and in the second half of their crossing (after reaching the median) are more likely to be involved in a multiple threat scenario.
- Drivers are more likely to yield to pedestrians in the marked crosswalk.

Figure 11

SITE 3 PHOTOGRAPHS: SACRAMENTO AND BLAKE

Looking north on Sacramento

Looking south on Sacramento

Looking north on Sacramento

Looking east on Blake

DESCRIPTIVE STATISTICS:

Table 7

SITE 3: SACRAMENTO AND BLAKE
PEDESTRIAN CHARACTERISTICS BY CROSSWALK TYPE

	Unmarked n (column %)	Marked n (column %)	Total N (column %)	*p*-value
Pedestrians	84	150	327	
Age				0.7797
Child	1 (1.2)	3 (2.0)	4 (1.7)	
Teen	16 (19.3)	22 (14.7)	38 (16.3)	
Young adult	27 (32.5)	58 (38.7)	85 (36.5)	
Older adult	34 (41.0)	56 (37.3)	90 (38.6)	
Elderly	5 (6.0)	11 (7.3)	16 (6.9)	
Sex				0.1337
Male	56 (66.7)	85 (56.7)	141 (60.3)	
Female	28 (33.3)	65 (43.3)	93 (39.7)	

Table 8

SITE 3: SACRAMENTO AND BLAKE
PEDESTRIAN AND DRIVER BEHAVIOR BY CROSSWALK TYPE

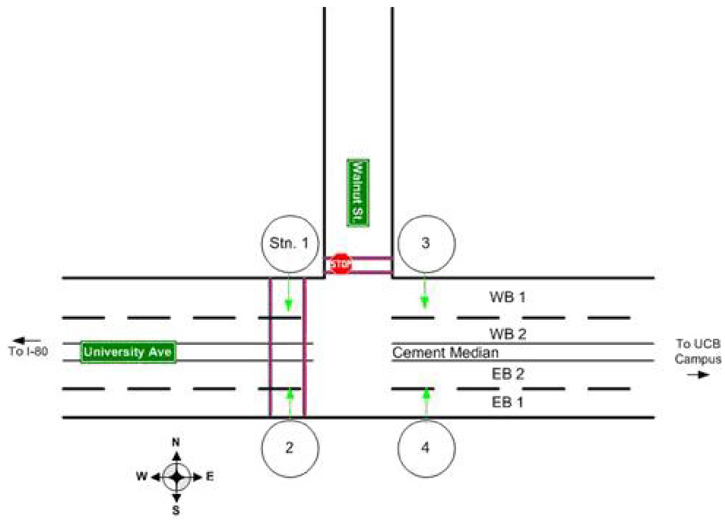
	Unmarked n (column %)	Marked n (column %)	Total N (column %)	*p*-value
Pedestrian Behavior				
Assertiveness				0.9715
Waited on curb	35 (42.2)	61 (40.7)	96 (41.2)	
Waited on street	11 (13.3)	21 (14.0)	32 (13.7)	
Did not wait	37 (44.6)	68 (45.3)	105 (45.1)	
Looking				0.2707
Didn't look	3 (3.7)	3 (2.0)	6 (2.6)	
Looked one way	32 (39.0)	65 (43.6)	97 (42.0)	
Looked both ways	39 (47.6)	75 (50.3)	114 (49.4)	
Looked more than 2 times	8 (9.8)	6 (4.0)	14 (6.1)	
Pace				0.8073
Slow	5 (6.0)	12 (8.0)	17 (7.3)	
Normal	60 (71.4)	111 (74.0)	171 (73.1)	
Fast	6 (7.1)	9 (6.0)	15 (6.4)	
Ran	13 (15.5)	18 (12.0)	31 (13.2)	
Capture				
None	75 (50.0)			
Partial	74 (49.3)			
Complete	1 (0.7)			
Driver Behavior / Traffic				
Multiple Threat				
First ½ Crossing Pair				0.2527
No MT Scenario during crossing (peds)	80 (96.4)	139 (92.7)	219 (86.3)	
MT Scenario during crossing (peds)	3 (3.6)	11 (7.3)	14 (13.7)	
Second ½ Crossing Pair				0.0305
No MT Scenario during crossing (peds)	81 (96.4)	132 (88.0)	213 (91.0)	
MT Scenario during crossing (peds)	3 (3.6)	18 (12.0)	21 (9.0)	

	Unmarked	Marked	Total	*p*-value
Average gap acceptance (lanes)	3.0	2.8	2.9	0.2406
Average number of immediate yields (drivers)	0.4	0.7	0.6	0.0036
Average vehicle exposure (pedestrians)	1.3	1.5	1.4	0.6171

SITE 4: UNIVERSITY AVE. AND WALNUT ST., BERKELEY

Figure 12

**SITE 3: UNIVERSITY AVE. AND WALNUT ST.
DIAGRAM AND AERIAL PHOTOGRAPH**



BACKGROUND CHARACTERISTICS:

- **2-Way Traffic Volume Main Road:** (University) 23,300/day
- **Peak Pedestrian Volume:** 40 pedestrians/hour (marked and unmarked crosswalks)
- **Surrounding Land Uses:** Restaurants, Stores, University Buildings, Parking Lots, Apartments
- **Speed Limit Main Road:** (University) 25 MPH
- **Distance from Nearest Traffic Signal:** 1/2 Block (200 feet) on Main Road
- **Important Notes for This Intersection:**

  This is the only “T” intersection analyzed for this study. Pedestrian behavior may be affected by this design.

  The concrete median is narrow and may provide insufficient “refuge space” for some pedestrians.

SUMMARY OF STATISTICALLY SIGNIFICANT FINDINGS, UNIVERSITY AVE. AND WALNUT ST.:

- Pedestrians in the unmarked crosswalk are more likely to run when crossing.
- Pedestrians in the marked crosswalk and in the second half of their crossing (after reaching the median) are more likely to be involved in a multiple threat scenario.
- Pedestrians in the unmarked crosswalk are more likely to wait for larger gaps in traffic before crossing.
- Drivers are more likely to yield to pedestrians in the marked crosswalk.

Figure 13

SITE 4 PHOTOGRAPHS: UNIVERSITY AND WALNUT

Looking northwest with view of westerly crosswalk on University.

Looking north on Walnut.

DESCRIPTIVE STATISTICS:

Table 9

SITE 4: UNIVERSITY AND WALNUT
PEDESTRIAN CHARACTERISTICS BY CROSSWALK TYPE

	Unmarked	**Marked**	**Total**	***p*-value**
	n (column %)	n (column %)	N (column %)	
Pedestrians	84	150	327	
Age				0.7797
Child	1 (1.2)	3 (2.0)	4 (1.7)	
Teen	16 (19.3)	22 (14.7)	38 (16.3)	
Young adult	27 (32.5)	58 (38.7)	85 (36.5)	
Older adult	34 (41.0)	56 (37.3)	90 (38.6)	
Elderly	5 (6.0)	11 (7.3)	16 (6.9)	
Sex				0.1337
Male	56 (66.7)	85 (56.7)	141 (60.3)	
Female	28 (33.3)	65 (43.3)	93 (39.7)	

ANALYSIS RESULTS:

Table 10

SITE 4: UNIVERSITY AND WALNUT
PEDESTRIAN AND DRIVER BEHAVIOR BY CROSSWALK TYPE

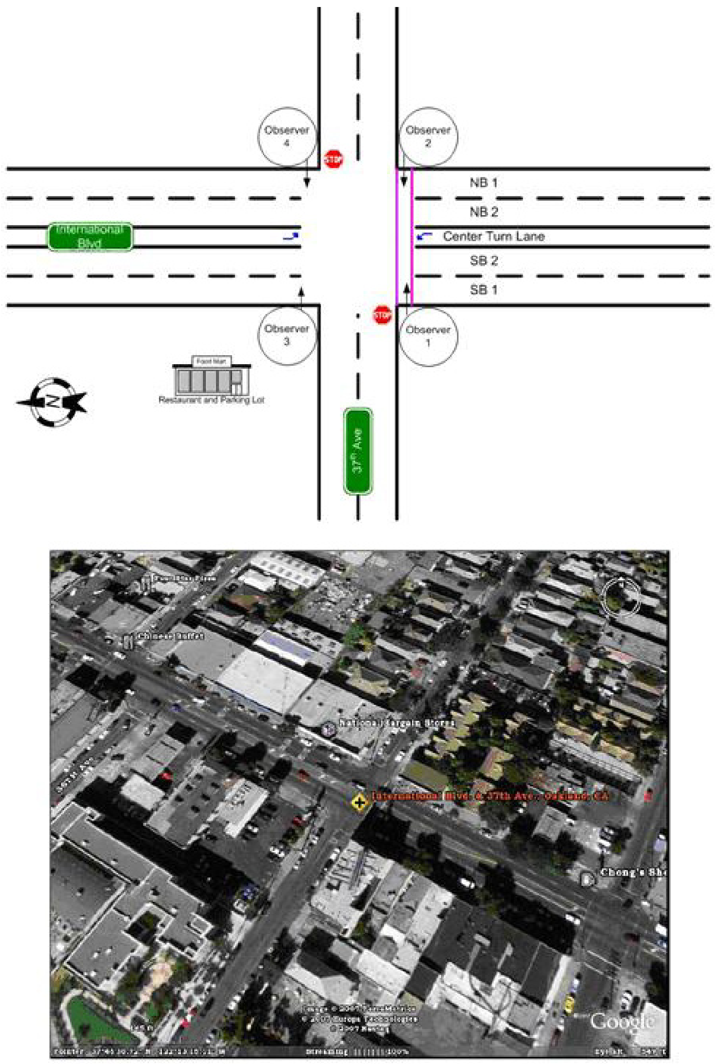
	Unmarked n (column %)	**Marked** n (column %)	**Total** N (column %)	***p*-value**
Pedestrian Behavior				
Assertiveness				0.1449
Waited on curb	10 (18.2)	219 (31.2)	229 (30.3)	
Waited on street	15 (27.3)	185 (26.4)	200 (26.5)	
Did not wait	30 (54.5)	291 (41.5)	321 (42.5)	
Forced driver to yield	0 (0.0)	6 (0.9)	6 (0.8)	
Looking				0.0537
Didn't look	1 (1.9)	14 (2.0)	15 (2.0)	
Looked one way	33 (61.1)	357 (51.1)	390 (51.8)	
Looked both ways	20 (37.0)	265 (37.9)	285 (37.8)	
Looked more than 2 times	0 (0.0)	63 (9.0)	63 (8.4)	
Pace				<0.0001
Slow	1 (1.6)	12 (1.7)	13 (1.7)	
Normal	42 (68.9)	657 (92.3)	699 (90.4)	
Fast	8 (13.1)	15 (2.1)	23 (3.0)	
Ran	10 (16.4)	28 (3.9)	38 (4.9)	
Capture				
None	308 (55.7)			
Partial	238 (43.0)			
Complete	7 (1.3)			
Driver Behavior / Traffic				
Multiple Threat				
First ½ Crossing Pair				0.1603
No	61 (100.0)	682 (95.8)	743 (96.1)	
Yes	0 (0.0)	30 (4.2)	30 (3.9)	
Second ½ Crossing Pair				0.0282
No	60 (98.4)	639 (89.8)	699 (90.4)	
Yes	1 (1.6)	73 (10.3)	74 (9.6)	

	Unmarked	**Marked**	**Total**	***p*-value**
Average gap acceptance (lanes)	3.5	3.0	3.1	0.0002
Average number of immediate yields (drivers)	0.2	0.7	0.6	<0.0001
Average vehicle exposure (pedestrians)	0.9	1.2	1.2	0.1104

SITE 5: INTERNATIONAL BLVD. AND 37TH AVE., OAKLAND

Figure 14

SITE 5: INTERNATIONAL BLVD. AND 37TH AVE.
DIAGRAM AND AERIAL PHOTOGRAPH



BACKGROUND CHARACTERISTICS:

- **2-Way Traffic Volume Main Road:** (International) 30,000/day
- **Peak Pedestrian Volume:** 30 pedestrians/hour (marked), 4 pedestrians/hour (unmarked)
- **Surrounding Land Uses:** Restaurants, Nail Salon, Apartments, Clothing Stores
- **Speed Limit Main Road:** (International) 30 MPH
- **Distance from Nearest Traffic Signal:** 1 Block (320 feet) on Main Road
- **Important Notes for This Intersection:**

  We had the largest amount of data for this site, making the analysis particularly robust

  This site is in a low-income neighborhood with a large Hispanic population, and pedestrians and drivers in this area may have different characteristics and cultural norms than those observed in the Berkeley crosswalks (near campus or affluent areas)

SUMMARY OF STATISTICALLY SIGNIFICANT FINDINGS, UNIVERSITY AVE. AND WALNUT ST.:

- Teenage pedestrians are more likely to cross in the unmarked crosswalk, while elderly pedestrians are more likely to cross in the marked crosswalk.
- Female pedestrians are more likely to use the marked crosswalk.
- Pedestrians in the unmarked crosswalk are more likely to be assertive, waiting in the street instead of on the curb before crossing.
- Pedestrians in the unmarked crosswalk are more likely to look both ways before crossing.
- Pedestrians in the unmarked crosswalk are more likely to run when crossing.
- Pedestrians in the marked crosswalk, in both the first and second halves of their crossings, are more likely to be involved in multiple threat scenarios.
- Pedestrians in the unmarked crosswalk are more likely to wait for larger gaps in traffic before crossing.
- Drivers are more likely to yield to pedestrians in the marked crosswalk.
- Pedestrians in the marked crosswalk likely have a higher exposure to vehicles when crossing.

Figure 15

SITE 5 PHOTOGRAPHS: INTERNATIONAL BLVD. AND 37TH AVE.

Looking southeast with view of southerly crosswalk

Looking west on 37th with view of southerly crosswalk

Looking north on International

Looking south on International

DESCRIPTIVE STATIST CS

Table 11

SITE 5: INTERNATIONAL BLVD. AND 37TH AVE.
PEDESTRIAN CHARACTERISTICS BY CROSSWALK TYPE

	Unmarked n (column %)	**Marked** n (column %)	**Total** N (column %)	***p*-value**
Pedestrians	186	153	339	
Age				0.0004
Child	0 (0.0)	0 (0.0)	0 (0.0)	
Teen	29 (15.6)	6 (3.9)	35 (10.3)	
Young adult	72 (38.7)	78 (51.0)	150 (44.2)	
Older adult	85 (45.7)	67 (43.8)	152 (44.8)	
Elderly	0 (0.0)	2 (1.3)	2 (0.6)	
Sex				<0.0001
Male	148 (80.0)	80 (52.3)	228 (67.5)	
Female	37 (20.0)	73 (47.7)	110 (32.5)	

Table 12

SITE 5: INTERNATIONAL BLVD. AND 37TH AVE. PEDESTRIAN AND DRIVER BEHAVIOR BY CROSSWALK TYPE

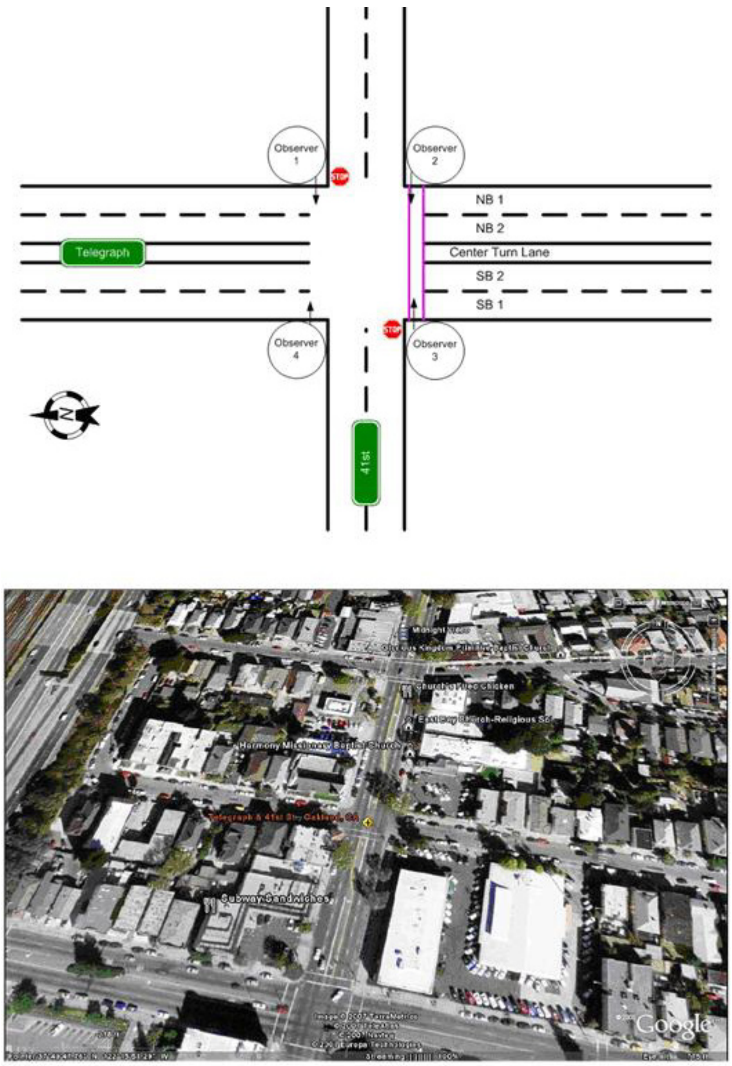
	Unmarked N (column %)	**Marked** n (column %)	**Total** (N column %)	***p*-value**
Pedestrian Behavior				
Assertiveness				0.0283
Waited on curb	25 (14.0)	38 (25.0)	63 (19.1)	
Waited on street	97 (54.5)	67 (44.1)	164 (49.7)	
Did not wait	56 (31.5)	46 (30.3)	102 (30.9)	
Forced driver to yield	0 (0.0)	1 (0.7)	1 (0.3)	
Looking				<0.0001
Didn't look	0 (0.0)	4 (2.6)	4 (1.2)	
Looked one way	72 (40.9)	110 (72.4)	182 (55.5)	
Looked both ways	104 (59.1)	38 (25.0)	142 (43.3)	
Pace				<0.0001
Slow	5 (2.7)	1 (0.7)	6 (1.8)	
Normal	98 (52.7)	137 (89.5)	235 (69.3)	
Fast	13 (7.0)	9 (5.9)	22 (6.5)	
Ran	70 (37.6)	6 (3.9)	76 (22.4)	
Driver Behavior / Traffic				
Multiple Threat				
First ½ of crossing pair				0.0211
No	176 (94.6)	134 (87.6)	310 (91.4)	
Yes	10 (5.4)	19 (12.4)	29 (8.6)	
Second ½ of crossing pair				<0.0001
No	154 (82.8)	96 (62.8)	250 (73.7)	
Yes	32 (17.2)	57 (37.3)	89 (26.3)	

	Unmarked	**Marked**	**Total**	***p*-value**
Average gap acceptance (lanes)	3.4	2.7	3.1	<0.0001
Average number of immediate yields (drivers)	0.9	1.6	1.2	<0.0001
Average vehicle exposure (pedestrians)	2.7	3.5	3.1	0.0174

SITE 6: TELEGRAPH AND 41ST, OAKLAND

Figure 16

SITE 6: TELEGRAPH AND 41ST
DIAGRAM AND AERIAL PHOTOGRAPH



BACKGROUND CHARACTERISTICS:

- **2-Way Traffic Volume Main Road:** (Telegraph) 17,300/day
- **Peak Pedestrian Volume:** 20 pedestrians/hour (marked), 4 pedestrians/hour (unmarked)
- **Surrounding Land Uses:** Restaurants, Parking Lot, Church, Apartments, Car Dealership
- **Speed Limit Main Road:** (Telegraph) 25 MPH
- **Distance from Nearest Traffic Signal:** 1 Block (305 feet) on Main Road
- **Important Notes for This Intersection:**

  The small (n=38) sample size for pedestrians in the unmarked crosswalk may contribute to fewer statistically significant differences in pedestrian and driver behavior at this location.

SUMMARY OF STATISTICALLY SIGNIFICANT FINDINGS, UNIVERSITY AVE. AND WALNUT ST.:

- Female pedestrians are more likely to use the marked crosswalk.
- Pedestrians in the unmarked crosswalk are more likely to run when crossing.
- Pedestrians in the unmarked crosswalk are more likely to wait for larger gaps in traffic before crossing.
- Drivers are more likely to yield to pedestrians in the marked crosswalk.

Figure 17

SITE 6 PHOTOGRAPHS: TELEGRAPH AND 41ST

Looking east on 41st

Looking south on Telegraph

Looking north on Telegraph

DESCRIPTIVE STATIST CS

Table 13

SITE 6: TELEGRAPH AND 41ST
PEDESTRIAN CHARACTERISTICS BY CROSSWALK TYPE

	Unmarked n (column %)	**Marked** n (column %)	**Total** N (column %)	***p*-value**
Pedestrians	38	536	574	
Age				0.7581
Child	0 (0.0)	0 (0.0)	0 (0.0)	
Teen	3 (7.9)	35 (6.5)	38 (6.6)	
Young adult	16 (42.1)	226 (42.2)	242 (42.2)	
Older adult	18 (47.4)	266 (49.6)	284 (49.5)	
Elderly	1 (2.6)	9 (1.7)	10 (1.7)	
Sex				0.0498
Male	28 (73.7)	308 (57.5)	336 (58.5)	
Female	10 (26.3)	228 (42.5)	238 (41.5)	

ANALYSIS RESULTS:

Table 14

SITE 6: TELEGRAPH AND 41ST
PEDESTRIAN AND DRIVER BEHAVIOR BY CROSSWALK TYPE

	Unmarked n (column %)	Marked n (column %)	Total N (column %)	*p*-value
Pedestrian Behavior				
Assertiveness				0.1786
Waited on curb	8 (24.2)	158 (30.7)	166 (30.3)	
Waited on street	17 (51.5)	168 (32.7)	185 (33.8)	
Did not wait	8 (24.2)	184 (35.8)	192 (35.1)	
Forced driver to yield	0 (0.0)	4 (0.8)	4 (0.7)	
Looking				0.6167
Didn't look	0 (0.0)	5 (1.0)	5 (0.9)	
Looked one way	13 (40.6)	249 (48.7)	262 (48.3)	
Looked both ways	12 (37.5)	180 (35.2)	192 (35.4)	
Looked more than 2 times	7 (21.9)	77 (15.1)	84 (15.5)	
Pace				<0.0001
Slow	3 (7.9)	7 (1.3)	10 (1.7)	
Normal	21 (55.3)	452 (84.5)	473 (82.5)	
Fast	2 (5.3)	15 (2.8)	17 (3.0)	
Ran	12 (31.6)	61 (11.4)	73 (12.7)	
Capture				
None	51 (49.5)			
Partial	47 (45.6)			
Complete	5 (4.9)			
Driver Behavior / Traffic				
Multiple Threat				
First ½ of Crossing Pair				1.0000
No	34 (97.1)	493 (94.6)	527 (94.8)	
Yes	1 (2.9)	28 (5.4)	29 (5.2)	
Second ½ of Crossing Pair				0.0363
No	33 (91.7)	400 (76.6)	433 (77.6)	
Yes	3 (8.3)	122 (23.4)	125 (22.4)	

	mean	mean	mean	
Sum gaps for all lanes	3.7	3.3	3.3	0.0284
Sum of immediate yields	0.4	1.1	1.0	0.0002
Exposure	2.3	2.6	2.6	0.4877

Table 15

SUMMARY OF ANALYSIS RESULTS

Intersection		Cedar/ Walnut	16th/ Capp	Sacramento / Blake	University / Walnut	International / 37th	Telegraph / 41st
Lanes		2	3	4	4	5	5
Speed Limit		25 MPH	25 MPH	30 MPH	25 MPH	30 MPH	25 MPH
Median				Grass Median	Concrete Median		
N (UM/M)		206/639	70/383	84/150	61/712	186/153	38/536
Capture		Data Not Collected	4% CC	1% CC	1% CC	Data Not Collected	5% CC
Factors	**Age**					More Teens	
	Gender	More Males				More Males	More Males
	Assertiveness					More Assertive	
	Looking		More Looking			More Looking	
	Pace	Faster Pace			Faster Pace	Faster Pace	Faster Pace
	Gap	More Gaps	More Gaps		More Gaps	More Gaps	More Gaps
	Yield	Less Yielding	Less Yielding	Less Yielding	Less Yielding	Less Yielding	Less Yielding
	Exposure		Less Exposure			Less Exposure	
	Multiple Threat	N/A		Lower Threat	Lower Threat	Lower Threat	

DISCUSSION

The following trends are evident from our comparison of pedestrian and driver behavior in unmarked versus marked crosswalks at unsignalized intersections:

- Pedestrians have a similar age distribution in both crosswalk types, with more teens and fewer elderly in unmarked crosswalks when differences arise
- More males cross in unmarked crosswalks
- Pedestrians seem to be more assertive and exhibit better looking behavior in multi-lane unmarked crosswalks
- Pedestrians walk with a faster pace in unmarked crosswalks
- Pedestrians wait for larger gaps in traffic before crossing in unmarked crosswalks
- Drivers yield more frequently to pedestrians in marked crosswalks

- Pedestrians experience somewhat less exposure to vehicles when crossing in multi-lane unmarked crosswalks
- The potential for multiple threat collisions is lower in unmarked crosswalks

Combined with the results from companion surveys and focus groups regarding driver and pedestrian knowledge of right-of-way laws, these findings may help to explain the observed differences in collision risk in marked versus unmarked crosswalks on certain multi-lane roadways. Notably:

- Drivers encountering a pedestrian in an unmarked crosswalk in fact were less likely to yield. This may be at least partially a result of a lack of knowledge of the pedestrian's right-of-way within unmarked crosswalks.
- However, rather than increasing the pedestrian collision risk in the unmarked crossings, less yielding, coincides with reduced collisions. This paradox may at least partially be explained by differences found in pedestrian behavior in unmarked crosswalks. That is, pedestrians appear to exhibit greater caution when crossing in unmarked crosswalks (looking both ways before crossing, waiting for gaps in traffic, and hurrying across the road) as compared to marked crosswalks.
- Pedestrians possibly exhibit greater caution in unmarked crosswalks because either (1) they do not know they have the same legal right-of-way when crossing, or (2) experience has taught them that drivers are not likely to yield in these areas.
- Pedestrians possibly exhibit less caution when crossing in marked crosswalks for similar reasons: (1) they know they have the right-of-way, or (2) experience has taught them that drivers are likely to yield.
- Even for marked crosswalks, Mitman and Ragland (2007) note that some drivers lack knowledge of right-of-way laws (i.e., they do not understand their responsibility to stop for pedestrians). Others who know the law still act in violation and fail to yield. Thus, because driver yielding in marked crosswalks does not always occur, the less cautious pedestrian may be more vulnerable to collisions.
- Also paradoxically, the higher rate of yielding in marked crosswalks appears to coincide with an increased incidence of multiple threat collisions. Again because the yielding rate is not 100%, a driver yielding in one lane does not assure a driver will yield in an adjacent, same direction travel lane on a multi-lane road. Because the first driver is more likely to yield at a marked crosswalk, there is a greater risk a pedestrian crossing in a marked crosswalk will be involved in a dangerous multiple threat scenario.

Unlike previous behavioral studies (specifically the Knoblauch (2001) study), our results show statistically significant differences in driver and pedestrian behavior at marked versus unmarked crosswalks, even for two and three-lane roads. These differences do appear more pronounced for multi-lane roads, however, with International and 37th being the most robust example. This finding is consistent with the Zegeer (2001) study that illustrated gradients in collision rate differences related to the number of lanes (with the difference in marked versus unmarked becoming significant only for multi-lane roads).

Also consistent with the Zegeer study is our finding that multiple threat scenarios arise more commonly in marked crosswalks. Zegeer's analysis of collision data from 1000 matched pair sites concluded that, "The greatest difference in pedestrian collision types between marked and unmarked crosswalks involved 'multiple-threat' collisions"[1].

CONCLUDING THOUGHTS

Crosswalks at unsignalized intersections are numerous and widespread throughout the State Highway System. Not unlike a large beach filled with swimmers, Caltrans faces a choice of deploying lifeguards (engineering countermeasures) or posting warning signs and offering swimming lessons (enforcement and education countermeasures). While engineering countermeasures offer significant potential for reducing pedestrian collision risk, not every intersection can be treated, just as on a large and crowded beach not every swimmer can be protected by a lifeguard. Prioritizing deployment of engineering countermeasures to the areas with the highest risk and potential for the greatest improvement represents the best use of limited resources. For the other portions of the State Highway System, there is a need for a Departmental paradigm shift to include broader deployment of education and enforcement countermeasures. These treatments must supplement engineering treatments to provide pedestrian safety benefits for all and ensure walking is embraced as a legitimate and important transport mode.

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APPENDIX A-1:
PILOT TEST OF FIELD DATA COLLECTION METHODOLOGY OPTIONS

METHODOLOGY OPTIONS AND CONSIDERATIONS

The TSC researchers identified several available methods for observing driver and pedestrian behavior at selected "matched pair" intersections (with both marked and unmarked crosswalks across the main road). There were two basic options: video-based observations or manual (clipboard-based) observations. From these two choices, the following alternatives were defined.

For a four-way intersection, observe behavior within the two crossings of the major road by:

- Video taping pedestrian and driver behavior in the field and then recording data in the office via a computer play-back tool:
  - Using one camera on the street level (with a fish-eye lens to capture both crossings),
  - Using two cameras on the street level, or
  - Using one camera mounted on a pole or building above the intersection.
- Record pedestrian and driver behavior "manually" in the field via clipboards with paper, PDAs, or laptops with:
  - Eight observers (two on each corner with duplication and each observer recording data for pedestrians crossing one crosswalk in one direction),
  - Four observers (one on each corner with no duplication with each observer recording data for pedestrians crossing one crosswalk in one direction),
  - Two observers (each observer recording data for pedestrians crossing one crosswalk in two directions), or
  - One observer recording data for all pedestrians in both crossings.

The TSC researchers initially recommended that clipboard observations be utilized for this study based on the reasons discussed in the following sections. However, the reliability of this method needed verification.

MATCHING THE METHODOLOGY TO THE OUTCOME VARIABLES

In order to achieve an appropriate video angle for viewing drivers and pedestrians in both the marked and unmarked crosswalks of the study intersections, two cameras would be needed at each site. In addition to the double expense of two cameras with two camera operators, discerning the crosswalk capture rate of the marked crosswalk (i.e., whether pedestrians who have a choice in their route prefer the marked to the unmarked crosswalk) is challenging with two cameras. Recording this variable would require synchronizing the videos from the two cameras and following pedestrians as they exit one frame and enter another. In contrast, this is a variable that can easily be observed in the field.

Additionally, researchers felt from previous experience that discerning gender, age, and intricate pedestrian behavior such as looking before crossing would be easier for field observers standing next to a person as compared to staff in the office reviewing the video (as captured from a distance and with poorer viewing quality).

COST-EFFECTIVENESS

All twelve of the study sites have very low pedestrian volumes (ranging from 20 to 60 pedestrians per hour in most cases, with as low as 1 to 2 pedestrians per hour at some of the unmarked crossings). Initial power calculations suggested that 150 pedestrians would need to be observed in each crossing to obtain statistically significant results (assuming a 15 percent difference in driver yielding behavior in marked versus unmarked crossings per related TSC studies). Thus, a primary motivating factor of the initial recommendation to use clipboard observers was cost effectiveness for this lengthy process. The researchers determined that it would be more expensive to video tape since doing so would require camera operators to operate and protect the video cameras during the entire observation period, truck rentals for the camera tripods, the purchase of at least 600 tapes (one per estimated hour), and also staff to watch all hours of the tapes using the play-back tool. TSC researchers have previously found that an hour of video can require two to four hours of time for review.

Additionally, researchers were concerned that pedestrians may be blocked by trucks and render the video unusable in some instances. This could be an added cost because, if the number of trucks at an intersection is high, additional filming during the analysis phase (beyond the estimated number of hours) could be required to achieve the target amount of data. In contrast, field observers can adjust their viewing angle in real time to continue the observations and therefore eliminate this issue.

REALISTIC DATA

Finally, researchers were concerned that cameras mounted on tripods in trucks, as per common procedure, are more obtrusive than plain-clothed clipboard observers. Thus, the use of manual observers would offer less opportunity for affecting the realistic nature of the data.

PILOT EVALUATION

A pilot study was designed to collect empirical data that would support or refute the researchers' hypothesis that manual data collection is a preferable method for this study. A protocol for the pilot study at International Boulevard and 37th Avenue in Oakland, California, was developed and refined prior to conducting data collection and analysis. The pilot study methodology is presented in the following sections.

VIDEOTAPING

A video camera was mounted on a tripod in the flat bed of a truck parked on the northwest corner of the study intersection. This location was selected to allow for a camera angle with a complete view of the marked crosswalk (the southerly crossing of International Boulevard).

FIELD (CLIPBOARD) OBSERVERS

Two observers were stationed at each end of the marked crosswalk (the "Observer Posts") on the southerly crossing of International Boulevard, for a total of four field observers. The marked crosswalk was selected because it had a higher pedestrian volume (approximately 60 pedestrians/hour) and could thus serve as a "worst case" scenario for the twelve study sites. Each observer post pair (Observer A and B) recorded the same data to allow for a test of inter-observer reliability. For this reason, observers did not communicate with each other about the data collection process or elements of the data during the observation periods. Observers recorded data for pedestrians who began crossing at their observer post and crossed away from the observer, as illustrated in Figure 1.

Observer posts 1 and 2 had separate versions of the data collection form to facilitate more intuitive data collection. Specifically, the forms were designed so that data entry for driver yielding behavior occurred from left to right in the order in which the pedestrian entered each lane.

For each pedestrian-vehicle interaction, observers recorded the following data:

- Time pedestrian arrives at intersection,
- Age of pedestrian (choose from C (child), T (teen), YA (younger adult), OA (older adult), and E (elderly)),
- Gender (choose from M (male) and F (female)),
- Pedestrian Level of Assertiveness (choose from 0 (wait on curb), 1 (wait on street), 2 (no wait), and 3 (force driver to yield)),
- Pedestrian Looking Behavior (choose from 0 (did not look), 1 (look 1 direction), 2 (look both directions), and 3 (look more times)),
- Pedestrian Gait (choose from S (slow), N (normal), R (ran)), and
- Driver Behavior in each Lane (choose from Y (1st driver yielded), W (pedestrian waited; 1st driver did not yield), 0 (no vehicle encountered in that lane)).

Figure 1

OBSERVER STATIONS, LANE NUMBERING, AND OBSERVATION DIRECTIONS

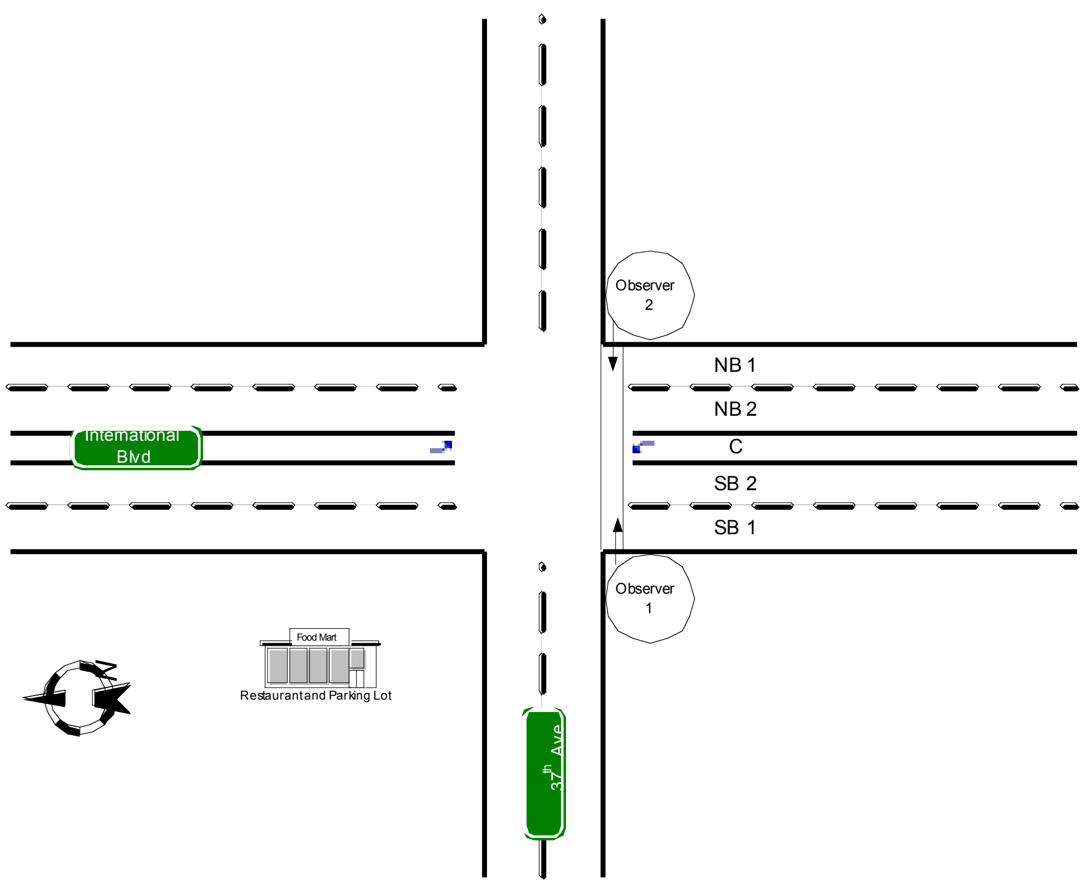
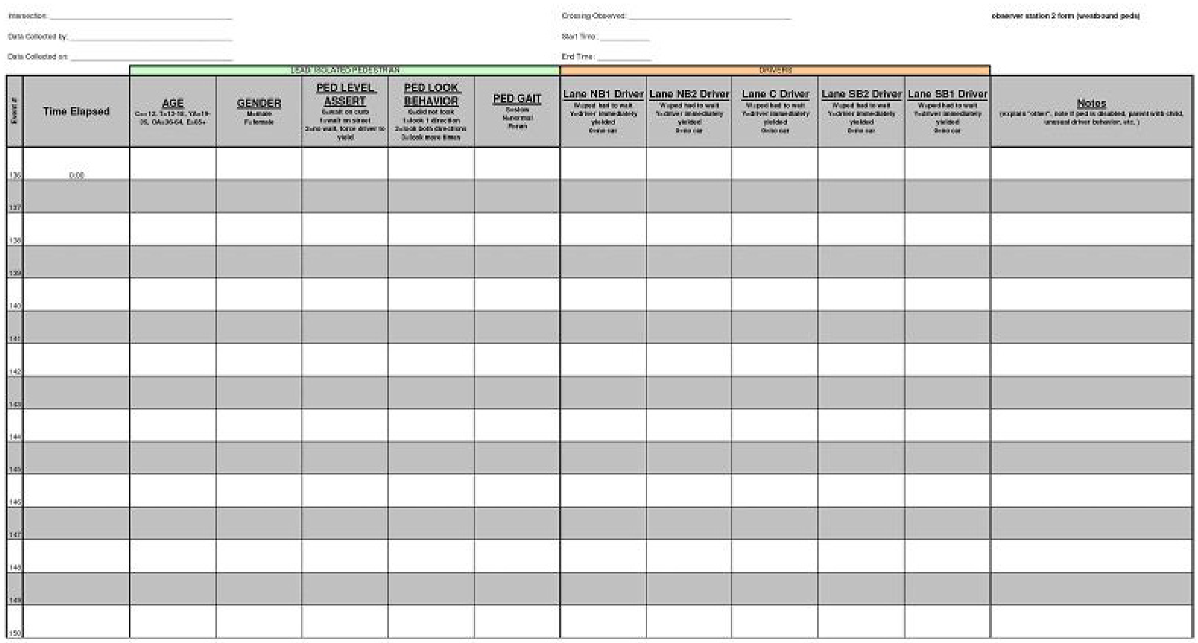


Figure 2

DATA COLLECTION FORM FOR OBSERVER STATION 2



Intersection: ______________________ Crossing Observed: ______________________ observer station 2 form (westbound peds)

Data Collected by: ______________________ Start Time: __________

Data Collected on: ______________________ End Time: __________

		LEAD ISOLATED PEDESTRIAN					DRIVERS					
Event #	Time Elapsed	AGE C=<12, T=13-18, YA=19-35, OA=36-64, E=65+	GENDER M=male F=female	PED LEVEL ASSERT 0=wait on curb 1=wait on street 2=no wait, force driver to yield	PED LOOK BEHAVIOR 0=did not look 1=look 1 direction 2=look both directions 3=look more times	PED GAIT S=slow N=normal R=run	Lane NB1 Driver W=ped had to wait Y=driver immediately yielded 0=no car	Lane NB2 Driver W=ped had to wait Y=driver immediately yielded 0=no car	Lane C Driver W=ped had to wait Y=driver immediately yielded 0=no car	Lane SB2 Driver W=ped had to wait Y=driver immediately yielded 0=no car	Lane SB1 Driver W=ped had to wait Y=driver immediately yielded 0=no car	Notes (explain "other", note if ped is disabled, parent with child, unusual driver behavior, etc.)
136	0:00											
137												
138												
139												
140												
141												
142												
143												
144												
145												
146												
147												
148												
149												
150												

The data forms were carefully pre-tested by TSC staff prior to the pilot test (i.e., data entry codes were changed to be more "user-friendly". For example, instead of age codes 0-5, letter codes such as C (child), T (teen), etc. were used. Further, the columns were re-ordered to increase time for complex variables to be recorded. Data collectors observed pedestrians crossing in one direction only (with the pedestrian crossing away from the observer) and data was recorded only for the lead pedestrian in a group of pedestrians. The Observer Station 2 version of the data collection form is presented in Figure 2.

PROCEDURE

A 30-minute orientation session was held at the beginning of the pilot testing day, followed by a 30-minute sample observation period. Videotaping did not occur during the sample period, as it was intended only as an opportunity for field observers to become familiar with the data collection forms. A debrief session followed to discuss questions or issues that arose during the sample period. This session was designed so that all observers would receive the same information and direction for any alterations to the methodology, forms, etc. Following a short break, a 2-hour observation period then took place. This period was video taped. For comparison purposes, it was essential that all observers and the video camera operator were synchronized in their start times. This was accomplished by using elapsed time from stopwatches with time "0:00" being the time video recording begins (signaled by a whistle). Following another short break, the team then debriefed the 2-hour observation period.

Using the same data collection forms, trained TSC staff recorded data from the 2-hour observation period video via a QuickTime play-back tool that allowed for pausing, rewinding, and fast-forwarding of the video. This data was then entered into a combined database with the clipboard data.

RESULTS AND CONCLUSIONS

Results from the pilot test were grouped in three categories:

- Field observer comparisons (1A versus 1B and 2A versus 2B),
- Field observer-video comparisons (1A versus V, 1B versus V, 2A versus V, and 2B versus V), and
- Variable comparisons.

These comparisons are discussed in the following sections. In addition to presenting the numerical results, anecdotal evidence is included based on supervisor notes regarding each observer during the pilot test. In all, 27 unique pedestrians were observed in Direction 1 (eastbound pedestrians observed from Observer Station 1) and 20 unique pedestrians were observed in Direction 2 (westbound pedestrians observed from Observer Station 2) during the 2-hour test period In Direction 1, Observer 1A recorded data for 25 of the pedestrians Observer 1B recorded data for 25 of the pedestrians, and the Video Observer (V), watching the video in the TSC office, recorded data for 26 of the pedestrians. In Direction 2, Observer 2A recorded data for 16 of the pedestrians, Observer 2B recorded data for 18 of the pedestrians, and the Video Observer recorded data for all 20 of the pedestrians. The data entries were matched by direction and timestamp for line-by-line comparisons.

Table 1

SUMMARY OF FIELD OBSERVER COMPARISONS

hour/test	Inter-reliability (average variable agreement out of 10)		
	post 1	post 2	p-value (post 1 v. post 2)
1	7.11	6.88	0.06
2	6.10	8.00	**<0.01**
p-value (hr 1 v. hr 2)	**0.02**	**0.02**	

FIELD OBSERVER COMPARISONS: RELIABILITY

Field supervisors noted that field observers 1B, 2A, and 2B remained at their posts, recording data throughout the test. These observers also requested clarification during the sample testing period and orientation. Observer 1A, however, was seen wandering away from his post and showed little interest in the project during the training session. Results from the pilot test reflect this anecdotal evidence and demonstrate that inter-observer reliability is highest for well-trained, vigilant observers in the field. Comparing hour 1 and hour 2 for Observer Station 1, the drop in reliability is significant (p-value=0.02), as Observer 1A became progressively less vigilant and the inter-reliability dropped to an average of 6.10 out of 10 variables in agreement. In contrast, following a statistically significant learning curve from hour 1 to hour 2 (p-value=<0 1), the inter-reliability was 80 percent for the pair of vigilant observers (at Observer Post 2) and those variables for which observers did not show 100 percent agreement had a majority of disagreements in adjacent categories (i.e., Older Adult versus Elderly age categories). The difference between Observer Posts 1 and 2 in the second hour was also significant (p-value=<0.01). These results suggest that it is possible to collect the desired amount of data with one vigilant observer for each direction because two such observers would collect redundant data.

FIELD OBSERVER-VIDEO COMPARISONS: DATA ACCURACY AND RELIABILITY

For the more objective variables (such as drivers yielding or not yielding), the video data can be considered a "gold standard" for comparisons to evaluate accuracy. However, for other variables such as gender, age, and gait, the video data is burdened by the same level of subjectivity, if not more, as the field observer data.

Table 2

SUMMARY OF FIELD OBSERVER VIDEO COMPARISONS

Hour/test	Video v. A (avg. # same out of 10)	Video v. B (avg. # same out of 10)	p-value (Video/A v. Video/B)
1	7.1	7.73	0.11
2	6.1	7.15	**0.02**
p-value (hr 1 v. hr 2)	**0.02**	0.14	

Observer Post 2

hour/test	Video v. A (avg. # same out of 10)	Video v. B (avg. # same out of 10)	p-value (Video/A v. Video/B)
1	6.00	6.56	0.34
2	7.25	7.29	0.95
p-value (hr 1 v. hr 2)	**0.03**	0.17	

In a comparison of field observers to the video observer, the "best" field observers exhibited up to an average of 77 percent agreement with the video based on a comparison over the ten variables observed. These observers again included the two highly vigilant observers in Direction 2, and the most senior field observer, Observer 1B. For Observer Post 1 the deterioration in performance can be seen particularly for Observer 1A (p-value=0 02 from hour 1 to 2) Observer 1B performed better than Observer 1A during both hours, with the difference statistically significant in hour 2 (p-value=.02). For Observer Post 2, there was some improvement for both Observe 2A (p-value=0.03 for improvement from hour 1 to 2) and Observer 2B, but not much difference in agreement with the video between Observer 2A and Observer 2B.

The discrepancies noted in the comparison for the "best" observers often occurred in adjacent categories within each variable, and mostly in the subjective variables. Thus, the researchers concluded that 77 percent agreement should be considered acceptable in terms of the field observer's ability to collect accurate, reliable data. Table 2 presents a summary of these results.

VARIABLE COMPARISONS: DATA RELIABILITY

Those variables with the most disagreement were identified based on a comparison of all field and video observer data. Table 3 presents the average variable agreement among the ten variables observed.

As illustrated, the most subjective and intricate variables showed the greatest discrepancies in the comparison of Observers A, B, and video (V) for each direction. Specifically, pedestrian assertiveness (Direction 1) and looking behavior (Direction 2) had non-significant agreement levels, suggesting these two variables should be eliminated or collection methods for these variables should be improved or clarified.

Table 3

COMPARISON OF VARIABLE RELIABILITY

Observer Post 1

Variable Average Agreement (based on 1/3, 2/3 or 3/3 observers agreeing on each variable) for 2-Hour Period

Variable	Age	Gender	Ped Level Assert	Ped Look Behavior	Ped Gait	Lane SB1 Driver	Lane SB2 Driver	Lane C Driver	Lane NB2 Driver	Lane NB1 Driver
Average Agreement of A, B, V	84%	96%	64%	70%	87%	77%	80%	91%	88%	88%
p-value	<.01	<.01	0.07	<.01	<.01	<.01	<.01	<.01	<.01	<.01

Observer Post 2

Variable Average Agreement (A, B, Video)

Variable	Age	Gender	Ped Level Assert	Ped Look Behavior	Ped Gait	Lane NB1 Driver	Lane NB2 Driver	Lane C Driver	Lane SB2 Driver	Lane SB1 Driver
Average Agreement of A, B, V	88%	100%	77%	63%	85%	94%	94%	94%	81%	78%
p-value	<.01	<.01	<.01	0.12	<.01	<.01	<.01	<.01	<.01	<.01

CONCLUSION

As a result of the pilot test, the following decisions and changes were made for the TSC crosswalk study. It was determined that four observers at each of the matched pair study sites (one on each corner or two per crosswalk) with clipboards (instead of video) would be acceptable. The pilot results were used to select observers to continue with the project. Observers 1B, 2A, and 2B were asked to participate in future data collection efforts. Observer 1A was not asked to continue.

Figure 3 presents a revised data collection form developed for the project based on the debriefing comments and results of the pilot test. This form includes re-ordered columns to increase time available for variable recording. Field observers noted that some of the variables were collected "in the background," such as gender and age, while others required more time and concentration. These background variables were moved to the end (right side) of the variable list to prevent distraction from the complex variable collection. The revised form also includes additional options for pedestrian gait and driver yielding behavior classifications in an effort to clarify these variables. An enhanced training program was required for observers prior to use of the revised forms.

Figure 3

REVISED DATA COLLECTION FORM

Intersection: International and 37th | Crossing Observed: Unmarked | observer station 4

Data Collected by: ____________________ | Start Time: ________

Data Collected on: ____________________ | End Time: ________

	LEAD/ ISOLATED PEDESTRIAN			DRIVERS					LEAD/ ISOLATED PEDESTRIAN				
Event #	Time Ped Arrived	**PED LEVEL ASSERT** 0=wait on curb 1=wait on street 2=no wait 3=force driver to yield	**PED LOOK BEHAVIOR** 0=did not look 1=look 1 direction 2=look both directions 3=look more times	**Lane NB1 Driver** U=driver unable to yield Y=driver 1 yielded W=ped had to wait for n cars 0=no car	**Lane NB2 Driver** Y=driver 1 yielded W=ped had to wait for n cars 0=no car	**Lane C Driver** Y=driver 1 yielded W=ped had to wait for n cars 0=no car	**Lane SB2 Driver** Y=driver 1 yielded W=ped had to wait for n cars 0=no car	**Lane SB1 Driver** Y=driver 1 yielded W=ped had to wait for n cars 0=no car	**AGE** C=<13, T=13-18, YA=19-35, OA=36-64, E=65+	**GENDER** M=male F=female	**PED GAIT** S=slow N=normal F=fast R=ran	Time Ped Finished Crossing	**Notes** (note if ped is disabled, parent with child, unusual walking behavior, etc.)
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													

APPENDIX A-2:
SAS STATISTICAL ANALYSIS OUTPUT

CEDandWAL_p01 Pedestrian characteristics stratified by crosswalk type

The FREQ Procedure

Table of agecat by xwalkn			
agecat(Age category 1=Child 2=Teen 3=Young Adult 4=Older Adult 5=Elderly)	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Child	0 0.00	1 0.16	1
Teen	1 0.49	6 0.94	7
Young adult	89 43.63	291 45.68	380
Older adult	97 47.55	292 45.84	389
Elderly	17 8.33	47 7.38	64
Total	204	637	841
Frequency Missing = 4			

Statistics for Table of agecat by xwalkn

Statistic	DF	Value	Prob
Chi-Square	4	1.1263	0.8901
Likelihood Ratio Chi-Square	4	1.4048	0.8434
Mantel-Haenszel Chi-Square	1	0.7147	0.3979
Phi Coefficient		0.0366	
Contingency Coefficient		0.0366	
Cramer's V		0.0366	
WARNING: 30% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

CEDandWAL_p01 Pedestrian characteristics stratified by crosswalk type

The FREQ Procedure

Statistics for Table of agecat by xwalkn

Fisher's Exact Test	
Table Probability (P)	0.0016
Pr <= P	0.9094

Effective Sample Size = 841
Frequency Missing = 4

Table of female by xwalkn			
female(IND: 1=female 0=male)	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Male	109 52.91	286 44.90	395
Female	97 47.09	351 55.10	448
Total	206	637	843
Frequency Missing = 2			

Statistics for Table of female by xwalkn

Statistic	DF	Value	Prob
Chi-Square	1	4.0154	0.0451
Likelihood Ratio Chi-Square	1	4.0093	0.0453
Continuity Adj. Chi-Square	1	3.7000	0.0544
Mantel-Haenszel Chi-Square	1	4.0106	0.0452
Phi Coefficient		0.0690	
Contingency Coefficient		0.0689	
Cramer's V		0.0690	

CEDandWAL_p01 Pedestrian characteristics stratified by crosswalk type

The FREQ Procedure

Statistics for Table of female by xwalkn

Fisher's Exact Test	
Cell (1,1) Frequency (F)	109
Left-sided Pr <= F	0.9814
Right-sided Pr >= F	0.0273
Table Probability (P)	0.0086
Two-sided Pr <= P	0.0538

Effective Sample Size = 843
Frequency Missing = 2

CEDandWAL_p01 Pedestrian behavior stratified by crosswalk type

The FREQ Procedure

Table of assertn by xwalkn			
assertn	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Waited on curb	77 37.75	209 32.97	286
Waited on street	56 27.45	222 35.02	278
Did not wait	71 34.80	201 31.70	272
Forced driver to yield	0 0.00	2 0.32	2
Total	204	634	838
Frequency Missing = 7			

Statistics for Table of assertn by xwalkn

Statistic	DF	Value	Prob
Chi-Square	3	4.7962	0.1873
Likelihood Ratio Chi-Square	3	5.3533	0.1477
Mantel-Haenszel Chi-Square	1	0.1218	0.7270
Phi Coefficient		0.0757	
Contingency Coefficient		0.0754	
Cramer's V		0.0757	
WARNING: 25% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Fisher's Exact Test	
Table Probability (P)	3.730E-04
Pr <= P	0.1977

Effective Sample Size = 838
Frequency Missing = 7

CEDandWAL_p01 Pedestrian behavior stratified by crosswalk type

The FREQ Procedure

Table of lookn by xwalkn			
lookn	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Didn't look	4 2.00	13 2.06	17
Looked one way	34 17.00	126 19.97	160
Looked both ways	127 63.50	413 65.45	540
Looked more than 2 times	35 17.50	79 12.52	114
Total	200	631	831
Frequency Missing = 14			

Statistics for Table of lookn by xwalkn

Statistic	DF	Value	Prob
Chi-Square	3	3.5323	0.3166
Likelihood Ratio Chi-Square	3	3.4039	0.3334
Mantel-Haenszel Chi-Square	1	2.4549	0.1172
Phi Coefficient		0.0652	
Contingency Coefficient		0.0651	
Cramer's V		0.0652	

Fisher's Exact Test	
Table Probability (P)	3.159E-04
Pr <= P	0.3191

Effective Sample Size = 831
Frequency Missing = 14

CEDandWAL_p01 Pedestrian behavior stratified by crosswalk type

The FREQ Procedure

Table of gaitn by xwalkn			
gaitn	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Slow	1 0.49	1 0.16	2
Normal	177 85.92	586 91.99	763
Fast	5 2.43	13 2.04	18
Ran	23 11.17	37 5.81	60
Total	206	637	843
Frequency Missing = 2			

Statistics for Table of gaitn by xwalkn

Statistic	DF	Value	Prob
Chi-Square	3	7.7258	0.0520
Likelihood Ratio Chi-Square	3	7.0252	0.0711
Mantel-Haenszel Chi-Square	1	6.3874	0.0115
Phi Coefficient		0.0957	
Contingency Coefficient		0.0953	
Cramer's V		0.0957	
WARNING: 38% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Fisher's Exact Test	
Table Probability (P)	3.467E-04
Pr <= P	0.0365

Effective Sample Size = 843
Frequency Missing = 2

CEDandWAL_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Class Level Information		
Class	Levels	Values
xwalkn	2	0 1

Number of Observations Read	845
Number of Observations Used	844

CEDandWAL_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Dependent Variable: lngap   Sum of gaps lane1-lane5

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	4.5322969	4.5322969	12.18	0.0005
Error	842	313.3290775	0.3721248		
Corrected Total	843	317.8613744			

R-Square	Coeff Var	Root MSE	lngap Mean
0.014259	63.32806	0.610020	0.963270

Source	DF	Type I SS	Mean Square	F Value	Pr > F
xwalkn	1	4.53229689	4.53229689	12.18	0.0005

Source	DF	Type III SS	Mean Square	F Value	Pr > F
xwalkn	1	4.53229689	4.53229689	12.18	0.0005

CEDandWAL_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Level of xwalkn	N	lngap	
		Mean	Std Dev
0	206	1.09223301	0.62175037
1	638	0.92163009	0.60619707

CEDandWAL_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Class Level Information		
Class	Levels	Values
xwalkn	2	0 1

Number of Observations Read	845
Number of Observations Used	844

CEDandWAL_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Dependent Variable: totyield Sum of yields

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	10.3589993	10.3589993	26.51	<.0001
Error	842	329.0284414	0.3907701		
Corrected Total	843	339.3874408			

R-Square	Coeff Var	Root MSE	totyield Mean
0.030523	101.2664	0.625116	0.617299

Source	DF	Type I SS	Mean Square	F Value	Pr > F
xwalkn	1	10.35899933	10.35899933	26.51	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
xwalkn	1	10.35899933	10.35899933	26.51	<.0001

CEDandWAL_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Level of xwalkn	N	totyield	
		Mean	Std Dev
0	206	0.42233010	0.57702890
1	638	0.68025078	0.63982332

CEDandWAL_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Class Level Information		
Class	Levels	Values
xwalkn	2	0 1

Number of Observations Read	845
Number of Observations Used	844

CEDandWAL_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Dependent Variable: totexp Sum of exposure for lanes (excludes no car or missing)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	0.625847	0.625847	0.38	0.5381
Error	842	1389.061357	1.649717		
Corrected Total	843	1389.687204			

R-Square	Coeff Var	Root MSE	totexp Mean
0.000450	93.45211	1.284413	1.374408

Source	DF	Type I SS	Mean Square	F Value	Pr > F
xwalkn	1	0.62584700	0.62584700	0.38	0.5381

Source	DF	Type III SS	Mean Square	F Value	Pr > F
xwalkn	1	0.62584700	0.62584700	0.38	0.5381

CEDandWAL_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Level of xwalkn	N	totexp	
		Mean	Std Dev
0	206	1.42233010	1.49838495
1	638	1.35893417	1.20751446

CEDandWAL_p01 Gaps and driver behavior stratified by crosswalk type

CEDandWAL_p01 Pedestrian capture subset by marked crosswalk

The FREQ Procedure

capture	Frequency	Percent	Cumulative Frequency	Cumulative Percent

Frequency Missing = 639

CAPand16_p01 Pedestrian characteristics stratified by crosswalk type

The FREQ Procedure

Table of agecat by xwalkn			
agecat(Age category 1=Child 2=Teen 3=Young Adult 4=Older Adult 5=Elderly)	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Child	0 0.00	1 0.33	1
Teen	0 0.00	1 0.33	1
Young adult	34 48.57	131 42.67	165
Older adult	32 45.71	162 52.77	194
Elderly	4 5.71	12 3.91	16
Total	70	307	377
Frequency Missing = 76			

Statistics for Table of agecat by xwalkn

Statistic	DF	Value	Prob
Chi-Square	4	1.8986	0.7544
Likelihood Ratio Chi-Square	4	2.2358	0.6925
Mantel-Haenszel Chi-Square	1	0.0994	0.7525
Phi Coefficient		0.0710	
Contingency Coefficient		0.0708	
Cramer's V		0.0710	
WARNING: 50% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

CAPand16_p01 Pedestrian characteristics stratified by crosswalk type

The FREQ Procedure

Statistics for Table of agecat by xwalkn

Fisher's Exact Test	
Table Probability (P)	0.0082
Pr <= P	0.6313

Effective Sample Size = 377
Frequency Missing = 76

WARNING: 17% of the data are missing.

Table of female by xwalkn			
female(IND: 1=female 0=male)	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Male	49 70.00	268 70.16	317
Female	21 30.00	114 29.84	135
Total	70	382	452
Frequency Missing = 1			

Statistics for Table of female by xwalkn

Statistic	DF	Value	Prob
Chi-Square	1	0.0007	0.9789
Likelihood Ratio Chi-Square	1	0.0007	0.9789
Continuity Adj. Chi-Square	1	0.0000	1.0000
Mantel-Haenszel Chi-Square	1	0.0007	0.9790
Phi Coefficient		-0.0012	
Contingency Coefficient		0.0012	
Cramer's V		-0.0012	

CAPand16_p01 Pedestrian characteristics stratified by crosswalk type

The FREQ Procedure

Statistics for Table of female by xwalkn

Fisher's Exact Test	
Cell (1,1) Frequency (F)	49
Left-sided Pr <= F	0.5408
Right-sided Pr >= F	0.5719
Table Probability (P)	0.1127
Two-sided Pr <= P	1.0000

Effective Sample Size = 452
Frequency Missing = 1

CAPand16_p01 Pedestrian behavior stratified by crosswalk type

The FREQ Procedure

Table of assertn by xwalkn			
assertn	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Waited on curb	8 15.38	42 10.97	50
Waited on street	22 42.31	124 32.38	146
Did not wait	22 42.31	207 54.05	229
Forced driver to yield	0 0.00	10 2.61	10
Total	52	383	435
Frequency Missing = 18			

Statistics for Table of assertn by xwalkn

Statistic	DF	Value	Prob
Chi-Square	3	4.6794	0.1968
Likelihood Ratio Chi-Square	3	5.7892	0.1223
Mantel-Haenszel Chi-Square	1	3.9842	0.0459
Phi Coefficient		0.1037	
Contingency Coefficient		0.1032	
Cramer's V		0.1037	

Fisher's Exact Test	
Table Probability (P)	0.0012
Pr <= P	0.2168

Effective Sample Size = 435
Frequency Missing = 18

CAPand16_p01 Pedestrian behavior stratified by crosswalk type

The FREQ Procedure

Table of lookn by xwalkn			
lookn	xwalkn(IND: 1=marked 0=unmarked)		Total
Frequency Col Pct	Unmarked	Marked	
Didn't look	0 0.00	8 2.12	8
Looked one way	18 35.29	207 54.91	225
Looked both ways	15 29.41	82 21.75	97
Looked more than 2 times	18 35.29	80 21.22	98
Total	51	377	428
Frequency Missing = 25			

Statistics for Table of lookn by xwalkn

Statistic	DF	Value	Prob
Chi-Square	3	9.4189	0.0242
Likelihood Ratio Chi-Square	3	10.1777	0.0171
Mantel-Haenszel Chi-Square	1	8.9832	0.0027
Phi Coefficient		0.1483	
Contingency Coefficient		0.1467	
Cramer's V		0.1483	

Fisher's Exact Test	
Table Probability (P)	1.168E-04
Pr <= P	0.0267

Effective Sample Size = 428
Frequency Missing = 25

CAPand16_p01 Pedestrian behavior stratified by crosswalk type

The FREQ Procedure

Table of gaitn by xwalkn			
gaitn	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Slow	6 8.57	26 6.79	32
Normal	48 68.57	288 75.20	336
Fast	9 12.86	31 8.09	40
Ran	7 10.00	38 9.92	45
Total	70	383	453

Statistics for Table of gaitn by xwalkn

Statistic	DF	Value	Prob
Chi-Square	3	2.1375	0.5444
Likelihood Ratio Chi-Square	3	1.9776	0.5771
Mantel-Haenszel Chi-Square	1	0.1141	0.7356
Phi Coefficient		0.0687	
Contingency Coefficient		0.0685	
Cramer's V		0.0687	

Fisher's Exact Test	
Table Probability (P)	0.0019
Pr <= P	0.4861

Sample Size = 453

CAPand16_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Class Level Information		
Class	**Levels**	**Values**
xwalkn	2	0 1

Number of Observations Read	453
Number of Observations Used	453

CAPand16_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Dependent Variable: lngap   Sum of gaps lane1-lane5

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	3.8062303	3.8062303	4.98	0.0262
Error	451	344.8207012	0.7645692		
Corrected Total	452	348.6269316			

R-Square	Coeff Var	Root MSE	lngap Mean
0.010918	44.35628	0.874396	1.971302

Source	DF	Type I SS	Mean Square	F Value	Pr > F
xwalkn	1	3.80623034	3.80623034	4.98	0.0262

Source	DF	Type III SS	Mean Square	F Value	Pr > F
xwalkn	1	3.80623034	3.80623034	4.98	0.0262

CAPand16_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Level of xwalkn	N	lngap	
		Mean	**Std Dev**
0	70	2.18571429	0.88943651
1	383	1.93211488	0.87165214

CAPand16_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Class Level Information		
Class	**Levels**	**Values**
xwalkn	2	0 1

Number of Observations Read	453
Number of Observations Used	453

CAPand16_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Dependent Variable: totyield Sum of yields

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	10.2053852	10.2053852	18.54	<.0001
Error	451	248.2449459	0.5504323		
Corrected Total	452	258.4503311			

R-Square	Coeff Var	Root MSE	totyield Mean
0.039487	119.1794	0.741911	0.622517

Source	DF	Type I SS	Mean Square	F Value	Pr > F
xwalkn	1	10.20538521	10.20538521	18.54	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
xwalkn	1	10.20538521	10.20538521	18.54	<.0001

CAPand16_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Level of xwalkn	N	totyield	
		Mean	**Std Dev**
0	70	0.27142857	0.58783387
1	383	0.68668407	0.76644636

CAPand16_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Class Level Information		
Class	Levels	Values
xwalkn	2	0 1

Number of Observations Read	453
Number of Observations Used	453

CAPand16_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Dependent Variable: totexp   Sum of exposure for lanes (excludes no car or missing)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	12.6318551	12.6318551	5.79	0.0165
Error	451	983.9950765	2.1818073		
Corrected Total	452	996.6269316			

R-Square	Coeff Var	Root MSE	totexp Mean
0.012675	108.4479	1.477094	1.362031

Source	DF	Type I SS	Mean Square	F Value	Pr > F
xwalkn	1	12.63185510	12.63185510	5.79	0.0165

Source	DF	Type III SS	Mean Square	F Value	Pr > F
xwalkn	1	12.63185510	12.63185510	5.79	0.0165

CAPand16_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Level of xwalkn	N	totexp	
		Mean	Std Dev
0	70	0.97142857	1.28504699
1	383	1.43342037	1.50917978

CAPand16_p01 Gaps and driver behavior stratified by crosswalk type

CAPand16_p01 Pedestrian capture subset by marked crosswalk

The FREQ Procedure

CAPTURE				
CAPTURE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
CC	15	3.93	15	3.93
NC	216	56.54	231	60.47
PC	151	39.53	382	100.00

Frequency Missing = 1

CAPand16_p01 Multiple Threat Lanes 1 and 2

The FREQ Procedure

Table of multhreat12 by xwalk_marking			
multhreat12(Multiple threat in lane 1 and 2 (1=yes 0=no))	xwalk_marking(MARKED vs. UNMARKED)		
Frequency Col Pct	MARKED	UNMARKED	Total
0	354 92.43	62 96.88	416
1	29 7.57	2 3.13	31
Total	383	64	447
Frequency Missing = 6			

Statistics for Table of multhreat12 by xwalk_marking

Statistic	DF	Value	Prob
Chi-Square	1	1.6801	0.1949
Likelihood Ratio Chi-Square	1	2.0208	0.1552
Continuity Adj. Chi-Square	1	1.0617	0.3028
Mantel-Haenszel Chi-Square	1	1.6763	0.1954
Phi Coefficient		-0.0613	
Contingency Coefficient		0.0612	
Cramer's V		-0.0613	
WARNING: 25% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Fisher's Exact Test	
Cell (1,1) Frequency (F)	354
Left-sided Pr <= F	0.1497
Right-sided Pr >= F	0.9542
Table Probability (P)	0.1038
Two-sided Pr <= P	0.2873

Effective Sample Size = 447
Frequency Missing = 6

BLAandSAC_p01 Pedestrian characteristics stratified by crosswalk type

The FREQ Procedure

Table of agecat by xwalkn			
agecat(Age category 1=Child 2=Teen 3=Young Adult 4=Older Adult 5=Elderly)	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Child	1 1.20	3 2.00	4
Teen	16 19.28	22 14.67	38
Young adult	27 32.53	58 38.67	85
Older adult	34 40.96	56 37.33	90
Elderly	5 6.02	11 7.33	16
Total	83	150	233
Frequency Missing = 94			

Statistics for Table of agecat by xwalkn

Statistic	DF	Value	Prob
Chi-Square	4	1.7605	0.7797
Likelihood Ratio Chi-Square	4	1.7665	0.7786
Mantel-Haenszel Chi-Square	1	0.0273	0.8688
Phi Coefficient		0.0869	
Contingency Coefficient		0.0866	
Cramer's V		0.0869	

Fisher's Exact Test	
Table Probability (P)	7.043E-04
Pr <= P	0.7957

Effective Sample Size = 233
Frequency Missing = 94

BLAandSAC_p01 Pedestrian characteristics stratified by crosswalk type

The FREQ Procedure

Statistics for Table of agecat by xwalkn

WARNING: 29% of the data are missing.

Table of female by xwalkn			
female(IND: 1=female 0=male)	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Male	56 66.67	85 56.67	141
Female	28 33.33	65 43.33	93
Total	84	150	234
Frequency Missing = 93			

Statistics for Table of female by xwalkn

Statistic	DF	Value	Prob
Chi-Square	1	2.2485	0.1337
Likelihood Ratio Chi-Square	1	2.2726	0.1317
Continuity Adj. Chi-Square	1	1.8503	0.1738
Mantel-Haenszel Chi-Square	1	2.2388	0.1346
Phi Coefficient		0.0980	
Contingency Coefficient		0.0976	
Cramer's V		0.0980	

Fisher's Exact Test	
Cell (1,1) Frequency (F)	56
Left-sided Pr <= F	0.9500
Right-sided Pr >= F	0.0864
Table Probability (P)	0.0364
Two-sided Pr <= P	0.1638

BLAandSAC_p01 Pedestrian characteristics stratified by crosswalk type

The FREQ Procedure

Statistics for Table of female by xwalkn

Effective Sample Size = 234
Frequency Missing = 93

WARNING: 28% of the data are missing.

BLAandSAC_p01 Pedestrian behavior stratified by crosswalk type

The FREQ Procedure

Table of assertn by xwalkn			
assertn	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Waited on curb	35 42.17	61 40.67	96
Waited on street	11 13.25	21 14.00	32
Did not wait	37 44.58	68 45.33	105
Total	83	150	233
Frequency Missing = 94			

Statistics for Table of assertn by xwalkn

Statistic	DF	Value	Prob
Chi-Square	2	0.0577	0.9715
Likelihood Ratio Chi-Square	2	0.0578	0.9715
Mantel-Haenszel Chi-Square	1	0.0315	0.8592
Phi Coefficient		0.0157	
Contingency Coefficient		0.0157	
Cramer's V		0.0157	

Fisher's Exact Test	
Table Probability (P)	0.0180
Pr <= P	0.9818

Effective Sample Size = 233
Frequency Missing = 94

WARNING: 29% of the data are missing.

BLAandSAC_p01 Pedestrian behavior stratified by crosswalk type

The FREQ Procedure

Table of lookn by xwalkn			
lookn	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Didn't look	3 3.66	3 2.01	6
Looked one way	32 39.02	65 43.62	97
Looked both ways	39 47.56	75 50.34	114
Looked more than 2 times	8 9.76	6 4.03	14
Total	82	149	231
Frequency Missing = 96			

Statistics for Table of lookn by xwalkn

Statistic	DF	Value	Prob
Chi-Square	3	3.7647	0.2880
Likelihood Ratio Chi-Square	3	3.5911	0.3091
Mantel-Haenszel Chi-Square	1	0.6283	0.4280
Phi Coefficient		0.1277	
Contingency Coefficient		0.1266	
Cramer's V		0.1277	
WARNING: 38% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Fisher's Exact Test	
Table Probability (P)	0.0014
Pr <= P	0.2707

Effective Sample Size = 231
Frequency Missing = 96

WARNING: 29% of the data are missing.

BLAandSAC_p01 Pedestrian behavior stratified by crosswalk type

The FREQ Procedure

Table of gaitn by xwalkn			
gaitn	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Slow	5 5.95	12 8.00	17
Normal	60 71.43	111 74.00	171
Fast	6 7.14	9 6.00	15
Ran	13 15.48	18 12.00	31
Total	84	150	234
Frequency Missing = 93			

Statistics for Table of gaitn by xwalkn

Statistic	DF	Value	Prob
Chi-Square	3	0.9603	0.8108
Likelihood Ratio Chi-Square	3	0.9580	0.8114
Mantel-Haenszel Chi-Square	1	0.9179	0.3380
Phi Coefficient		0.0641	
Contingency Coefficient		0.0639	
Cramer's V		0.0641	

Fisher's Exact Test	
Table Probability (P)	0.0045
Pr <= P	0.8073

Effective Sample Size = 234
Frequency Missing = 93

WARNING: 28% of the data are missing.

BLAandSAC_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Class Level Information		
Class	**Levels**	**Values**
xwalkn	2	0 1

Number of Observations Read	327
Number of Observations Used	234

BLAandSAC_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Dependent Variable: lngap Sum of gaps lane1-lane5

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	1.4701954	1.4701954	1.38	0.2406
Error	232	246.4614286	1.0623337		
Corrected Total	233	247.9316239			

R-Square	Coeff Var	Root MSE	lngap Mean
0.005930	35.46806	1.030696	2.905983

Source	DF	Type I SS	Mean Square	F Value	Pr > F
xwalkn	1	1.47019536	1.47019536	1.38	0.2406

Source	DF	Type III SS	Mean Square	F Value	Pr > F
xwalkn	1	1.47019536	1.47019536	1.38	0.2406

BLAandSAC_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Level of xwalkn	N	lngap	
		Mean	**Std Dev**
0	84	3.01190476	0.91169176
1	150	2.84666667	1.09137354

BLAandSAC_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Class Level Information		
Class	**Levels**	**Values**
xwalkn	2	0 1

Number of Observations Read	327
Number of Observations Used	234

BLAandSAC_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Dependent Variable: totyield Sum of yields

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	5.3833455	5.3833455	8.66	0.0036
Error	232	144.2790476	0.6218924		
Corrected Total	233	149.6623932			

R-Square	Coeff Var	Root MSE	totyield Mean
0.035970	140.8647	0.788602	0.559829

Source	DF	Type I SS	Mean Square	F Value	Pr > F
xwalkn	1	5.38334554	5.38334554	8.66	0.0036

Source	DF	Type III SS	Mean Square	F Value	Pr > F
xwalkn	1	5.38334554	5.38334554	8.66	0.0036

BLAandSAC_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Level of xwalkn	N	totyield	
		Mean	Std Dev
0	84	0.35714286	0.65201924
1	150	0.67333333	0.85527708

BLAandSAC_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Class Level Information		
Class	Levels	Values
xwalkn	2	0 1

Number of Observations Read	327
Number of Observations Used	234

BLAandSAC_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Dependent Variable: totexp Sum of exposure for lanes (excludes no car or missing)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	1.135836	1.135836	0.25	0.6171
Error	232	1051.654762	4.532995		
Corrected Total	233	1052.790598			

R-Square	Coeff Var	Root MSE	totexp Mean
0.001079	150.5152	2.129083	1.414530

Source	DF	Type I SS	Mean Square	F Value	Pr > F
xwalkn	1	1.13583639	1.13583639	0.25	0.6171

Source	DF	Type III SS	Mean Square	F Value	Pr > F
xwalkn	1	1.13583639	1.13583639	0.25	0.6171

BLAandSAC_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Level of xwalkn	N	totexp	
		Mean	Std Dev
0	84	1.32142857	2.16856354
1	150	1.46666667	2.10676974

BLAandSAC_p01 Gaps and driver behavior stratified by crosswalk type

BLAandSAC_p01 Pedestrian capture subset by marked crosswalk

The FREQ Procedure

CAPTURE				
CAPTURE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
CC	1	0.67	1	0.67
NC	75	50.00	76	50.67
PC	74	49.33	150	100.00

BLAandSAC_p01 Multiple Threat Lanes 1 and 2

The FREQ Procedure

Table of multhreat12 by xwalk_marking			
multhreat12(Multiple threat in lane 1 and 2 (1=yes 0=no))	xwalk_marking(MARKED vs. UNMARKED)		
Frequency Col Pct	MARKED	UNMARKED	Total
0	139 92.67	80 96.39	219
1	11 7.33	3 3.61	14
Total	150	83	233
Frequency Missing = 94			

Statistics for Table of multhreat12 by xwalk_marking

Statistic	DF	Value	Prob
Chi-Square	1	1.3085	0.2527
Likelihood Ratio Chi-Square	1	1.4122	0.2347
Continuity Adj. Chi-Square	1	0.7329	0.3920
Mantel-Haenszel Chi-Square	1	1.3029	0.2537
Phi Coefficient		-0.0749	
Contingency Coefficient		0.0747	
Cramer's V		-0.0749	
WARNING: 25% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Fisher's Exact Test	
Cell (1,1) Frequency (F)	139
Left-sided Pr <= F	0.1984
Right-sided Pr >= F	0.9293
Table Probability (P)	0.1278
Two-sided Pr <= P	0.3889

Effective Sample Size = 233
Frequency Missing = 94

WARNING: 29% of the data are missing.

BLAandSAC_p01 Multiple Threat Lanes 1 and 2

BLAandSAC_p01 Multiple Threat Lanes 3 and 4

The FREQ Procedure

Table of multhreat34 by xwalk_marking			
multhreat34(Multiple threat in lane 3 and 4 (1=yes 0=no))	xwalk_marking(MARKED vs. UNMARKED)		
Frequency Col Pct	MARKED	UNMARKED	Total
0	132 88.00	81 96.43	213
1	18 12.00	3 3.57	21
Total	150	84	234
Frequency Missing = 93			

Statistics for Table of multhreat34 by xwalk_marking

Statistic	DF	Value	Prob
Chi-Square	1	4.6827	0.0305
Likelihood Ratio Chi-Square	1	5.3476	0.0208
Continuity Adj. Chi-Square	1	3.7077	0.0542
Mantel-Haenszel Chi-Square	1	4.6627	0.0308
Phi Coefficient		-0.1415	
Contingency Coefficient		0.1401	
Cramer's V		-0.1415	

Fisher's Exact Test	
Cell (1,1) Frequency (F)	132
Left-sided Pr <= F	0.0224
Right-sided Pr >= F	0.9949
Table Probability (P)	0.0173
Two-sided Pr <= P	0.0326

Effective Sample Size = 234
Frequency Missing = 93

WARNING: 28% of the data are missing.

UNIandWAL_p01 Pedestrian characteristics stratified by crosswalk type

The FREQ Procedure

Table of agecat by xwalkn			
agecat(Age category 1=Child 2=Teen 3=Young Adult 4=Older Adult 5=Elderly)	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Teen	0 0.00	3 0.42	3
Young adult	27 44.26	323 45.37	350
Older adult	33 54.10	361 50.70	394
Elderly	1 1.64	25 3.51	26
Total	61	712	773

Statistics for Table of agecat by xwalkn

Statistic	DF	Value	Prob
Chi-Square	3	0.9846	0.8050
Likelihood Ratio Chi-Square	3	1.3449	0.7185
Mantel-Haenszel Chi-Square	1	0.0001	0.9922
Phi Coefficient		0.0357	
Contingency Coefficient		0.0357	
Cramer's V		0.0357	
WARNING: 38% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Fisher's Exact Test	
Table Probability (P)	0.0208
Pr <= P	0.8646

Sample Size = 773

UNIandWAL_p01 Pedestrian characteristics stratified by crosswalk type

The FREQ Procedure

Table of female by xwalkn			
female(IND: 1=female 0=male)	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Male	40 66.67	419 58.85	459
Female	20 33.33	293 41.15	313
Total	60	712	772
Frequency Missing = 1			

Statistics for Table of female by xwalkn

Statistic	DF	Value	Prob
Chi-Square	1	1.4032	0.2362
Likelihood Ratio Chi-Square	1	1.4332	0.2312
Continuity Adj. Chi-Square	1	1.0976	0.2948
Mantel-Haenszel Chi-Square	1	1.4014	0.2365
Phi Coefficient		0.0426	
Contingency Coefficient		0.0426	
Cramer's V		0.0426	

Fisher's Exact Test	
Cell (1,1) Frequency (F)	40
Left-sided Pr <= F	0.9080
Right-sided Pr >= F	0.1472
Table Probability (P)	0.0552
Two-sided Pr <= P	0.2741

Effective Sample Size = 772
Frequency Missing = 1

UNIandWAL_p01 Pedestrian behavior stratified by crosswalk type

The FREQ Procedure

Table of assertn by xwalkn			
assertn	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Waited on curb	10 18.18	219 31.24	229
Waited on street	15 27.27	185 26.39	200
Did not wait	30 54.55	291 41.51	321
Forced driver to yield	0 0.00	6 0.86	6
Total	55	701	756
Frequency Missing = 17			

Statistics for Table of assertn by xwalkn

Statistic	DF	Value	Prob
Chi-Square	3	5.3973	0.1449
Likelihood Ratio Chi-Square	3	6.1233	0.1058
Mantel-Haenszel Chi-Square	1	4.0893	0.0432
Phi Coefficient		0.0845	
Contingency Coefficient		0.0842	
Cramer's V		0.0845	

Fisher's Exact Test	
Table Probability (P)	8.723E-04
Pr <= P	0.1586

Effective Sample Size = 756
Frequency Missing = 17

UNIandWAL_p01 Pedestrian behavior stratified by crosswalk type

The FREQ Procedure

Table of lookn by xwalkn			
lookn	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Didn't look	1 1.85	14 2.00	15
Looked one way	33 61.11	357 51.07	390
Looked both ways	20 37.04	265 37.91	285
Looked more than 2 times	0 0.00	63 9.01	63
Total	54	699	753
Frequency Missing = 20			

Statistics for Table of lookn by xwalkn

Statistic	DF	Value	Prob
Chi-Square	3	5.8581	0.1187
Likelihood Ratio Chi-Square	3	10.3180	0.0160
Mantel-Haenszel Chi-Square	1	3.8549	0.0496
Phi Coefficient		0.0882	
Contingency Coefficient		0.0879	
Cramer's V		0.0882	
WARNING: 25% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Fisher's Exact Test	
Table Probability (P)	2.594E-04
Pr <= P	0.0537

Effective Sample Size = 753
Frequency Missing = 20

UNIandWAL_p01 Pedestrian behavior stratified by crosswalk type

The FREQ Procedure

Table of gaitn by xwalkn			
gaitn	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Slow	1 1.64	12 1.69	13
Normal	42 68.85	657 92.28	699
Fast	8 13.11	15 2.11	23
Ran	10 16.39	28 3.93	38
Total	61	712	773

Statistics for Table of gaitn by xwalkn

Statistic	DF	Value	Prob
Chi-Square	3	44.0388	<.0001
Likelihood Ratio Chi-Square	3	28.6587	<.0001
Mantel-Haenszel Chi-Square	1	31.4626	<.0001
Phi Coefficient		0.2387	
Contingency Coefficient		0.2322	
Cramer's V		0.2387	
WARNING: 38% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Fisher's Exact Test	
Table Probability (P)	6.858E-09
Pr <= P	5.506E-07

Sample Size = 773

UNIandWAL_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Class Level Information		
Class	**Levels**	**Values**
xwalkn	2	0 1

Number of Observations Read	773
Number of Observations Used	773

UNIandWAL_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Dependent Variable: lngap   Sum of gaps lane1-lane5

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	10.4794245	10.4794245	14.05	0.0002
Error	771	574.8633957	0.7456075		
Corrected Total	772	585.3428202			

R-Square	Coeff Var	Root MSE	lngap Mean
0.017903	28.05693	0.863486	3.077620

Source	DF	Type I SS	Mean Square	F Value	Pr > F
xwalkn	1	10.47942453	10.47942453	14.05	0.0002

Source	DF	Type III SS	Mean Square	F Value	Pr > F
xwalkn	1	10.47942453	10.47942453	14.05	0.0002

UNIandWAL_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Level of xwalkn	N	lngap	
		Mean	Std Dev
0	61	3.47540984	0.67346263
1	712	3.04353933	0.87764091

UNIandWAL_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Class Level Information		
Class	Levels	Values
xwalkn	2	0 1

Number of Observations Read	773
Number of Observations Used	773

UNIandWAL_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Dependent Variable: totyield Sum of yields

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	9.7711009	9.7711009	16.22	<.0001
Error	771	464.4125990	0.6023510		
Corrected Total	772	474.1836999			

R-Square	Coeff Var	Root MSE	totyield Mean
0.020606	123.1900	0.776113	0.630013

Source	DF	Type I SS	Mean Square	F Value	Pr > F
xwalkn	1	9.77110087	9.77110087	16.22	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
xwalkn	1	9.77110087	9.77110087	16.22	<.0001

UNIandWAL_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Level of xwalkn	N	totyield	
		Mean	Std Dev
0	61	0.24590164	0.47101797
1	712	0.66292135	0.79653003

UNIandWAL_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Class Level Information		
Class	Levels	Values
xwalkn	2	0 1

Number of Observations Read	773
Number of Observations Used	773

UNIandWAL_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Dependent Variable: totexp Sum of exposure for lanes (excludes no car or missing)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	5.061735	5.061735	2.55	0.1104
Error	771	1527.724811	1.981485		
Corrected Total	772	1532.786546			

R-Square	Coeff Var	Root MSE	totexp Mean
0.003302	121.1710	1.407652	1.161708

Source	DF	Type I SS	Mean Square	F Value	Pr > F
xwalkn	1	5.06173473	5.06173473	2.55	0.1104

Source	DF	Type III SS	Mean Square	F Value	Pr > F
xwalkn	1	5.06173473	5.06173473	2.55	0.1104

UNIandWAL_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Level of xwalkn	N	totexp	
		Mean	Std Dev
0	61	0.88524590	1.60310491
1	712	1.18539326	1.38990134

UNIandWAL_p01 Gaps and driver behavior stratified by crosswalk type

UNIandWAL_p01 Pedestrian capture subset by marked crosswalk

The FREQ Procedure

CAPTURE				
CAPTURE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
CC	7	1.27	7	1.27
NC	308	55.70	315	56.96
PC	238	43.04	553	100.00

Frequency Missing = 159

UNIandWAL_p01 Multiple Threat Lanes 1 and 2

The FREQ Procedure

Table of multhreat12 by xwalk_marking			
multhreat12(Multiple threat in lane 1 and 2 (1=yes 0=no))	xwalk marking(MARKED vs. UNMARKED)		
Frequency Col Pct	MARKED	UNMARKED	Total
0	682 95.79	61 100.00	743
1	30 4.21	0 0.00	30
Total	712	61	773

Statistics for Table of multhreat12 by xwalk_marking

Statistic	DF	Value	Prob
Chi-Square	1	2.6740	0.1020
Likelihood Ratio Chi-Square	1	5.0346	0.0248
Continuity Adj. Chi-Square	1	1.6638	0.1971
Mantel-Haenszel Chi-Square	1	2.6705	0.1022
Phi Coefficient		-0.0588	
Contingency Coefficient		0.0587	
Cramer's V		-0.0588	
WARNING: 25% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Fisher's Exact Test	
Cell (1,1) Frequency (F)	682
Left-sided Pr <= F	0.0808
Right-sided Pr >= F	1.0000
Table Probability (P)	0.0808
Two-sided Pr <= P	0.1603

Sample Size = 773

UNIandWAL_p01 Multiple Threat Lanes 1 and 2

UNIandWAL_p01 Multiple Threat Lanes 3 and 4

The FREQ Procedure

Table of multhreat34 by xwalk_marking			
multhreat34(Multiple threat in lane 3 and 4 (1=yes 0=no))	xwalk_marking(MARKED vs. UNMARKED)		
Frequency Col Pct	MARKED	UNMARKED	Total
0	639 89.75	60 98.36	699
1	73 10.25	1 1.64	74
Total	712	61	773

Statistics for Table of multhreat34 by xwalk_marking

Statistic	DF	Value	Prob
Chi-Square	1	4.8154	0.0282
Likelihood Ratio Chi-Square	1	6.9348	0.0085
Continuity Adj. Chi-Square	1	3.8718	0.0491
Mantel-Haenszel Chi-Square	1	4.8092	0.0283
Phi Coefficient		-0.0789	
Contingency Coefficient		0.0787	
Cramer's V		-0.0789	

Fisher's Exact Test	
Cell (1,1) Frequency (F)	639
Left-sided Pr <= F	0.0134
Right-sided Pr >= F	0.9983
Table Probability (P)	0.0117
Two-sided Pr <= P	0.0223

Sample Size = 773

INTand37_p01 Pedestrian characteristics stratified by crosswalk type

The FREQ Procedure

Table of agecat by xwalkn			
agecat(Age category 1=Child 2=Teen 3=Young Adult 4=Older Adult 5=Elderly)	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Teen	29 15.59	6 3.92	35
Young adult	72 38.71	78 50.98	150
Older adult	85 45.70	67 43.79	152
Elderly	0 0.00	2 1.31	2
Total	186	153	339

Statistics for Table of agecat by xwalkn

Statistic	DF	Value	Prob
Chi-Square	3	16.4292	0.0009
Likelihood Ratio Chi-Square	3	18.3820	0.0004
Mantel-Haenszel Chi-Square	1	2.8628	0.0907
Phi Coefficient		0.2201	
Contingency Coefficient		0.2150	
Cramer's V		0.2201	
WARNING: 25% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Fisher's Exact Test	
Table Probability (P)	1.750E-06
Pr <= P	3.787E-04

Sample Size = 339

INTand37_p01 Pedestrian characteristics stratified by crosswalk type

The FREQ Procedure

Table of female by xwalkn			
female(IND: 1=female 0=male)	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Male	148 80.00	80 52.29	228
Female	37 20.00	73 47.71	110
Total	185	153	338
Frequency Missing = 1			

Statistics for Table of female by xwalkn

Statistic	DF	Value	Prob
Chi-Square	1	29.2955	<.0001
Likelihood Ratio Chi-Square	1	29.5602	<.0001
Continuity Adj. Chi-Square	1	28.0468	<.0001
Mantel-Haenszel Chi-Square	1	29.2088	<.0001
Phi Coefficient		0.2944	
Contingency Coefficient		0.2824	
Cramer's V		0.2944	

Fisher's Exact Test	
Cell (1,1) Frequency (F)	148
Left-sided Pr <= F	1.0000
Right-sided Pr >= F	5.271E-08
Table Probability (P)	3.885E-08
Two-sided Pr <= P	6.780E-08

Effective Sample Size = 338
Frequency Missing = 1

INTand37_p01 Pedestrian behavior stratified by crosswalk type

The FREQ Procedure

Table of assertn by xwalkn			
assertn	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Waited on curb	25 14.04	38 25.00	63
Waited on street	97 54.49	67 44.08	164
Did not wait	56 31.46	46 30.26	102
Forced driver to yield	0 0.00	1 0.66	1
Total	178	152	330
Frequency Missing = 9			

Statistics for Table of assertn by xwalkn

Statistic	DF	Value	Prob
Chi-Square	3	8.1529	0.0430
Likelihood Ratio Chi-Square	3	8.5384	0.0361
Mantel-Haenszel Chi-Square	1	1.9326	0.1645
Phi Coefficient		0.1572	
Contingency Coefficient		0.1553	
Cramer's V		0.1572	
WARNING: 25% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Fisher's Exact Test	
Table Probability (P)	1.629E-04
Pr <= P	0.0283

Effective Sample Size = 330
Frequency Missing = 9

INTand37_p01 Pedestrian behavior stratified by crosswalk type

The FREQ Procedure

Table of lookn by xwalkn			
lookn	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Didn't look	0 0.00	4 2.63	4
Looked one way	72 40.91	110 72.37	182
Looked both ways	104 59.09	38 25.00	142
Total	176	152	328
Frequency Missing = 11			

Statistics for Table of lookn by xwalkn

Statistic	DF	Value	Prob
Chi-Square	2	41.0739	<.0001
Likelihood Ratio Chi-Square	2	43.6690	<.0001
Mantel-Haenszel Chi-Square	1	40.8990	<.0001
Phi Coefficient		0.3539	
Contingency Coefficient		0.3336	
Cramer's V		0.3539	
WARNING: 33% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Fisher's Exact Test	
Table Probability (P)	3.397E-11
Pr <= P	2.311E-10

Effective Sample Size = 328
Frequency Missing = 11

INTand37_p01 Pedestrian behavior stratified by crosswalk type

The FREQ Procedure

Table of gaitn by xwalkn			
gaitn	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Slow	5 2.69	1 0.65	6
Normal	98 52.69	137 89.54	235
Fast	13 6.99	9 5.88	22
Ran	70 37.63	6 3.92	76
Total	186	153	339

Statistics for Table of gaitn by xwalkn

Statistic	DF	Value	Prob
Chi-Square	3	61.1279	<.0001
Likelihood Ratio Chi-Square	3	70.3046	<.0001
Mantel-Haenszel Chi-Square	1	50.4414	<.0001
Phi Coefficient		0.4246	
Contingency Coefficient		0.3909	
Cramer's V		0.4246	
WARNING: 25% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Fisher's Exact Test	
Table Probability (P)	7.543E-18
Pr <= P	1.088E-15

Sample Size = 339

INTand37_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Class Level Information		
Class	**Levels**	**Values**
xwalkn	2	0 1

Number of Observations Read	339
Number of Observations Used	339

INTand37_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Dependent Variable: lngap   Sum of gaps lane1-lane5

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	38.0806377	38.0806377	41.23	<.0001
Error	337	311.2644950	0.9236335		
Corrected Total	338	349.3451327			

R-Square	Coeff Var	Root MSE	lngap Mean
0.109006	31.11737	0.961059	3.088496

Source	DF	Type I SS	Mean Square	F Value	Pr > F
xwalkn	1	38.08063770	38.08063770	41.23	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
xwalkn	1	38.08063770	38.08063770	41.23	<.0001

INTand37_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Level of xwalkn	N	lngap	
		Mean	Std Dev
0	186	3.39247312	0.96520398
1	153	2.71895425	0.95598885

INTand37_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Class Level Information		
Class	Levels	Values
xwalkn	2	0 1

Number of Observations Read	339
Number of Observations Used	339

INTand37_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Dependent Variable: totyield Sum of yields

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	35.5147502	35.5147502	33.40	<.0001
Error	337	358.3318575	1.0632993		
Corrected Total	338	393.8466077			

R-Square	Coeff Var	Root MSE	totyield Mean
0.090174	84.64034	1.031164	1.218289

Source	DF	Type I SS	Mean Square	F Value	Pr > F
xwalkn	1	35.51475020	35.51475020	33.40	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
xwalkn	1	35.51475020	35.51475020	33.40	<.0001

INTand37_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Level of xwalkn	N	totyield	
		Mean	Std Dev
0	186	0.92473118	0.98898320
1	153	1.57516340	1.08028268

INTand37_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Class Level Information		
Class	Levels	Values
xwalkn	2	0 1

Number of Observations Read	339
Number of Observations Used	339

INTand37_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Dependent Variable: totexp   Sum of exposure for lanes (excludes no car or missing)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	47.147152	47.147152	5.71	0.0174
Error	337	2783.372022	8.259264		
Corrected Total	338	2830.519174			

R-Square	Coeff Var	Root MSE	totexp Mean
0.016657	93.14053	2.873894	3.085546

Source	DF	Type I SS	Mean Square	F Value	Pr > F
xwalkn	1	47.14715211	47.14715211	5.71	0.0174

Source	DF	Type III SS	Mean Square	F Value	Pr > F
xwalkn	1	47.14715211	47.14715211	5.71	0.0174

INTand37_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Level of xwalkn	N	totexp	
		Mean	Std Dev
0	186	2.74731183	2.34707829
1	153	3.49673203	3.40688966

INTand37_p01 Gaps and driver behavior stratified by crosswalk type

INTand37_p01 Pedestrian capture subset by marked crosswalk

The FREQ Procedure

capture	Frequency	Percent	Cumulative Frequency	Cumulative Percent

Frequency Missing = 153

INTand37_p01 Multiple Threat Lanes 1 and 2

The FREQ Procedure

Table of multhreat12 by xwalk_marking			
multhreat12(Multiple threat in lane 1 and 2 (1=yes 0=no))	xwalk_marking(MARKED vs. UNMARKED)		
Frequency Col Pct	MARKED	UNMARKED	Total
0	134 87.58	176 94.62	310
1	19 12.42	10 5.38	29
Total	153	186	339

Statistics for Table of multhreat12 by xwalk_marking

Statistic	DF	Value	Prob
Chi-Square	1	5.3215	0.0211
Likelihood Ratio Chi-Square	1	5.3301	0.0210
Continuity Adj. Chi-Square	1	4.4593	0.0347
Mantel-Haenszel Chi-Square	1	5.3058	0.0213
Phi Coefficient		-0.1253	
Contingency Coefficient		0.1243	
Cramer's V		-0.1253	

Fisher's Exact Test	
Cell (1,1) Frequency (F)	134
Left-sided Pr <= F	0.0174
Right-sided Pr >= F	0.9939
Table Probability (P)	0.0113
Two-sided Pr <= P	0.0305

Sample Size = 339

INTand37_p01 Multiple Threat Lanes 1 and 2

INTand37_p01 Multiple Threat Lanes 4 and 5

The FREQ Procedure

Table of multhreat45 by xwalk_marking			
multhreat45(Multiple threat in lane 4 and 5 (1=yes 0=no))	xwalk marking(MARKED vs. UNMARKED)		
Frequency Col Pct	MARKED	UNMARKED	Total
0	96 62.75	154 82.80	250
1	57 37.25	32 17.20	89
Total	153	186	339

Statistics for Table of multhreat45 by xwalk_marking

Statistic	DF	Value	Prob
Chi-Square	1	17.4313	<.0001
Likelihood Ratio Chi-Square	1	17.4798	<.0001
Continuity Adj. Chi-Square	1	16.4110	<.0001
Mantel-Haenszel Chi-Square	1	17.3798	<.0001
Phi Coefficient		-0.2268	
Contingency Coefficient		0.2211	
Cramer's V		-0.2268	

Fisher's Exact Test	
Cell (1,1) Frequency (F)	96
Left-sided Pr <= F	2.506E-05
Right-sided Pr >= F	1.0000
Table Probability (P)	1.675E-05
Two-sided Pr <= P	3.799E-05

Sample Size = 339

TELand41_p01 Pedestrian characteristics stratified by crosswalk type

The FREQ Procedure

Table of agecat by xwalkn			
agecat(Age category 1=Child 2=Teen 3=Young Adult 4=Older Adult 5=Elderly)	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Teen	3 7.89	35 6.53	38
Young adult	16 42.11	226 42.16	242
Older adult	18 47.37	266 49.63	284
Elderly	1 2.63	9 1.68	10
Total	38	536	574

Statistics for Table of agecat by xwalkn

Statistic	DF	Value	Prob
Chi-Square	3	0.3212	0.9560
Likelihood Ratio Chi-Square	3	0.2929	0.9614
Mantel-Haenszel Chi-Square	1	0.0251	0.8740
Phi Coefficient		0.0237	
Contingency Coefficient		0.0237	
Cramer's V		0.0237	
WARNING: 25% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Fisher's Exact Test	
Table Probability (P)	0.0116
Pr <= P	0.7581

Sample Size = 574

TELand41_p01 Pedestrian characteristics stratified by crosswalk type

The FREQ Procedure

Table of female by xwalkn			
female(IND: 1=female 0=male)	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Male	28 73.68	308 57.46	336
Female	10 26.32	228 42.54	238
Total	38	536	574

Statistics for Table of female by xwalkn

Statistic	DF	Value	Prob
Chi-Square	1	3.8470	0.0498
Likelihood Ratio Chi-Square	1	4.0489	0.0442
Continuity Adj. Chi-Square	1	3.2077	0.0733
Mantel-Haenszel Chi-Square	1	3.8403	0.0500
Phi Coefficient		0.0819	
Contingency Coefficient		0.0816	
Cramer's V		0.0819	

Fisher's Exact Test	
Cell (1,1) Frequency (F)	28
Left-sided Pr <= F	0.9854
Right-sided Pr >= F	0.0344
Table Probability (P)	0.0198
Two-sided Pr <= P	0.0604

Sample Size = 574

TELand41_p01 Pedestrian behavior stratified by crosswalk type

The FREQ Procedure

Table of assertn by xwalkn			
assertn	xwalkn(IND: 1=marked 0=unmarked)		Total
Frequency Col Pct	Unmarked	Marked	
Waited on curb	8 24.24	158 30.74	166
Waited on street	17 51.52	168 32.68	185
Did not wait	8 24.24	184 35.80	192
Forced driver to yield	0 0.00	4 0.78	4
Total	33	514	547
Frequency Missing = 27			

Statistics for Table of assertn by xwalkn

Statistic	DF	Value	Prob
Chi-Square	3	5.1187	0.1633
Likelihood Ratio Chi-Square	3	5.1018	0.1645
Mantel-Haenszel Chi-Square	1	0.1992	0.6554
Phi Coefficient		0.0967	
Contingency Coefficient		0.0963	
Cramer's V		0.0967	
WARNING: 25% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Fisher's Exact Test	
Table Probability (P)	0.0023
Pr <= P	0.1786

Effective Sample Size = 547
Frequency Missing = 27

TELand41_p01 Pedestrian behavior stratified by crosswalk type

The FREQ Procedure

Table of lookn by xwalkn			
lookn	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Didn't look	0 0.00	5 0.98	5
Looked one way	13 40.63	249 48.73	262
Looked both ways	12 37.50	180 35.23	192
Looked more than 2 times	7 21.88	77 15.07	84
Total	32	511	543
Frequency Missing = 31			

Statistics for Table of lookn by xwalkn

Statistic	DF	Value	Prob
Chi-Square	3	1.6688	0.6439
Likelihood Ratio Chi-Square	3	1.8872	0.5962
Mantel-Haenszel Chi-Square	1	1.5431	0.2142
Phi Coefficient		0.0554	
Contingency Coefficient		0.0554	
Cramer's V		0.0554	
WARNING: 38% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Fisher's Exact Test	
Table Probability (P)	0.0111
Pr <= P	0.6167

Effective Sample Size = 543
Frequency Missing = 31

TELand41_p01 Pedestrian behavior stratified by crosswalk type

The FREQ Procedure

Table of gaitn by xwalkn			
gaitn	xwalkn(IND: 1=marked 0=unmarked)		
Frequency Col Pct	Unmarked	Marked	Total
Slow	3 7.89	7 1.31	10
Normal	21 55.26	452 84.49	473
Fast	2 5.26	15 2.80	17
Ran	12 31.58	61 11.40	73
Total	38	535	573
Frequency Missing = 1			

Statistics for Table of gaitn by xwalkn

Statistic	DF	Value	Prob
Chi-Square	3	24.5508	<.0001
Likelihood Ratio Chi-Square	3	17.9923	0.0004
Mantel-Haenszel Chi-Square	1	9.5758	0.0020
Phi Coefficient		0.2070	
Contingency Coefficient		0.2027	
Cramer's V		0.2070	
WARNING: 38% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Fisher's Exact Test	
Table Probability (P)	1.580E-06
Pr <= P	8.865E-05

Effective Sample Size = 573
Frequency Missing = 1

TELand41_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Class Level Information		
Class	**Levels**	**Values**
xwalkn	2	0 1

Number of Observations Read	574
Number of Observations Used	574

TELand41_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Dependent Variable: lngap   Sum of gaps lane1-lane5

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	6.2381450	6.2381450	4.83	0.0284
Error	572	738.5911233	1.2912432		
Corrected Total	573	744.8292683			

R-Square	Coeff Var	Root MSE	lngap Mean
0.008375	34.51073	1.136329	3.292683

Source	DF	Type I SS	Mean Square	F Value	Pr > F
xwalkn	1	6.23814496	6.23814496	4.83	0.0284

Source	DF	Type III SS	Mean Square	F Value	Pr > F
xwalkn	1	6.23814496	6.23814496	4.83	0.0284

TELand41_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Level of xwalkn	N	lngap	
		Mean	**Std Dev**
0	38	3.68421053	1.06809411
1	536	3.26492537	1.14089700

TELand41_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Class Level Information		
Class	Levels	Values
xwalkn	2	0 1

Number of Observations Read	574
Number of Observations Used	574

TELand41_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Dependent Variable: totyield Sum of yields

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	13.7133746	13.7133746	14.06	0.0002
Error	572	557.8406324	0.9752459		
Corrected Total	573	571.5540070			

R-Square	Coeff Var	Root MSE	totyield Mean
0.023993	96.07645	0.987545	1.027875

Source	DF	Type I SS	Mean Square	F Value	Pr > F
xwalkn	1	13.71337460	13.71337460	14.06	0.0002

Source	DF	Type III SS	Mean Square	F Value	Pr > F
xwalkn	1	13.71337460	13.71337460	14.06	0.0002

TELand41_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Level of xwalkn	N	totyield	
		Mean	Std Dev
0	38	0.44736842	0.72400420
1	536	1.06902985	1.00321529

TELand41_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Class Level Information		
Class	Levels	Values
xwalkn	2	0 1

Number of Observations Read	574
Number of Observations Used	574

TELand41_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Dependent Variable: totexp Sum of exposure for lanes 1-5 (excludes no car or missing)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	3.034234	3.034234	0.48	0.4877
Error	572	3599.934407	6.293592		
Corrected Total	573	3602.968641			

R-Square	Coeff Var	Root MSE	totexp Mean
0.000842	96.90415	2.508703	2.588850

Source	DF	Type I SS	Mean Square	F Value	Pr > F
xwalkn	1	3.03423420	3.03423420	0.48	0.4877

Source	DF	Type III SS	Mean Square	F Value	Pr > F
xwalkn	1	3.03423420	3.03423420	0.48	0.4877

TELand41_p01 Gaps and driver behavior stratified by crosswalk type

The GLM Procedure

Level of xwalkn	N	totexp	
		Mean	Std Dev
0	38	2.31578947	2.76175877
1	536	2.60820896	2.49025160

TELand41_p01 Gaps and driver behavior stratified by crosswalk type

TELand41_p01 Pedestrian capture subset by marked crosswalk

The FREQ Procedure

CAPTURE				
CAPTURE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
CC	5	4.85	5	4.85
NC	51	49.51	56	54.37
PC	47	45.63	103	100.00

Frequency Missing = 433

TELand41_p01 Multiple Threat Lanes 1 and 2

The FREQ Procedure

Table of multhreat12 by xwalk_marking			
multhreat12(Multiple threat in lane 1 and 2 (1=yes 0=no))	xwalk_marking(MARKED vs. UNMARKED)		
Frequency Col Pct	MARKED	UNMARKED	Total
0	493 94.63	34 97.14	527
1	28 5.37	1 2.86	29
Total	521	35	556
Frequency Missing = 2			

Statistics for Table of multhreat12 by xwalk_marking

Statistic	DF	Value	Prob
Chi-Square	1	0.4203	0.5168
Likelihood Ratio Chi-Square	1	0.4939	0.4822
Continuity Adj. Chi-Square	1	0.0654	0.7982
Mantel-Haenszel Chi-Square	1	0.4196	0.5172
Phi Coefficient		-0.0275	
Contingency Coefficient		0.0275	
Cramer's V		-0.0275	
WARNING: 25% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Fisher's Exact Test	
Cell (1,1) Frequency (F)	493
Left-sided Pr <= F	0.4412
Right-sided Pr >= F	0.8558
Table Probability (P)	0.2969
Two-sided Pr <= P	1.0000

Effective Sample Size = 556
Frequency Missing = 2

TELand41_p01 Multiple Threat Lanes 1 and 2

TELand41_p01 Multiple Threat Lanes 4 and 5

The FREQ Procedure

Table of multhreat45 by xwalk_marking			
multhreat45(Multiple threat in lane 4 and 5 (1=yes 0=no))	xwalk_marking(MARKED vs. UNMARKED)		
Frequency Col Pct	MARKED	UNMARKED	Total
0	400 76.63	33 91.67	433
1	122 23.37	3 8.33	125
Total	522	36	558

Statistics for Table of multhreat45 by xwalk_marking

Statistic	DF	Value	Prob
Chi-Square	1	4.3813	0.0363
Likelihood Ratio Chi-Square	1	5.3429	0.0208
Continuity Adj. Chi-Square	1	3.5589	0.0592
Mantel-Haenszel Chi-Square	1	4.3735	0.0365
Phi Coefficient		-0.0886	
Contingency Coefficient		0.0883	
Cramer's V		-0.0886	

Fisher's Exact Test	
Cell (1,1) Frequency (F)	400
Left-sided Pr <= F	0.0222
Right-sided Pr >= F	0.9943
Table Probability (P)	0.0165
Two-sided Pr <= P	0.0380

Sample Size = 558

APPENDIX A-3:
ADVISORY COMMITTEE

NAME	ORGANIZATION
Frank Markowitz	City of San Francisco DPT
Jeffrey Spencer	Caltrans
Maggie O'Mara	Caltrans
Jim Misener	PATH
Susan Shaheen	PATH/CCIT
Caroline Rodier	PATH/CCIT
Richard Haggstrom	Caltrans
Nancy Okasaki	MTC
Ken Kochevar	FHWA
Barb Alberson	CA DHS
Jason Patton	Oakland Pedestrian Safety Project
Ginny Mecham	CHP
Ken McGuire	Caltrans
Ted Link-Oberstar	Caltrans
Charlie Zegeer	UNC-CH
David Ragland	TSC
Jill Cooper	TSC
Meghan Mitman	TSC
Chris Congleton	TSC
Andrew Duszak	TSC

APPENDIX B:
FOCUS GROUP RESULTS

BERKELEY, OAKLAND, WALNUT CREEK, AND ALBANY

INTRODUCTION

Driver/pedestrian concerns and experiences at crosswalks, understanding of the right-of-way law at crosswalks, and opinions regarding countermeasure effectiveness were explored in five focus groups conducted in Northern California between October 2005 and March 2006. The focus groups were held in three different locations and among two different cohorts: adults over the age of 65 (senior) and adults 65 years of age or younger (adult). There were three senior groups and two adult groups including two senior groups in Walnut Creek; one senior group and one adult group in Berkeley; and one adult group in Oakland. Each focus group consisted of 10 – 12 participants. In total, 55 persons participated, including 22 adults and 33 seniors. Forty-one of the participants were women and 14 were men. This summary describes the general findings from all five focus groups.

PARTICIPANT SURVEY

At the beginning of each focus group a questionnaire was administered that explored the demographic profiles of focus group participants, their primary mode of travel, and their knowledge of the right-of-way at crosswalks (see Appendix F). It should be noted that all of the adult participants live in an urban environment, while the seniors live in either a suburban environment (Walnut Creek) or an urban environment (Berkeley). This section breaks down these differences for the more informative categories (income, automobile ownership rates, and travel mode).

DEMOGRAPHICS

Aggregate demographic attributes of all participants in the five focus groups are provided below. Participants were asked their gender, age (5 year range), marital status, education, and income. Table 1 shows the results of the survey.

Table 1

DEMOGRAPHICS

GENDER			*AGE*	
male	25%		18-29	4%
female	75%		30-39	10%
			40-49	11%
			50-59	8%
			60-64	5%
MARITAL STATUS			65-69	5%
single	38%		70-74	13%
married	29%		75-79	24%
separated	0%		80-84	11%
divorced	16%		85-89	4%
widowed	11%		90 and older	0%
declined to respond	5%		declined to respond	5%
EDUCATION			*INCOME*	
grade school	2%		under $10,000	13%
high school degree	18%		$10,000 - $19,999	9%
associates degree	15%		$20,000 - $49,999	40%
bachelor degree	38%		$50,000 - $79,999	15%
master's degree	18%		$80,000 - $109,999	4%
PhD or higher	4%		more than $110,000	0%
declined to respond	5%		declined to respond	20%

THE AVERAGE WALNUT CREEK SENIOR PARTICIPANT:

- Was between 75 and 79 years old and married
- Had a Bachelor's degree and an income between $20,000 to $79,999

Table 2

AUTOMOBILE OWNERSHIP

Aggregate Automobile Ownership	
Own	78%
Borrow	4%
No access	18%
Senior Automobile Ownership	
Own	88%
Borrow	3%
No access	9%
Adult Automobile Ownership	
Own	64%
Borrow	4%
No access	32%

THE AVERAGE BERKELEY SENIOR PARTICIPANT:

- Was between 75 and 79 years old and divorced
- Had a Master's degree and an income under $20,000

THE AVERAGE ADULT PARTICIPANT:

- Was between 40 and 49 years old and single
- Had a Bachelor's degree and an income between $20,000 to $49,000

PRIMARY TRAVEL MODE AND AUTO OWNERSHIP

Participants were asked whether they owned a vehicle, could borrow a vehicle, or did not have access to a vehicle whenever they needed it. Participants were also asked how many trips they had made the previous week by either driving, walking, or by transit. Individual trips were added to determine their primary mode of travel. Tables 2-3 show the percentage of participants for each category of automobile ownership and primary travel mode.

Table 3

PRIMARY TRAVEL MODE

Aggregate Travel Mode	
Drive	44%
Walk	41%
Transit	15%
Senior Travel Mode	
Drive	48%
Walk	40%
Transit	12%
Adult Travel Mode	
Drive	37%
Walk	42%
Transit	21%

When income[1] is broken down by location, the results of the analysis indicate that only 9% of senior participants in Walnut Creek make less than $20,000 compared with 60% of seniors in Berkeley. 18% of the adult participants made less than $20,000. Rates of automobile ownership and travel mode are not surprising once the analysis accounts for location; the seniors that were located in the urban environment had a 70% ownership rate compared with the seniors that were located in the suburban environment who had a 96% ownership rate. Likewise, the travel mode of seniors in the suburban environment versus seniors in the urban environment is much different: 68% of the Walnut Creek seniors drive as their primary mode, while 21% of the Berkeley seniors drives as their primary mode; 28% of the Walnut Creek seniors walk as their primary mode, while 57% of the Berkeley seniors walk as their primary mode; and 4% of the Walnut Creek seniors take transit as their primary mode, while 22% of the Berkeley seniors take transit as their primary mode.

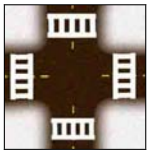
R GHT-OF-WAY

There were two qu stions on he survey to assess knowledge of pedestrian igh -of-way at both marked and unmarked crosswalks. The first question asked when pedestrians trying to cross the street have the right of way. The second question asked when it is illegal to cross the street in California.[2] Tables 4-5 show the percentage of participants who responded positively (checking the box) to the specific section of the question. The questions appeared as follows:

[1] 30% of Walnut creek seniors, 20% of Berkeley seniors, and 9% of adults did not identify their income.

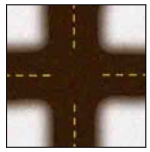
[2] the second question was not asked of the Walnut Creek participants (see methodology).

1) When do pedestrians trying to cross the street have the right of way (check all that apply)?



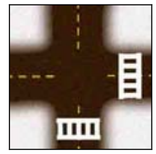
At intersections with a marked crosswalk (note: correct)

❑



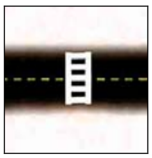
At intersections *without* a marked crosswalk (note: correct)

❑



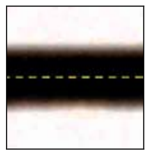
Only in the marked crosswalk in this situation (note: incorrect)

❑



Midblock with a marked crosswalk (note: correct)

❑



Midblock *without* a marked crosswalk (note: incorrect)

❑

When the pedestrian is in the street (note: correct)

❑

When the Pedestrian is on the curb (note: correct, but requires additional information)

❑

2) Which of the following, if any, are illegal in California:

Crossing midblock between two signalized intersections (note: illegal)	Crossing midblock if there's no signal at the intersection (note: not illegal)	Crossing at an intersection with no marked crosswalk (note: not illegal)	Stepping out in front of a vehicle, even in a marked crosswalk (note: illegal)
❑	❑	❑	❑

SYNTHESIS OF FOCUS GROUP DISCUSSIONS

EXPERIENCES, CONCERNS, AND CONFLICTS

DRIVER/PEDESTRIAN BEHAVIOR: Several participant concerns came up repeatedly in the focus groups including: aggressive/speeding drivers; drivers who don't watch for pedestrians or deliberately ignore the pedestrian (especially when turning); drivers who speed up to make the light; and drivers who are distracted (e.g., music, cell phones). Specific concerns about drivers were: drivers who don't know the right-of-way rules; drivers who ignore the law because another driver did; drivers who don't respect the crosswalks without a light; drivers who honk their horn at pedestrians in the crosswalk; drivers who stop their vehicle in the middle of a crosswalk; and drivers who edge out into the crosswalk when making a turn Other comments about drivers were: older drivers have slow reaction times; drivers lose control on windy roads; and drivers don't recognize the weight of their vehicles; Participants were also concerned about pedestrians who don't make drivers aware of their presence, who fail to look right or left before stepping out into the crosswalk, who assert their right-of-way, and who don't recognize the dangers of their actions.

Table 4

PEDESTRIAN RIGHT-OF-WAY
(PERCENT OF RESPONDENTS SELECTING EACH OPTION)

marked crosswalk at the intersection	100%
unmarked crosswalk at the intersection	56%
Two marked & two unmarked crosswalks at the intersection	49%
midblock-marked crosswalk	75%
midblock-unmarked crosswalk	3%
Pedestrian in street	47%
Pedestrian on curb	20%

Table 5

ILLEGAL CROSSING
(PERCENT OF RESPONDENTS SELECTING EACH OPTION)

midblock (no marked crosswalk) w/ signal at the intersection	81%
Midblock (no marked crosswalk) w/ no signal at the intersection	56%
unmarked intersection	25%
The pedestrian steps in front of vehicle	41%

PHYSICAL ATTRIBUTES: The concerns that came up the most often were: signals that don't allow enough time for pedestrians to cross the street; potholes/uneven pavement; crosswalk markings that are faded or difficult to see; obstructions (e.g., tree branches, barriers, and parked cars) that block the driver's view, lack of lights at night, and the inability of drives to see pedestrians when there are cars in adjacent lanes. Other concerns were: unmarked crosswalks lack of curb cutouts for wheelchairs, and a lack of multi-lingual signs and signal devices. Participants would like to see: separate lights for vehicles turning and pedestrians c ossing; more islands in the middle of the crosswalks; fewer lanes to cross; and signs, clearer markings, and in-pavement flashing lights that alert drivers sooner about crosswalks.

OTHER FACTORS: Other factors of concern to the participants were: the effects of weather and vehicle weight on the ability of drivers to stop, lack of security/police enforcement, and bicyclists who don't pay attention to pedestrians, "whip through" the crosswalk, and ignore traffic signals.

CROSSWALK RIGHT-OF-WAY

MARKED CROSSWALK: There was little d scussion since all but one person agreed that the pedestrian has the right-of-way when an intersection has four marked crosswalks. The one person who disagreed said the driver would have the right-of-way if completing a left turn.

UNMARKED CROSSWALK: Most of the participants agreed that pedestrians have the right-of-way at the intersection with four unmarked crosswalks. However, several said it depended on whether or not there was a stop sign in the intersection and whether or not the pedestrian indicates they want to cross the street (by signaling to/making eye contact with the driver or by stepping into the street).

MARKED AND UNMARKED CROSSWALK: Once again, while most participants agreed that the pedestrian has the right-of-way in any of the crosswalks when there are two marked and two unmarked crosswalks, their answers depended on whether or not there was a stop sign and whether or not the pedestrian has already stepped into the intersection. A few respondents said the pedestrian would only have the right-of-way in the marked crosswalks in this situation, while a few people said they would go out of their way to cross in the marked crosswalk. One person said that the pedestrian could only cross in an unmarked area when it appeared safe.

YIELDING THE RIGHT-OF-WAY: Approximately one-half of the participants indicated that drivers would typically yield to them in a crosswalk. They felt drivers were more likely to yield the right-of-way when: the driver is courteous, alert, has an unobstructed view, knows the law and wants to avoid getting a ticket, the pedestrian acknowledges the driver; there are traffic calming barriers, caution/stop signs, police patrol, flashing lights, and traffic signals with beeping/ chirping. Responses for situations in which drivers were unlikely to yield to a pedestrian were when drivers were: in a hurry/impatient; aggressive; not aware of the right-of-way; distracted (e.g., cell phone, radio, passengers/kids); rude; have a slow reaction time/can't stop in time; trying to make the light; intoxicated; unfamiliar with the area; don't see pedestrians; have the sun in their eyes; or when there is a lack of police enforcement. Participants felt drivers were more likely to yield to: children, the elderly, disabled persons, pregnant women, mothers with strollers, and animals.

EDUCATIONAL COUNTERMEASURES

SCHOOL CAMPAIGNS: All of the 22 participants indicated that school campaigns would be effective for educating people about crosswalk safety. Comments included: kids listen, kids can share the knowledge with each other and their parents, school campaigns educate kids early, and learned behavior when people are very young stays with them. Suggestions were to assign homework and have an ongoing discussion, design a program where kids actually practice crossing the street, and that adults need to learn how to cross the street also.

DRIVER'S MANUAL: 12/22 said the driver's manual would be effective for educating people about crosswalk safety. While one person said that reading makes people think, others said nobody reads the driver's manual, people read it but don't retain it, it won't be seen by pedestrians who don't drive, drivers only have to renew their license every 5-6 years, and "the last thing drivers think about when taking their test is pedestrians."

RADIO: 15/22 felt that the radio would be an effective educational medium. Comments included: people listen to the radio when they are driving, repetition helps, and radio can have a positive impact. Other respondents countered that people tend to channel surf when there are commercials, that not all stations have announcements, and that some people don't listen to the radio.

PRINT: 9/22 thought print is a good educational medium. Comments included: that the print needs to be big and that people receive a lot of junk mail and may put it in the recycling bin without reading it. Participants thought newspapers would be most effective and that insurance companies could mail something out that requires a response.

TV: 20/22 thought TV was an effective educational medium. While one person said parents watch TV a lot, another said that people might channel surf during advertisements. Suggestions were to have multilingual advertisements, and to run the spots during Sesame Street, Oprah, and soap operas.

BILLBOARDS: 11/22 thought billboards were effective. Comments included: billboards are an eye-catcher, especially if the message is emotional (e.g., with a body, a kid), advertisers only have about 5 seconds to catch someone's attention, people are driving too fast to see them, people only notice billboards when they are changing lanes, adults are conditioned to overlook billboards, children are more cognizant and would remember billboard messages better, and that billboards may dangerously distract drivers. Opinion was mixed regarding whether highway billboards or transit billboards were more effective. Some participants said that transit billboards are really visible and people stop to read them but they don't work for people with a visual disability. One person suggested that signs should be on the roads where people drive while another person suggested that advertisements on public transportation should utilized to warn pedestrians to be more careful and cautious.

OTHER IDEAS: Additional methods/media suggested for educational campaigns included: the internet, focus groups, public service announcements, the morning weather/traffic report, the DMV (online and when renewing a license), high school, driving school, movie theaters, the 511 recording, children's websites, shopping bags, milk cartons, night lights, and electronic displays on the road.

ENGINEERING COUNTERMEASURES[3]

YIELD SIGN: 16/23 participants felt the yield sign was effective. Reasons were: drivers are familiar with it, its message is clear and powerful with little text, simple graphics, and bright colors. Concerns about the yield sign were: seeing it might give pedestrians a false sense of security and cause them to be less cautious, drivers might knock the sign over, and "the sign reinforces the misconception that pedestrians have the right-of-way in the crosswalk." Suggestions included: the symbol of the person walking should be in both directions, blinking lights would make the sign more effective, the sign should be placed further upstream, and it could be more effective if it were posted everywhere.

STENCILED CROSSWALK: 15/23 participants felt the stenciled crosswalk would be effective. A few people said it counters people who just walk out into the street and tells people to look. Others said it should be in a more universal language, the printing is confusing, and it may be difficult to see if there are several people in the crosswalk.

RAISED CROSSWALK: 3/23 participants felt the raised crosswalk was effective. Comments included: the raised crosswalk is attractive, drivers have to slow down for the raised crosswalk, and pedestrians are higher than the roadway. Suggestions were to add eye-catching stripes, stenciling, a pedestrian crossing sign, or lights. Several respondents worried about the cost-effectiveness of the raised crosswalk and one person said that funds would be better spent on speed bumps.

VIVID STRIPING: 47/55 participants felt that vivid striping was an effective engineering countermeasure. Comments included: that vivid stripes are more visible from far away, drivers are more aware of the crosswalk and will pay more attention to pedestrians, the zebra design is asymmetric making the lines stand out, and the hatch marks send a prohibitive message. Others thought vivid striping might be more effective with certain types of road/pavement and if the stripes were a different color.

BULB-OUT: 18/55 participants thought the bulb-out design was effective. Participants were told the purpose of the bulb-out is to extend the curb and make it a shorter distance to cross the street. Comments included: that pedestrians can get across the shorter distance faster, the bulb-out is visible, it makes pedestrians more visible especially when there are parked cars, and it's great for small neighborhoods. Other comments were: it would back up traffic, drivers may be scared of bumping into it, it's unsafe for the driver, it cuts out parking spaces, it funnels bicyclists in with drivers creating more chaos, and that it's confusing. Suggestions were to add a sign and lights to the design and that stripes would better define the crosswalk.

FLASHING BEACON: 30/55 participants thought the flashing beacon was effective. One person thought it offers a lot of visibility. Some people thought drivers would be more aware of the beacon if it were flashing while others thought that drivers would be focused on the beacon/lights and not the pedestrians. Other comments were: it would be more useful in the vicinity of schools; rural areas are more apt to have this instead of lights; redundancy of the device in multiple locations would detract from its value; it would blight the neighborhood; people tend to ignore signs with clutter; it would only be effective in the dark; it's unfamiliar, confusing, distracting, and dangerous; it might cause false confidence in pedestrians; it's expensive; the sign shouldn't be too high up; and it may be difficult to see it at night.

IN-PAVEMENT LIGHTING: 47/55 participants thought in-pavement lighting is an effective engineering countermeasure. Comments included: that it would be good at night, it's more visible, the blinking lights remind drivers that there are pedestrians crossing, drivers will see it ahead because they are looking at the road, cars will slow down for it, it's emotionally satisfying, and it's good because it starts up automatically. One person said in-pavement lighting is needed where there is heavy traffic while another person said it should be on every street. Other comments were: it's more of a mild warning or yield device, it won't work in the snow, drivers may not see the lights during the day or when it's raining, pedestrians may be less cautious, and it may be costly.

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[3] Pictures of countermeasures used in the focus groups are included in the appendix.

ROUNDABOUT: 9/22 participants felt the roundabout was effective. Comments included: that it creates anxiety because there is too much going on, the driver has to look in three or four directions, it's confusing, pedestrians don't know when they have the right-of-way, drivers will do "doughnuts" around them, drivers don't know how to use them and may go the wrong way or avoid them by going on other streets, it could be a problem for merging, it might be best in a small town, it shouldn't be used in commercial areas, and that they're expensive

ANGLED CROSSWALK: 8/21 participants thought the angled crosswalk would be effective. Most of the participants had never seen an angled crosswalk but were told that the purpose of the angled crosswalk is to allow pedestrians to see on-coming traffic before they cross the street. Those who liked it said the island makes it safer to cross the four lanes and that it shortens the period of time the pedestrian is in the street. Other comments included: it will take too long to cross the street, people will jay-walk to avoid going out of their way, a vehicle's headlights would be too bright for pedestrians to see the crosswalk, it penalizes pedestrians, it's difficult for those in wheelchairs, the disabled and people with strollers, it would be difficult to teach people how to use them, it needs lights, and there are too many signs.

ADVANCED YIELD MARKING: 1/22 participant thought the advanced yield marking were effective. Participants were told the purpose of the yield marking is to stop traffic before the crosswalk so that pedestrians in the crosswalk would be in the driver's line of sight (i.e., when there are other vehicles to the driver's right or left). Comments included: drivers would stop before the actual crosswalk, drivers won't see it, the markings and sign are unfamiliar and confusing, and the pedestrian may think they should cross at the yield markings. Participants said that the sign would be better if it said "yield here," and that people would need to be educated about it.

LANE REDUCTION / ROAD DIET: 14/32 participants though the lane reduction / road diet engineering countermeasure was effective. Comments included: it's a good way to slow drivers down, the median is a good part of the design, and it's a great countermeasure if people know how to use it. Others said it doesn't work well for pedestrians, reducing the lanes will confuse people and make drivers mad, it backs up traffic when drivers have to turn left, there should either be a left turn lane or a median but not both, and delivery trucks park in the turn lane.

COUNT DOWN SIGNAL CROSSING: 38/44 participants said the countdown signal is effective. Comments included: pedestrians have more control and can pace themselves and drivers know how much time pedestrians have left to cross the street. However some respondents thought that drivers may pay more attention to the signal than the pedestrians, the countdown may act as a "pedestrian pacifier" and some pedestrian may not be able to see the countdown. Suggestions were to provide more time for seniors, the disabled/ wheelchairs, and pregnant women, a camera or sensor would be better than buttons, it's important to have both the symbol and the countdown in the signal, the beeping/chirping sound is highly effective for helping pedestrians cross the street safely but pedestrians may not know which beep goes with which crossing, and traffic signal designers need to better understand pedestrian impairments.

OTHER IDEAS: Additional suggestions for engineering countermeasures were: Braille signs at crosswalks, lights that hold on yellow to clear the intersection, the flashing hand, separate lights for cars and pedestrians, talking/chirping/ beeping signals, camera enforcement, speed indicator devices, motion-sensitive signals, multiple paint stripes, protective right turns, traffic calming devices, signs that say "yield to pedestrians," and signs that say "fine."

ENFORCEMENT COUNTERMEASURES:

COMMUNITY ENFORCEMENT: 16/32 participants thought community enforcement would be effective. Participants said: it could be more effective if the community turned people in, drivers will be more cautious if community enforcers are actually on the side of the road (as in the picture), and lawn signs give the impression that people care and may be watching for speeding drivers. Other comments included: it's "big brother," people know they won't get in trouble, it won't work on young people, and the effectiveness would depend on the number, location (e.g., residential areas), type, and brightness of signs that were posted.

POLICE WARNINGS: 43/55 participants indicated that police warnings are effective. Comments included: drivers realize they are not invisible and will think they may get a ticket the next time; warnings startle people, promote awareness and explain the law, and may stay in the driver's consciousness longer than actually getting a ticket. Others said that warnings do nothing for habitual "scofflaws," some drivers may not read the warning, and that too many signs that say police are patrolling is "like crying wolf." Some people felt warnings might be more effective if the person knew a second incident would result in a ticket or if drivers actually saw people getting a ticket. One person said that warnings should be given over and over to be effective while another person said there should be a limit on how many warnings are given out. Suggestions were to tell people what the fine would be, to give drivers something to read or sign and return to the DMV, and to use positive reinforcement for those who obey the law.

FINES: 51/55 participants thought fines were an effective countermeasure. Comments included: it's better to hit someone in the pocket and the expense and realness of fines would remind drivers to slow down. Others said that tickets were a slight deterrent only, once a person gets a citation they don't think about it again, fines aren't effective for rich people, and giving out tickets may drain police resources. Suggestions were to tie the fine amount to income, make the infraction a city ordinance so it goes on the record, and conduct sting operations in multiple locations.

OTHER IMPRESSIONS

Other comments were fines should be spent on more police enforcement of pedestrian safety, there needs to be better lighting at night, crosswalks are just painted lines and it's the drivers you have to worry about, there needs to be increased police presence on the streets, there needs to be more emphasis on the driver, there needs to be more focus on bicyclists who break the law, crosswalks need to be more consistent, the crosswalk is more effective when the crosswalk is used frequently or when there are a lot of people in the crosswalk at one time, and mid-block crosswalks avoid cars making right hand turns.

CONCLUSIONS

All of the participants understood that the pedestrian has the right-of-way in a marked crosswalk, while approximately half of the participants thought the pedestrian has the right-of-way in an unmarked crosswalk or when there are both marked and unmarked crosswalks in the intersection. At mid-block, 75% of participants felt the pedestrian has the right-of-way in a marked crosswalk, while only 3% thought pedestrians have the right-of-way when there is no marked crosswalk mid-block. However, if there is no signal at the intersection, 81% of participants thought the pedestrian could legally cross the street mid-block without a marked crosswalk. Forty-one percent (41%) of participants thought it was illegal for pedestrians to step out in front of a vehicle. Primary concerns of participants were: driver behavior (e.g., aggressive or distracted drivers who don't give pedestrians the right-of-way), and inadequate signal timing to cross the street (especially for the disabled and senior population). Participants felt school campaigns were an effective educational countermeasure, while print ads were thought to be the least effective of those countermeasures presented. Vivid-striping, in-pavement lighting, and the countdown signal were thought to be the most effective engineering countermeasures, while raised crosswalks and advanced yield-marking were thought to be the least effective of those countermeasure presented to participants. Fines were thought to be the most effective enforcement countermeasure.

METHODOLOGY AND STUDY LIMITATIONS

The focus group research methodology allows for detailed, in-depth exploration of relatively new research areas, but its small, non-random sample limits generalizations to the larger population.

Due to lessons learned in the two Walnut Creek focus groups and changes in the scope of the project as requested by the client, there were several changes to both the questionnaire and the protocol for the Berkeley and Oakland focus groups. First, questions regarding trip purpose were dropped for the Berkeley and Oakland questionnaires due to participant confusion and inconsistencies with regard to how Walnut Creek participants ranked their choices. Second, the questionnaire graphics that were confusing to the Walnut Creek participants were dropped from the questionnaire for the Berkeley and Oakland participants. Third, the segregation of Walnut Creek participants' travel mode for trips made within their gated senior community and for those made outside the gated community did not apply to participants living in Berkeley and Oakland. Next, there was a request from the client to drop specific countermeasures that were used in Walnut Creek and add other countermeasures to the protocol for Berkeley and Oakland. Finally, there was a question added to the Berkeley and Oakland questionnaire regarding right-of-way mid-block of an intersection.

Given the confusion in the Walnut Creek questionnaire, feedback regarding trip purpose is not included in this report. It is possible that eliminating the graphic of the curb image from the Berkeley and Oakland questionnaire resulted in a different interpretation of the question and different answers. It is also possible that the Walnut Creek participants were able to recall more trips since they were asked to categorize their trips by whether or not they were made within the Rossmoor community. While it would have been helpful to have feedback from each of the participants for all of the countermeasures, it is not thought to have an effect on the results since feedback is reported as a percentage of those persons who were shown the countermeasure. The same is thought to be true regarding the questions about mid-block crosswalks.

Additional comments regarding specific methodology for each focus group is included in the relevant focus group summaries, which can be found in the appendix.

APPENDIX B-1:
FOCUS GROUP SUMMARIES

WALNUT CREEK: PEDESTRIAN FOCUS GROUP

OCTOBER 19, 2005, 10:00 AM – 12:00 PM
ROSSMOOR, GATEWAY CLUBHOUSE, MULTI-PURPOSE ROOM #3

Driver/pedestrian concerns and experiences at crosswalks, understanding of the right-of-way law at crosswalks, and opinions regarding countermeasure effectiveness were explored in a focus group conducted on October 19, 2005 at the Rossmoor Senior Adult Community in Walnut Creek, California. The participants in the focus group were Rossmoor residents who primarily drive as their mode of travel and were between the ages of 65 and 84. This summary describes the findings from the focus group. Cynthia McCormick, a graduate student researcher from the

BACKGROUND SURVEY RESULTS

At the beginning of the focus group, PATH researchers administered a survey that explored the socio-demographic attributes of focus group participants, travel patterns, and knowledge of right-of-way.

SOCIO-DEMOGRAPHIC ATTRIBUTES[1]

- Nine participants were women, and three were men.
- Four individuals were single, four were married, two were widowed, and one was divorced.
- Two individuals were between the ages of 70 and 74, and nine were between the ages of 75 and 84.
- One person had a high school degree, one had an associates degree, six had a bachelor's degree, one had a master's degree, one had a J.D., and one had a Ph.D.
- One person had an income in the $10,000 - $19,999 range, four in the $20,000 - $49,000 range, one in the $50,000 - $79,000 range, and two were in the $80,000-$109,000 range. Four declined to respond.

Participants' responses to questions about their travel patterns indicated that they use the automobile as their primary commute mode and use walking and transit as supplemental modes:

- Eleven of the participants owned an automobile, while one participant did not have access to a vehicle whenever she needed it.
- Nine participants indicated driving was their primary mode of travel outside Rossmoor with five of these individuals stating driving was their only mode of travel outside Rossmoor, two indicated walking was their primary mode of travel outside Rossmoor, and one person indicated transit was their only mode of travel outside Rossmoor.
- Seven persons indicated walking was their primary mode of travel within Rossmoor, four persons indicated driving was their primary mode of travel within Rossmoor, and one person split their travel time within Rossmoor evenly between driving and walking.
- Four persons stated they use a mode of travel other than driving or walking outside Rossmoor (e.g., BART) and three indicated they use another form of travel within Rossmoor (e.g., the shuttle).

[1] One person declined to respond to any of the socio-demographic questions.

Participants were also asked when pedestrians trying to cross the street have the right-of-way (meaning drivers legally must yield to pedestrians)? However, participants had difficulty understanding the graphics associated with this question. For example, in part four of the question, they wanted to know if there was a marked crosswalk at the intersection with the curb before answering the question.

- All 12 participants felt the pedestrian has the right-of-way at any crossing within a four-way intersection when all four crosswalks are marked.
- Six individuals felt the pedestrian has the right-of-way at any crossing within a four-way intersection when there are no marked crosswalks.
- Four individuals felt the pedestrian has the right-of-way only at the marked crossing within a four-way intersection when two crossings are marked and two crossings are unmarked. However, one individual contradicted herself in part two of this question by indicating that the pedestrian has the right-of-way at any crossing within a four-way intersection when two crossings are marked and two crossings are unmarked (the graphic is the same for part two and three).
- Four individuals felt the pedestrian has the right of way when the pedestrian is on the curb at the intersection.

LIKES AND DISLIKES OF WALKING

Participants were asked what they liked most and least about walking. Many participants enjoyed socializing (2) and viewing nature/scenery (3). Others like the exercise, walking downtown, walking their dog, the meditative experience, a sense of physical well-being afterwards, the lack of automobile hassles, walking can be faster than traffic in the city, and the adventure of walking. Dislikes included the irregularity in the pavement (2), danger from cars (2), car fumes (2), walking alone, walking in the rain, physical disability/discomfort, poor lighting, sidewalks that are too close to passing cars, no sidewalk, drivers who make California stops, traffic, crosswalk right-of-way violators, fear for pets, and that walking takes too long.

PEDESTRIAN EXPERIENCES AND CONCERNS

Participants were then asked to share some of their experiences and concerns at crosswalks. Participants were concerned with a lack of signs for pedestrians, drivers who don't see them, drivers who are looking where they are turning rather than in the crosswalk, drivers who make California stops or don't stop when going downhill, older drivers with slow reaction times, and drivers who lose control on windy roads. Participants also felt that pedestrians need to understand the importance of stopping at the crosswalk, make drivers aware of them, and the danger to drivers when pedestrians are unaware at the crosswalk. One person felt it was safer to walk in the middle of the road rather than at a crosswalk. One person indicated that some drivers would signal for pedestrians to cross.

Many of the participants experienced situations where there were multiple lanes of roadway with drivers in the far right lane and drivers in the lanes to the left, where the driver in the left hand lane did not see the pedestrian crossing the street in the crosswalk. One individual witnessed a driver hit a person in a wheelchair because they continued driving through the crosswalk despite the fact that the driver in the right lane had stopped.

UNDERSTANDING OF THE RIGHT-OF-WAY LAW

Using power point and a projector, focus group participants were shown three different photo scenarios: an intersection with four marked crosswalks, an intersection with four unmarked crosswalks, and an intersection with two marked and two unmarked crosswalks. They were then asked when the pedestrian has the right-of-way under each of these scenarios.

For the intersection with four marked crosswalks, all twelve of the focus group participants agreed the pedestrian has the right-of-way at all of the crossings. Eleven of the participants indicated that pedestrians have the right-of-way at the intersection with four unmarked crosswalks, while one did not think the pedestrian has the right-of-way. One individual stated that pedestrians have the right-of-way "no matter what," and another person said drivers should have the courtesy to stop. Another individual stated that pedestrians have to initiate the action with another person stating the pedestrian should make eye contact with the driver. Another individual indicated a person is not considered a pedestrian unless they make a move to cross. Eleven of the participants felt the pedestrian has the right-of-way at the intersection with two marked and two unmarked crosswalks. One individual stated they would not cross anywhere other than the marked section of the intersection.

YIELDING THE RIGHT-OF-WAY

Participants were asked if drivers typically yield to them when crossing the street. All of the participants indicated that drivers do not typically yield to them. Participants were then asked when drivers are less likely and more likely to yield to a pedestrian at a crosswalk. Reasons given for failing to yield to a pedestrian were drivers ignore or don't see pedestrians, drivers are in a hurry or inpatient, pedestrian doesn't make the driver aware of him/her, drivers going with flow of traffic, drivers who have never experienced walking, cars give drivers power, aggressive drivers, and drivers are not aware of the pedestrian right-of-way. Participants felt drivers were more likely to yield to a pedestrian if the driver is courteous, when the pedestrian raises his hand, makes eye contact with the driver, or steps off the curb, when an animal is crossing the road, or when the pedestrian is disabled, "beautiful," or a child. Eleven individuals thought the driver would be likely to stop at a crosswalk if going under 25 mph, while nine thought the driver would stop if going over 25 mph One person was unsure in either case

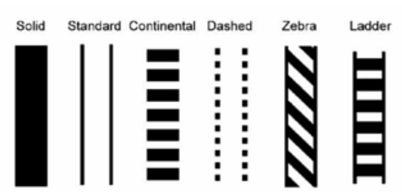
COUNTERMEASURES

EDUCATIONAL COUNTERMEASURES

Participants were asked whether billboards, radio, or TV was most effective for educational campaigns. Seven individuals preferred television while six liked billboards. No one chose radio as the most effective medium, stating listeners prefer music and will tune out the message if not interesting. One individual stated television advertisements must be very startling to be effective and can be counterproductive because we are inundated with advertisements, while another said that drivers couldn't see billboards when driving.

ENGINEERING COUNTERMEASURES

Using power point and a projector, the participants were then shown the following engineering countermeasures and asked to rate their effectiveness on a scale of low, medium, or high. If there was time, participants commented on the effectiveness of the print media.



YIELD SIGN		VIVID STRIPING	
LOW	0	LOW	0
MEDIUM	0	MEDIUM	1
HIGH	12	HIGH	11

Participants felt the yield sign was effective because it is bright yellow and drivers can't miss it because it is "in their face." One individual was concerned that pedestrians might be less cautious. Another thought drivers might knock the sign over. One individual thought the effectiveness of vivid striping would depend on the type of road/pavement. In addition to rating the effectiveness of vivid striping, participants were asked to pick the striping they found most effective. One person chose the ladder striping, five chose the continental striping, and five chose the zebra striping as most effective.

SIGNAL COUNTDOWN	
LOW	0
MEDIUM	0
HIGH	12

LIGHTED CROSSWALK	
LOW	1
MEDIUM	0
HIGH	11

FLASHING BEACON	
LOW	2
MEDIUM	1
HIGH	7

For the signal countdown, participants liked that the pedestrian has control and can pace themselves according to the countdown, but said it depends on if the pedestrian can see the countdown One person thought it was important to have both the symbol and the countdown in the signal Participants also felt the signal timing needed to be longer. Eight of the participants felt the beeping/chirping was highly effective for helping pedestrians cross the street safely, but one person asked how a person would know which beep goes with which crossing Another individual stated that t affic signal designers should better understand pedestrian imparities when crossing Two individuals have never seen the lighted crosswalk. None of the participants were familiar with the flashing beacon. One individual felt that drivers shouldn't be looking up at the beacon and another thought the beacon was too high

BULB-OUT	
LOW	1
MEDIUM	7
HIGH	4

RAISED CROSSWALK	
LOW	3
MEDIUM	8
HIGH	1

PAVEMENT STENCILING	
LOW	2
MEDIUM	1
HIGH	9

One individual commented on the lack of striping in the bu b-out crosswalk, stating stripes are more "eye catching," while another thought the design defined the crosswalk well. One individual liked that the crosswalk was mid-block, avoiding cars making right hand turns, and another felt it would centralize jaywalking. Another individual suggested adding lights to the bulb-out crosswalk. However, one concern with the bulb-out design is that it would cut out parking spaces. For the raised crosswalk, participants liked that drivers have to slow down for the raised crosswalk and that pedestrians are higher than the roadway While one person found the raised crosswa k to be attractive, another individual commented on the lack of striping in this crosswalk, stat ng the crosswalk is not eye catching without the stripes. Another individual suggested adding lights and a pedestrian crossing sign to the raised crosswalk. For the stenciled crosswalk, one individual commented that not everyone knows English. Another person felt the printing was confusing. Another liked the stenciling because "I do what I'm told."

WARNING		COMMUNITY ENFORCEMENT		FINE	
LOW	1	LOW	0	LOW	0
MEDIUM	5	MEDIUM	7	MEDIUM	0
HIGH	6	HIGH	3	HIGH	12

Participants were asked if they thought drivers were more likely to stop at a crosswalk if police regularly patrolled the area. Eleven individuals said yes, one said no. One person felt the police would have no effect, while others thought this concept would be more effective if you actually see someone getting a ticket or a patrol car at the scene. Another person thought that too many signs that say police are patrolling is "like calling wolf " Participants liked the concept of warnings stating it promotes awareness and explains the law, but that some drivers may not read the warning. Moreover, this type of enforcement needs to be done over and over to be effective For community enforcement, one individual felt the effectiveness would depend on the number, location, and type of signs community members posted For fines participants felt the expense and realness of fines would remind drivers to slow down, but worried about draining police resources.

Other devices that participants mentioned as effective are speed bumps, camera enforcement, and speed indicator devices.

FOCUS GROUP METHODOLOGY AND LIMITATIONS

Recruitment for the Walnut Creek focus groups consisted of community newspaper advertisements and a public service announcement on the Rossmoor community television channel. A 5-10 minute phone interview was used to screen for participants who regularly made trips by both driving and walking and who had varied opinions regarding the subject of crosswalk safety. There were no major challenges in this focus group.

FOCUS GROUP SUMMARY TWO

WALNUT CREEK: DRIVER FOCUS GROUP

OCTOBER 19, 2005, 2:00 – 4:00 PM
ROSSMOOR, GATEWAY CLUBHOUSE, MULTI-PURPOSE ROOM #3

Driver/pedestrian concerns and experiences at crosswalks, understanding of the right-of-way law at crosswalks, and opinions regarding countermeasure effectiveness were explored in a focus group conducted on October 19, 2005 at the Rossmoor Senior Adult Community in Walnut Creek, California. The participants in the focus group were Rossmoor residents who primarily drive as their mode of travel and were between the ages of 65 and 84. This summary describes the findings from the focus group. Cynthia McCormick, a graduate student researcher from the University of California Berkeley, facilitated the focus group with researchers assisting and taking notes.

BACKGROUND SURVEY RESULTS

At the beginning of the focus group, PATH researchers administered a survey that explored the socio-demographic attributes of focus group participants, travel patterns, and knowledge of right-of-way.

SOCIO-DEMOGRAPHIC ATTRIBUTES

- Eight participants were women, and three were men;
- One individual was single, five were married, four were widowed, and one was divorced;
- Five individuals were between the ages of 65 and 74, and six were between the ages of 75 and 84;
- Two persons had a high school degree, two had an associates degree, four had a bachelor's degree, and two had a master's degree;
- One person had an income in the $10,000 - $19,999 range, two in the $20,000 - $49,000 range, and five were in the $50,000 - $79,000 range. Three declined to respond.

Participants' responses to questions about their travel patterns indicated that they use the automobile as their primary commute mode and use walking and transit as supplemental modes:

- All of the participants owned an automobile
- Nine participants indicating driving was their only mode of travel outside Rossmoor and five persons indicated driving was their only mode of travel within Rossmoor.
- Only one person indicated all of their trips within Rossmoor were by walking, while another four persons indicated walking counted for at least half of their trips within Rossmoor.
- Only one person stated they use a mode of travel other than driving or walking outside Rossmoor (e.g., transit) and only two indicated they use another form of travel within Rossmoor (e.g., a golf cart).

Participants were also asked when pedestrians trying to cross the street have the right-of-way (meaning drivers legally must yield to pedestrians)? However, participants had difficulty understanding the graphics associated with this question. For example, in part four of the question, they wanted to know if there was a marked crosswalk at the intersection with the curb before answering the question.

- All 11 participants felt the pedestrian has the right-of-way at any crossing within a four-way intersection when all four crosswalks are marked.
- Nine individuals felt the pedestrian has the right-of-way at any crossing within a four-way intersection when there are no marked crosswalks.

- Five individuals felt the pedestrian has the right-of-way only at the marked crossing within a four-way intersection when two crossings are marked and two crossings are unmarked. However, three of these individuals contradicted themselves in part two of this question (above) by indicating that the pedestrian has the right-of-way at any crossing within a four-way intersection when two crossings are marked and two crossings are unmarked (the graphic is the same for part two and three).
- Only two individuals felt the pedestrian has the right of way when the pedestrian is on the curb at the intersection. But this could be due to the confusion stated above.

LIKES AND DISLIKES OF DRIVING

Many participants reported they liked the independence of driving (5) and their ability to get to their destinations sooner (3). Others enjoyed the convenience of driving, ability to carry heavy items, adventure/exploration, ability to earn money, and the increased quality of life from driving. The dislikes of driving included high gas prices (2), traffic (3), vehicle mechanical problems, parallel parking or narrow parking spaces, and drivers who are oblivious, discourteous, use cell phones, speed, don't stop at stop signs, tailgate (3), cut other drivers off (3), or generally don't follow the rules of the road. One person liked driving in Walnut Creek because the signals are well timed and "everything is really well marked" while another person felt California streets were confusing due to sudden lane marking changes. One person disliked the fact that his 92-year-old neighbor could get a drivers license renewed without taking a test.

DRIVER EXPERIENCES AND CONCERNS

Pedestrians who fail to look right or left before stepping out into the crosswalk was the primary concern amongst this cohort. One individual stated they have difficulty seeing pedestrians when making a left hand turn. Another person stated there should be signs preventing pedestrians from walking through a crosswalk when vehicles are turning right. One person said that pedestrians don't take responsibility. Another individual felt that pedestrians challenge drivers by asserting their rights in the crosswalk, while another said that cars are more likely to challenge pedestrians. This later person went on to say that it is more difficult for the driver of a heavy vehicle to stop at the crosswalk. This disagreement spurred some debate regarding pedestrian right-of-way. One individual stated both the driver and pedestrian should be aware of each other in the crosswalk, while another argued it is "not a two-way street" and that pedestrians always have the right-of-way. When asked what would make drivers more comfortable when approaching a crosswalk, participants wanted to be warned of the crosswalk sooner, either through clearer markings, yield signs, or in-pavement flashing lights when someone is in the crosswalk. One person said it would be good to have more security/police patrol in the area. From the pedestrian perspective, this cohort was concerned with drivers who honk their horn at pedestrians in the crosswalk, ignore crosswalks, deliberately proceed through the crosswalk even after making eye contact with the pedestrian, or stop their vehicle in the middle of a crosswalk. Another person stated that bicyclists don't pay attention to pedestrians and "whip through" the crosswalk.

UNDERSTANDING OF THE RIGHT-OF-WAY LAW

Using power point and a projector, focus group participants were shown three different photo scenarios: an intersection with four marked crosswalks, an intersection with four unmarked crosswalks, and an intersection with two marked and two unmarked crosswalks. They were then asked when the pedestrian has the right-of-way under each of these scenarios.

For the intersection with four marked crosswalks, all the focus group participants indicated the pedestrian has the right-of-way at all of the crossings. All but one of the participants agreed that pedestrians have the right-of-way at the intersection with four unmarked crosswalks. When participants were show the intersection with two marked and two unmarked crosswalks, their answer regarding pedestrian right-of-way depended on where the pedestrian was standing. If the pedestrian has already stepped into the intersection, all the participants felt the pedestrian had the right-of-way. But when the pedestrian had not yet stepped off the sidewalk, only three participants felt the pedestrian had the right-of-way.

YIELDING THE RIGHT-OF-WAY

Participants were asked when drivers are less likely and more likely to yield to a pedestrian at a crosswalk. Reasons given for failing to yield to a pedestrian were drivers that are distracted (e.g., children, cell phone), rudeness, driver doesn't see the pedestrian, listening to the radio, in a hurry, slow reaction time, eating / drinking, reading books/ newspaper/maps, watching television, shaving, and putting on make up. Participants felt drivers were more likely to yield to a pedestrian if there were crosswalk caution signs, stop signs, police patrol, flashing lights, traffic signals with beeping/chirping, if the pedestrian was a child, elderly, disabled, pregnant, a blind person with a white cane, or a mom with a stroller, and if drivers were courteous, alert, aware of their surroundings, and had an unobstructed view.

COUNTERMEASURES

EDUCATIONAL COUNTERMEASURES

Participants were asked whether billboards, radio, or TV was most effective for educational campaigns. Nine individuals preferred television while one each felt either billboards or radio would be most effective. The person who thought billboards were most effective stated they have good retention value, are "in your face," and are located where people drive. The person who favored radio felt that young people listen to the radio and are the group that most needs to be educated. Those who favored television stated it is the most popular medium, is more visual, and allows for action. Some of the arguments against each of these mediums were billboards are distracting to drivers, people can mute the sound, and there is already too much advertising. Participants also recommended newspapers, the Internet, and e-mail as mediums for dissemination.

Using power point and a projector, the participants were then shown the following educational print media[2] and asked to rate their effectiveness on a scale of low, medium, or high. If there was time, participants commented on the effectiveness of the print media.

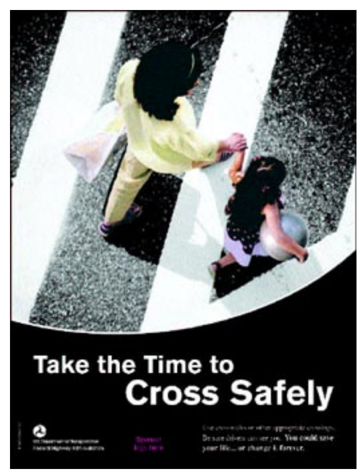


EXHIBIT 1		EXHIBIT 2		EXHIBIT 3	
LOW	2	LOW	7	LOW	6
MEDIUM	7	MEDIUM	4	MEDIUM	5
HIGH	2	HIGH	0	HIGH	0

For exhibit #1, participants liked the clear message and familiarity of the traffic signal while others stated this type of signal is not universal (e.g., other signals have the countdown). One individual thought it was distracting to look down to read the message while another thought the white part of the sign was much brighter than the rest of the sign. For exhibit #2, participants stated the message doesn't grab you, flow together, or make sense and the most

[2] Federal Highway Administration – National Pedestrian Safety Campaign.

important part of the message, "this shiny stuff," is in the smallest print. Moreover, the message is not clear because the focus is on the fireman not the pedestrian, thus the picture doesn't support the message. One person suggested that the fireman should point at the person wearing the jacket. Another person thought there should be a car in the picture For exhibit #3 participants thought the colors in the picture were bad felt the sign was too busy, and didn't like that the picture was not at the perspective angle of the pedestrian or driver.

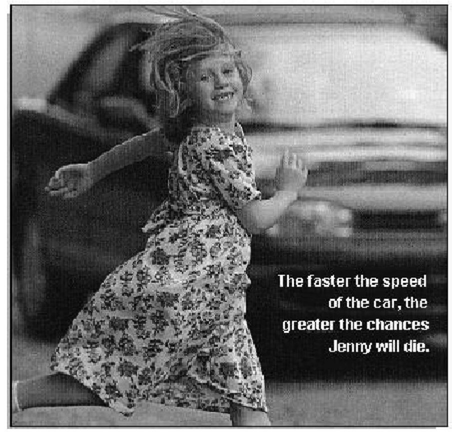


EXHIBIT 4

Low	3
Medium	3
H gh	4

EXHIBIT 5

Low	5
Medium	5
High	1

EXHIBIT 6

Low	4
Medium	6
H gh	1

EXHIBIT 7

Low	0
Medium	5
High	6

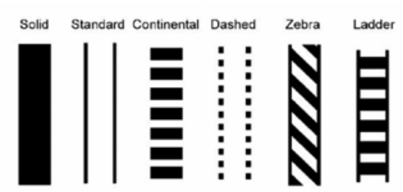
EXHIBIT 8

Low	5
Medium	5
High	1

There were no comments on exhibit 4 with one person abstaining from voting. Participants liked exhibit 5, stating "a picture is worth a thousand words" and "it tells you exactly what to do" and thought it would be effective on private streets They suggested replacing "we" in the expression to read, "Kids live here " For exhibit 6, they thought it was too wordy and that the context of the message is lost in the smiling child. Moreover the message includes a positive and a negative, and should say ".... the less chance Jenny will live." They felt the stop sign in exhibit 7 should come before the message. There were no comments on exhibit 8.

ENGINEERING COUNTERMEASURES

Next, we showed the participants the following photos of various engineering devices and asked them to rate their effectiveness on a scale of low, medium, or high. If there was time, participants commented on the effectiveness of the engineering devices.



YIELD SIGN	
LOW	0
MEDIUM	7
HIGH	4

VIVID STRIPING	
LOW	0
MEDIUM	4
HIGH	7

Participants liked the familiarity of the yield sign and felt the sign was clear with little text, simple graphics, and bright colors. One person found the sign to be very powerful and felt it could be as effective as a stop sign if it were everywhere One person said the sign re nforces the misconception that pedestrians have the right-of-way in the crosswa k Another individual thought the symbol of the person walking should be in both direct ons while another person thought blinking lights would make the sign more effective

In addition to rat ng the effectiveness of vivid striping, participants were asked to pick the striping they found most effective. One person chose the ladder striping, three chose the continental striping, and seven chose the zebra strip ng. There was some discussion over why participants did or did not choose the zebra striping Those who preferred the zebra striping liked the asymmetry and felt the l nes stood out. One person thought it would be more effective if the stripes were yellow instead of white. Another person felt the zebra striping looked like hatch marks, sending a prohibitive message while another felt the zebra striping blended into the pavement. One person indicated the yellow yield sign should be placed further upstream, rather than at the crosswalk.

COUNTDOWN SIGNAL	
LOW	0
MEDIUM	5
HIGH	6

LIGHTED CROSSWALK	
LOW	0
MEDIUM	2
HIGH	9

FLASHING BEACON	
LOW	3
MEDIUM	7
HIGH	1

For the countdown signal, eight participants felt that crossing signals do not give pedestrians enough time to cross the street, especially with multiple lane streets The lighted crosswalk received the most votes for being highly effective, although participants felt it might be somewhat less effective dur ng the day than at night or when it is raining. Participants also thought the device might be costly and that pedestrians may be more careless when crossing. For the flashing beacon, participants were concerned the lights overhead would be distracting to drivers.

BULB-OUT		RAISED CROSSWALK		STENCILED CROSSWALK	
LOW	1	LOW	7	LOW	1
MEDIUM	7	MEDIUM	2	MEDIUM	4
HIGH	3	HIGH	2	HIGH	6

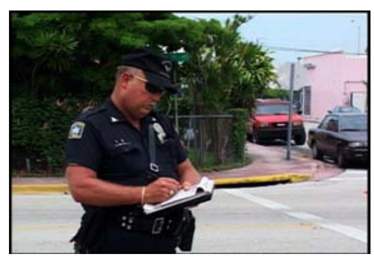
One person commented on the bulb-out, stating it makes pedestrians more visible, especially when there are parked cars on the road. For the raised crosswalk, participants questioned its cost-effectiveness and felt funds would be better spent on speed bumps. One person thought the raised crosswalk and stenciling concepts should be combined. For the stenciled crosswalk, one person liked it because it tells people to look, countering people who just walk out into the street. Another person stated it should be in a more universal language. And another thought the stencil would be difficult to see if there were several people in the crosswalk.

Participants were then asked to vote for the one engineering device that they thought was most effective. Seven individuals chose the in-pavement lighting, while one each chose the bright sign, countdown signal, vivid striping, and raised crosswalk.


MIAMI BEACH POLICE

You have just failed to yield to a pedestrian at a crosswalk in
MIAMI BEACH

We are trying to make your streets safer for you and your family.
Help us by cooperating and by encouraging others to do the same.



WARNING		COMMUNITY ENFORCEMENT		FINE	
LOW	0	LOW	3	LOW	0
MEDIUM	2	MEDIUM	8	MEDIUM	0
HIGH	9	HIGH	0	HIGH	11

Although all 11 participants ranked fines as highly effective, only 8 thought fines were the most effective of the three enforcement countermeasures. Three individuals chose warnings as the most effective means of enforcement.

FOCUS GROUP METHODOLOGY AND LIMITATIONS

Recruitment for the Walnut Creek focus groups consisted of community newspaper advertisements and a public service announcement on the Rossmoor community television channel. A 5-10 minute phone interview was used to screen for participants who regularly made trips by both driving and walking and who had varied opinions regarding the subject of crosswalk safety. There were no major challenges in this focus group.

FOCUS GROUP SUMMARY THREE

BERKELEY: SENIOR FOCUS GROUP

FEBRUARY 23, 2006, 1:00 – 3:00 PM
NORTH BERKELEY SENIOR CENTER

Driver/pedestrian concerns and experiences at crosswalks, understanding of the right-of-way law at crosswalks, and opinions regarding countermeasure effectiveness were explored in a focus group conducted on February 23, 2006 at the North Berkeley Senior Center in Berkeley, California. There were ten participants in the focus group. These individuals were between the ages of 70 and 89 and primarily walk as their mode of travel. This summary describes the findings from the focus group. Cynthia McCormick, a graduate student researcher from the University of California Berkeley, facilitated the focus group with researchers assisting and taking notes.

BACKGROUND SURVEY RESULTS

At the beginning of the focus group, PATH researchers administered a survey that explored the socio-demographic attributes of focus group participants, their travel patterns, and knowledge of right-of-way. This questionnaire differed from than the questionnaire administered at the Rossmoor focus groups due to lessons learned identified in the Rossmoor focus group summary.

SOCIO-DEMOGRAPHIC ATTRIBUTES

- Seven participants were women, and three were men;
- Three individuals were single, three were married, and four were divorced;
- Three individuals were between the ages of 70 and 74, three were between the ages of 75 and 79, and four were 80 years of age or older;
- One person had an associates degree, four had a bachelor's degree, and five had a master's degree;
- Three persons had an income under \$10,000, three in the \$10,000 - \$19,999 range, and two in the \$20,000 - \$49,999 range. Two individuals declined to respond.

Participants' responses to questions about their travel patterns indicated that they primarily walk as a commute mode and use driving and transit as supplemental modes:

- Seven participants owned an automobile, one participant could borrow a vehicle when needed, and two participants did not have access to a vehicle;
- Eight participants indicating walking was their primary mode of travel and two persons indicated driving was their primary mode of travel;
- As a whole, participants estimated that their travel in the week preceding the focus group was approximately 57% by walking, 21% by driving, and 22% by transit. The discrepancy between this statement and the previous statement is that those individuals who did not drive in the previous week made 36% of their combined trips by transit, while those individuals who did drive only made 8% of their combined trips by transit.

KNOWLEDGE OF RIGHT-OF-WAY

There were two questions on the survey to assess knowledge of pedestrian right-of-way at both marked and unmarked crosswalks. The first question asked when pedestrians trying to cross the street have the right of way. The second question asked when it is illegal to cross the street in California.

- All 10 participants felt the pedestrian has the right-of-way at any crossing within a four-way intersection when all four crosswalks are marked;
- Eight individuals felt the pedestrian has the right-of-way at any crossing within a four-way intersection when there are no marked crosswalks;
- Four individuals felt the pedestrian only has the right-of-way in the marked crosswalks of a four-way intersection when two crossings are marked and two crossings are unmarked;
- Six individuals felt the pedestrian has the right of way when there is a marked crosswalk midblock of an intersection, while none of the participants felt the pedestrian has the right-of-way when there is no marked crosswalk midblock.
- Five individuals felt the pedestrian has the right of way once they are in the street, but none of the participants thought the pedestrian has the right-of-way while still on the curb.
- Ten persons felt it was illegal to cross midblock between two signalized intersections, eight persons thought it was illegal to cross midblock if there was no signal at the intersection, none of the participants felt it was illegal to cross at an intersection with no marked crosswalk, and nine persons felt it was illegal to step out in front of a vehicle even in a marked crosswalk.

LIKES AND DISLIKES OF DRIVING

Participants liked walking for exercise/health (4), people watching, window shopping, fresh air, time to think, time not to think, the ability to walk after an injury, landscape/architecture/nature (2), and animals. Dislikes of walking were running out of energy, uneven sidewalk/streets (4), fear of falling, conflicts with skateboards/motorized wheelchairs/bicyclists (3), and pain.

DRIVER EXPERIENCES AND CONCERNS

Participants were asked about their concerns at crosswalks including behavior of other people and drivers, and any physical attributes that raise concern at crosswalks. Participants were concerned with signals that don't allow enough time to cross the street (4); vehicles that don't stop when the pedestrian has the light; fast traffic (2), cars that edge out into the crosswalk when making a turn, drivers talking on cell phones; lack of enforcement at crosswalks; potholes/uneven pavement (2); angry drivers; bicyclists who ignore traffic signals; crosswalk marking that are faded or difficult to see; obstructions (e.g., tree branches) that block the driver's view of signage; pedestrians who do not keep to the right; and people who are not alert. Participants indicated that islands in the middle of the crosswalk, more enforcement, fewer lanes, and eye contact with drivers make them feel safer.

UNDERSTANDING OF THE RIGHT-OF-WAY LAW

Using power point and a projector, focus group participants were shown three different photo scenarios: an intersection with four marked crosswalks; an intersection with four unmarked crosswalks; and an intersection with two marked and two unmarked crosswalks. They were then asked when the pedestrian has the right-of-way under each of these scenarios.

For the intersection with four marked crosswalks, all ten of the participants agreed that pedestrians have the right-of-way. Nine of the participants felt the pedestrian had the right-of-way at the intersection with four unmarked crosswalks, while one person said no but "not sure." Participants indicated that the right-of-way at an intersection with four unmarked crosswalks was subject to interpretation such that if the pedestrian was in the street or within view of the vehicle then the pedestrian has the right-of-way. One person countered that if it obvious the pedestrian wants to cross, then the driver must yield while another person said that the pedestrian has to make a signal that they want to cross, such as stepping into the street or making eye contact with the driver. When participants were shown the intersection with two marked and two unmarked crosswalks, eight persons felt the pedestrian had the right-of-way at all four corners, while two said the driver only has to yield at the marked crosswalks in the intersection. One person said the unmarked crosswalk indicates that it is not a pedestrian crossing while another person said "the DMV booklet states that the motorist has to yield to a pedestrian whether there is or is not a crosswalk." Other comments were the pedestrian must take responsibility (2), cars may not be able to stop in time, and "I only cross in a marked crosswalk." As a follow up, participants were asked if they would walk to the opposite side of the intersection in order to cross in the marked crosswalk. Four persons said they would go out of their way to cross in a marked crosswalk and six said they would not.

YIELDING THE RIGHT-OF-WAY

Participants were asked if drivers typically yield to them in the crosswalk and when drivers might be less likely and more likely to yield to a pedestrian at a crosswalk. Nine persons said that yes drivers yield to them, while one person said no. One person said "I'm not going to insist upon my right of-way" with two others agreeing. Participants felt drivers were more likely to yield to a pedestrian because: it's against the law, they don't want to get a ticket, it makes them feel like a good person, they don't want to hit the person coming into the crosswalk, or the pedestrian has a cane. Reasons given for failing to yield to a pedestrian were: personality of the driver (3), the driver thinks they can get through the crosswalk before the pedestrian, the driver can't stop in time, lack of police enforcement, the driver's view is obstructed by another car, young people (2), "certain ethnicities" don't stop, drivers who are on the phone, or drivers who are listening to music (2). One person commented that pedestrians don't pay attention and "just come right out" into the street.

COUNTERMEASURES

EDUCATIONAL COUNTERMEASURES

Due to t me constraints, educational countermeasures were not explored with this focus group

ENGINEERING COUNTERMEASURES

Participants were shown two local intersections in their community (Exhibits A and B) and asked what they liked and disliked about the intersection with regard to pedestrian safety when crossing the street. Participants were then shown several pictures of engineering devices and asked which devices would be effective for improving pedestrian safety at those intersections. Participants were also asked why they thought a particular device was or was not effective.

Crosswalk Exhibit A: All but two of the participants were familiar with the location of the crosswalk in Exhibit A.[3] Participants were made ware that the intersection only had one marked crosswalk. One person said they liked the intersection because it is "quiet." Another person said they were comfortable crossing the street at that intersection as long as there are no cars. Dislikes of the intersection were people drive too fast down the hill to try and make the light, the curb is broken, and drivers are looking for parking and not paying attention to pedestrians. One person said they try to avoid crossing that intersection.

Vivid Striping: Eight persons felt the viv d striping would improve safety at the crosswalk in Exhibit A. One person said that drivers are more aware of the crosswalk and another person said that drivers pay more attention to pedestrians. One person said they wouldn't feel safe or unsafe because crosswalks are just painted lines and it's the vehicles you have to worry about

[3] Location: Walnut and Cedar in Berkeley, CA.

Bulb-out: Participants were told the purpose of the bulb-out is to extend the curb and make it a shorter distance to cross the street. Three persons felt the bulb-out would improve safety at the crosswalk. One person said they would feel safer because it is a shorter distance to travel. Another person said it depends on the traffic and one person said t is rea ly unsafe for the dr ver.

Flashing Beacon Five pe sons thought the flashing beacon would improve safety at the intersect on. One person said drivers would be more aware of the beacon if it were flashing. Another person thought redundancy of the device in multiple ocations would detract from its value and another said that people tend to ignore signs with clutter. One person thought it wou d only be effective if it were dark outs de. Others commented were that it would blight the neighborhood, would confuse the driver, be a distraction to the driver, and that drivers would be focused on the beacon and not the pedestrians. One person though it would be more useful in vicinity of schools.

** n-Pavement Lighting:** F ve persons fe t n-paveme t l ghting would improve safety at the intersection One person said this type of device s needed where there is heavy traffic and nother person said they preferred it to the beacons. One person felt it was more of a mild warning and an ther person thought it was more like a yield device Another person said it was questionable if a driver can see the lights during the day

Roundabout: A head count was inadvertently not taken for this example. One person fe t the roundabout in this photo created high anxiety because too much going on and another pe son sa d the dr ver has to look in three or four directions

Crosswalk Exhib t B: Only a couple of participants were fami iar with the location of this crosswalk.[4] Comments were: it's terribly wide, there should be crosswalks because people drive very fast on this street, and there is not a lot of pedestrian traffic. One person liked this crossing because the island allows the pedestrian to cross the street in two stages.

[4] Location: Carleton and Sacramento in Berkeley, CA.

Angled Crosswalk: Most of the participants had never seen an angled crosswalk. Participants were told the purpose of the angled crosswalk is to allow pedestrians to see on-coming traffic before they cross the street. Seven people felt the angled crosswalk made it safer to cross the intersection. Comments were the crosswalk would be an incentive for jaywalking because people have to walk out of their way, a vehicle's headlights would be too bright for pedestrians to see, and there's not enough street lighting. Two persons felt the island made it safer to cross the four lanes.

Advanced Yield Marking: Participants were told the purpose of the yield marking is to stop traffic before the crosswalk so that pedestrians in the crosswalk would be in the driver's line of sight. No one felt this type of crosswalk would improve safety at the intersection. Participants felt that: drivers would not stop and that people wouldn't understand the markings.

Lane Reduction / Road Diet: All ten participants thought the lane reduction would improve safety at the intersection. One person thought reducing the lanes would confuse people, while another person said the lane reduction is only advantageous for the people that live on that street because it slows them down. A couple of participants were familiar with a location where the lanes had been reduced and felt it was a very good way to slow drivers down. Two people liked having the median, while another person said there should either be a left turn lane or a median but not both.

Count Down Signal Crossing: All ten participants felt the count down signal would improve safety at the intersection. One person said it gives people a time scale on how much time you have and whether you need to speed up. Nine persons felt that on average these types of signals give pedestrians enough time to cross the street. One person said that disabled people need more time. One person said the count down signal is a "pedestrian pacifier."

ENFORCEMENT COUNTERMEASURE

The last of the three countermeasures considered by the focus group was enforcement. Participants were asked if they thought police presence would enforce the right-of-way and which of three types of enforcement (community enforcement, police warnings, fines) would be effective at getting drivers to obey the right-of-way. Eight participants indicated that drivers would be more likely to give pedestrians the right-of-way if they think a policeman patrols the area.

Community Enforcement: Three persons thought community enforcement was a good countermeasure for getting drivers to obey the right-of-way. One person described community enforcement as Big Brother.

Police Warnings: Six participants thought that police warnings would be effective. One person said a warning would be effective if the person knew a second incident would result in a ticket. Another person said that "scofflaws are habitual and a warning does nothing." One person said that warnings are bad policy because they lead to a lack of uniform enforcement. Two others indicated that tickets would be more effective than warnings.

Fines: N ne persons felt that fines were an effective means of getting drivers to obey the right-of-way. One person said that tickets were a slight deterrent only.

OTHER CONCERNS:

One person thought that more crosswalks were needed at the ferry terminal Other comments were: multiple paint stripes would make crosswalks safer, there isn't enough enforcement, fines should be spent on more police enforcement of pedestrian safety, better lighting at night would be nice, there needs to be more emphasis on the driver, there needs to be increased police presence on the streets, there needs to be more focus on bicyclists who break the law.

FOCUS GROUP METHODOLOGY AND LIMITATIONS

Recruitment for the Berkeley focus group consisted of flyers posted at the North Berkeley Senior Center and on-site recruitment. A 5-10 minute phone interview was used to screen for participants who regularly made trips by driving and walking and who had varied opinions regarding the subject of crosswalk safety. There were no major challenges in this focus group.

FOCUS GROUP SUMMARY FOUR

BERKELEY: ADULT FOCUS GROUP

FEBRUARY 23, 2006, 6:30 – 8:30 PM
NORTH BERKELEY SENIOR CENTER

Driver/pedestrian concerns and experiences at crosswalks, understanding of the right-of-way law at crosswalks, and opinions regarding countermeasure effectiveness were explored in a focus group conducted on February 23, 2006 at the North Berkeley Senior Center in Berkeley, California. There were eleven participants in the adult focus group who were between the ages of 25 and 64 and primarily walk as their mode of travel. This summary describes the findings from the focus group. Cynthia McCormick, a graduate student researcher from the University of California Berkeley, facilitated the focus group with researchers assisting and taking notes.

BACKGROUND SURVEY RESULTS

At the beginning of the focus group, PATH researchers administered a survey that explored the socio-demographic attributes of focus group participants, their travel patterns, and knowledge of right-of-way. This questionnaire differed from than the questionnaire administered at the Rossmoor focus groups due to lessons learned identified in the Rossmoor focus group summary.

SOCIO-DEMOGRAPHIC ATTRIBUTES

- Eight participants were women, and three were men;
- Six individuals were single, two were married, and two were divorced;
- One individual was between the age of 25 and 29, one between the age of 30 and 34, two between the age of 35 and 39, one between the age of 40 and 44, two between the age of 45 and 49, one between the age of 50 and 54, one between the age of 55 and 59, and one between the age of 60 and 64;
- One person had a high school diploma, four had an associates degree, five had a bachelor's degree, and one had a master's degree;
- One person had an income under $10,000, eight in the $20,000 - $49,999 range, and one in the $50,000 - $79,999 range. One individual declined to respond.

Participants' responses to questions about their travel patterns indicated that they were almost split between walking and driving as their primary mode, with transit as a supplemental mode for most and a primary mode for one:

- Eight participants owned an automobile and three did not have access to a vehicle;
- Four participants indicating driving was their primary mode of travel, five indicated walking was their primary mode of travel, and one person indicated transit was their primary mode of travel. One person was evenly split between walking and driving trips;
- As a whole, participants estimated that their travel in the week preceding the focus group was approximately 41% by driving, 39% by walking, and 20% by transit.

KNOWLEDGE OF RIGHT-OF-WAY

There were two questions on the survey to assess knowledge of pedestrian right-of-way at both marked and unmarked crosswalks. The first question asked when pedestrians trying to cross the street have the right of way. The second question asked when it is illegal to cross the street in California.

- All 11 participants felt the pedestrian has the right-of-way at any crossing within a four-way intersection when all four crosswalks are marked;
- Five individuals felt the pedestrian has the right-of-way at any crossing within a four-way intersection when there are no marked crosswalks;
- Five individuals felt the pedestrian only has the right-of-way in the marked crosswalks of a four-way intersection when two crossings are marked and two crossings are unmarked;
- All eleven individuals felt the pedestrian has the right of way when there is a marked crosswalk midblock of an intersection, while only one of the participants felt the pedestrian has the right-of-way when there is no marked crosswalk midblock.
- Seven individuals felt the pedestrian has the right of way once they are in the street, and four of the participants thought the pedestrian has the right-of-way while still on the curb.
- Nine persons felt it was illegal to cross midblock between two signalized intersections, five persons thought it was illegal to cross midblock if there was no signal at the intersection, two of the participants felt it was illegal to cross at an intersection with no marked crosswalk, and two persons felt it was illegal to step out in front of a vehicle even in a marked crosswalk.

LIKES AND DISLIKES OF WALKING

Participants were asked what they liked and disliked about walking. Reasons for liking walking were: exercise (2), nature, interaction with people/animals, window shopping (2), an alternative mode, relaxing, time to think, and time to read. Dislikes of walking were: cars don't stop (3), cars go really fast, drivers don't pay attention (2), drivers assert their right of way, pain/injury (2), short time to get through the crosswalk before the light changes, bicyclists follow their own rules, bad weather, broken pavement, and pedestrians who block the crosswalk

DRIVER EXPERIENCES AND CONCERNS

Participants were asked about their concerns at crosswalks including behavior of both pedestrians and drivers and any physical attributes that raise concern at crosswalks. Participants were concerned with: drivers who are distracted due to loud music, cell phones, and interacting with their passengers; crossing the street without a light (3); drivers that can't see pedestrians because their view is blocked by other vehicles; corners, barriers, and parked cars; cars that stop in the middle of the crosswalk; drivers who aren't paying attention to pedestrians; drivers who speed up to make the light; drivers who go through the crosswalk even when they see pedestrians; drivers who don't recognize the weight of their vehicles; drivers who ignore the law because another driver did; crossing the street at night; trying to cross when there isn't a marked crosswalk; crosswalks that don't get remarked after the roads are repaved; and drivers who presume the right-of-way.

UNDERSTANDING OF THE RIGHT-OF-WAY LAW

Using power point and a projector, focus group participants were shown three different photo scenarios: an intersection with four marked crosswalks, an intersection with four unmarked crosswalks, and an intersection with two marked and two unmarked crosswalks. They were then asked when the pedestrian has the right-of-way under each of these scenarios.

For the intersection with four marked crosswalks, 10 persons said that pedestrians have the right-of-way and one person said the driver would have the right-of-way if they were completing a left turn. There were differing opinions when the intersection had four unmarked crosswalks. When participants were told there were stop signs at all four corners, all 11 participants said the pedestrian has the right-of-way, but only eight agreed this was true if there were no stop signs in the intersection. When participants were shown the intersection with two marked and two unmarked crosswalks, six persons thought the pedestrian had the right-of-way at all four corners, three thought the pedestrian only had the right of way if there was a stop sign, and two said there need to be a marked crosswalk for the pedestrian to have the right of way. One person said that the pedestrian can't step out in front of a car, but can cross in an unmarked area when it's safe.

YIELDING BEHAVIOR

Participants were then asked when drivers are less likely and more likely to yield to a pedestrian at a crosswalk. Five persons indicated that drivers will yield to pedestrians on average. Reasons given for failing to yield to a pedestrian were drivers who are trying to make the light (3), in a hurry to get home, driving while intoxicated, on their cell phones, playing music, talking to passengers (2), rude, a group of young people, reaching into the backseat when you have kids, road rage, sun in your eyes, picking up stuff off the floor, turning right on a corner and not paying attention to pedestrians trying to cross (2), and not paying attention. Participants felt drivers were more likely to yield to a pedestrian if: the pedestrian makes eye contact, communicates with the driver, or stands in the middle of the road; if there is a police car or the driver is fined; and if there are a lot of barriers to slow down traffic.

COUNTERMEASURES

EDUCATIONAL COUNTERMEASURES

Participants were asked which of several different types of educational countermeasures would be effective to get people to understand the right-of-way law.

School Campaigns: Eleven persons thought school campaigns were effective. Reasons were: kids listen, you're educating them early, they can share it with each other and their parents, they can be assigned homework and have an ongoing discussion, and learned behavior when you're very young stays with you.

Driver's Manual: Two persons thought the driver's manual was effective. One person said reading it makes you think. Counter to that, one person said it ought to be done but nobody reads the driver's manual.

Radio: Five persons thought radio was effective. Reasons given for why radio is effective were people listen to the radio when they are driving (2) and repetition helps. Others thought radio was ineffective because people channel surf when there are commercials, not all stations have announcements, and some people don't listen to the radio.

Print: Three persons thought print media was effective. However, participants said that it would need to be big and not disappear after a week.

TV: Nine persons thought TV was effective, but one person said people may channel surf during advertisements.

Billboards: All eleven participants thought billboards was an effective means of educating people about the right-of-way. One person said it's an eye-catcher, and another said it is especially effective if it's emotional (e.g., with a body, a kid). On the negative side, one person said advertisement on the side of the bus could make a driver crash if they look at it too long, and another person said advertisers only have about 5 seconds to catch someone's attention. Three persons thought billboards on the highway were more effective, five thought billboards on public transportation were more effective, and one person said they were indifferent. One person said signs should be on the roads where people drive, while another person said the bus is good because people see them immediately if they are sitting behind the advertisements. One person suggested that advertisement on public transportation target pedestrians to be more careful and cautious.

Other Ideas for Educational Campaigns: the internet, focus groups, public service announcements, the morning weather/traffic report, when renewing your license, on the DMV website, in high school, driving school, the movie theater (2), the 511 recording, and electronic displays on the road.

ENGINEERING COUNTERMEASURES

Participants were shown two local intersections in their community (Exhibits A and B) and asked what they liked and disliked about the intersection with regard to pedestrian safety when crossing the street Participants were then shown several pictures of engineering devices and asked which devices would be effective for improving pedestrian safety at those intersections Participants were also asked why they thought a particular device was or was not effective.

Crosswalk Exhibit A:[5] Participants were made aware that the intersection only had one marked crosswalk. Comments about this intersection were: the street is busy and dark which makes it prone to accidents, it's only a two-way stop, the street should have marked crosswalks at all the corners, and there should be a signal. One person said signals are too expensive, so they could put in another sign.

Vivid Striping: Ten persons felt the vivid striping would improve safety at the crosswalk in Exhibit A. Comments were: if the driver is not paying attention it does not matter if there is a marked crosswalk, the stripes are bigger are more visible, people will stop less if pedestrians don't cross the street very frequently, people will stop more if there is more than one person in the crosswalk.

Bulb-out Part cipants were told the purpose of the bulb-out s to extend the curb and make it a shorter distance to c oss the street. Three persons felt the bulb out would improve safety at the crosswalk. Reasons people thought it was effective were: it a shorter distance for the person cross ng the street, it's visually clear, and it alerts drivers there are pedestrians Other comments were it's great for small neighborhoods and the pole is good too. On the negative side, participants thought: t funnels bicyclists in with drivers creating more chaos, it might be confusing for a driver the pole is too b g and the des gn is distracting, and there is no s gn saying if it's one-way or two-way

Flashing Beacon: Ten persons thought the flashing beacon would improve safety at the intersection. One person said the sign might cause false confidence. Another person said the sign shouldn't be too high up. One person who has seen the device in Berkeley said it doesn't work, while another person who saw the device in Texas said it did work.

[5] Location: Carleton and Sacramento in Berkeley, CA.

In-Pavement Lighting: All eleven participants felt in-pavement lighting would improve safety at the intersection. Comments were: it automatically starts up, drivers will see it ahead because they are looking at the road, cars will slow down for it, it's emotionally satisfying it's like a force field, it should be on every street, it won't work in snow country.

Roundabout: Two persons thought roundabouts would improve safety at the intersection. Comments were they're expensive, they are confusing to the pedestrian because they don't know when to start crossing, cars zoom around them (2), drivers don t know how to use them and go the wrong way (2), drivers avoid them by going on other streets, and pedestrians don t realize they have the right of way.

Crosswalk Exhibit B:[6] Those familiar with the intersection said: it's a busy street, it's scary at night, driver's speed (2), and making a left turn is impossible. Others commented there's no crosswalk or s gns, it could use a streetlight (2), I like the slands, it's a big distance to cross (2), and it looks intimidating.

Angled Crosswalk: Participants were told the purpose of the angled crosswalk is to allow pedestrians to see on-coming traffic before they cross the street. Only one person felt the angled crosswalk made it safer to cross the intersection. Comments were: I don't like this at all, it penalizing pedestrians (2), it takes an extra two or three minutes to walk across the street (3), it needs lights, and it's bad for the handicapped (2).

Advanced Yield Marking: Participants were told the purpose of the yield marking is to stop traffic before the crosswalk so that pedestrians in the crosswalk would be in the driver's line of sight. None of the participants felt this type of crosswalk would improve safety at the intersection. Comments were: drivers are not going to know what it means (2), drivers will still stop in the stay clear area (2), the paint could fade and be less effective, drivers won't see it, it's confusing (2).

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[6] Location: Carleton and Sacramento in Berkeley, CA.

Lane Reduction / Road Diet: Three participants thought the lane reduction would improve safety at the intersection. Comments were: lowering capacity will make drivers mad (3) but be better for pedestrians, the island is a good addition, and you can’t control the driver so responsibility falls on the pedestrian.

Count Down Signal Crossing: A count was inadvertently not taken for this example. Comments were: I like the minutes and the seconds, pedestrians and drivers know how much time they have left to get across the street (3), and drivers see it because it’s bright (2). Other comments were drivers might not pay attention to the pedestrians, the lights are too bright, and some signals aren’t long enough.

Other effective engineering countermeasures: lights that hold on yellow to clear out the intersection, chirping sounds for the blind the flashing hand, a separate light for cars and pedestrians, talking signals, fake cameras, motion-sensitive signals (2), protective right turns, calm traffic, signs that say “yield to pedestrians,” and signs that say “fine ”

ENFORCEMENT COUNTERMEASURES

The last of the three countermeasures considered by the focus group was enforcement Participants were asked if they thought police presence would enforce the right-of-way and which of three types of enforcement (community enforcement, police warnings, fines) would be effective at getting drivers to obey the right-of-way.

Community Enforcement: No one thought community enforcement was a good countermeasure for getting drivers to obey the right-of-way. One person said that people know they won’t get in trouble.


MIAMI BEACH POLICE

You have just failed to yield to a pedestrian at a crosswalk in

MIAMI BEACH

Drivers MUST yield to pedestrians.

We are trying to make your streets safer for you and your family.
Help us by cooperating and by encouraging others to do the same.

A SAFETY MESSAGE FROM THE MIAMI BEACH POLICE DEPARTMENT

Police Warnings: Eleven participants thought that police warnings would be effective. Comments were it startles people, drivers realize they are not invisible, and drivers may think they won't get lucky next time. Suggestions were to tell people what the fine would be, give drivers something to read or sign and return to the DMV, and use positive reinforcement for those who obey the law.

Fines: Eight persons felt that fines were an effective means of getting drivers to obey the right-of-way. Comments were it's better to hit someone in the pocket, fines don't matter much to r ch people, fines should be tied to income, and the infraction should be a city ordinance so it goes on the record.

FOCUS GROUP METHODOLOGY AND LIMITATIONS

Recruitment for the Berkeley focus group consisted of flyers posted at the North Berkeley Senior Center and on-site recruitment A 5-10 minute phone interview was used to screen for participants who regularly made trips by driving and walking and who had varied opinions regarding the subject of crosswalk safety. There were no major challenges in this focus group.

FOCUS GROUP SUMMARY FIVE

FRUITVALE: ADULT FOCUS GROUP

MARCH 16, 2006, 6:00 – 8:00 PM
FRUITVALE SENIOR CENTER

Driver/pedestrian concerns and experiences at crosswalks, understanding of the right-of-way law at crosswalks, and opinions regarding countermeasure effectiveness were explored in a focus group conducted on March 16, 2006 at the Fruitvale Senior Center in Oakland, California. There were eleven participants in the adult focus group who were between the ages of 18 and 64 and primarily walk as their mode of travel. This summary describes the findings from the focus group. Cynthia McCormick, a graduate student researcher from the University of California Berkeley, facilitated the focus group with researchers assisting and taking notes.

BACKGROUND SURVEY RESULTS

At the beginning of the focus group, PATH researchers administered a survey that explored the socio-demographic attributes of focus group participants, their travel patterns, and knowledge of right-of-way. This questionnaire was identical to the one distributed at the Berkeley focus group.

SOCIO-DEMOGRAPHIC ATTRIBUTES

- Nine participants were women, and two were men.
- Seven individuals were single, two were married, and one was divorced.
- One individual was between the age of 18 and 24, two between the age of 30 and 34, one between the age of 35 and 39, one between the age of 40 and 44, two between the age of 45 and 49, one between the age of 50 and 54, one between the age of 50 and 59, and two between the age of 60 and 64.
- One person had completed grade school, seven persons had a high school diploma, two had a bachelor's degree, and one had a master's degree.
- Four persons had an income under $10,000, six in the $20,000 - $49,999 range, and one in the $50,000 - $79,999 range.

Participants' responses to questions about their travel patterns indicated that they were almost split between walking and driving as their primary mode, with transit as a supplemental mode for most and a primary mode for one:

- Six participants owned an automobile, one could borrow an automobile, and four did not have access to an automobile;
- Five participants indicating driving was their primary mode of travel, four indicated walking was their primary mode of travel, and one person indicated transit was their primary mode of travel. One person was evenly split between walking and driving trips;
- As a whole, participants estimated that their travel in the week preceding the focus group was approximately 29% by driving, 48% by walking, and 23% by transit.

KNOWLEDGE OF RIGHT-OF-WAY

There were two questions on the survey to assess knowledge of pedestrian right-of-way at both marked and unmarked crosswalks. The first question asked when pedestrians trying to cross the street have the right of way. The second question asked when it is illegal to cross the street in California.

- All 11 participants felt the pedestrian has the right-of-way at any crossing within a four-way intersection when all four crosswalks are marked;
- Three individuals felt the pedestrian has the right-of-way at any crossing within a four-way intersection when there are no marked crosswalks;
- Nine individuals felt the pedestrian only has the right-of-way in the marked crosswalks of a four-way intersection when two crossings are marked and two crossings are unmarked;
- Seven individuals felt the pedestrian has the right of way when there is a marked crosswalk midblock of an intersection, while none of the participants felt the pedestrian has the right-of-way when there is no marked crosswalk midblock.
- Three individuals felt the pedestrian has the right of way once they are in the street, and one of the participants thought the pedestrian has the right-of-way while still on the curb.
- Seven persons felt it was illegal to cross midblock between two signalized intersections, five persons thought it was illegal to cross midblock if there was no signal at the intersection, six of the participants felt it was illegal to cross at an intersection with no marked crosswalk, and two persons felt it was illegal to step out in front of a vehicle even in a marked crosswalk.

LIKES AND DISLIKES OF WALKING

Participants were asked what they liked and disliked about walking. Reasons for liking walking were: just because (2), see people (2), fresh air, exercise (2), good for you, different perspective of land/businesses than driving, and to see the stores (2). Dislikes of walking were: traffic (4), fast crosswalk lights, no crosswalk signal light, takes too long to get somewhere, waiting for cars to stop at the crosswalk, bikes on crosswalks, and fast cars.

DRIVER EXPERIENCES AND CONCERNS

Participants were asked about their concerns at crosswalks including behavior of both pedestrians and drivers and any physical attributes that raise concern at crosswalks. Participants were concerned with: cars that stop in the middle of the crosswalk, cars that ignore people with strollers and wheelchairs, not enough time to cross the street, no curb cut-outs for wheelchairs, drivers that don't stop at the light, lack of multi-lingual audio at signals, drivers that don't look for pedestrians when turning, traffic, people who don't know the right-of-way rules, speeding cars, drivers don't respect the crosswalks without a light, crosswalks that are not painted or have teeny lines, faded lines that don't get repainted, drivers behavior, and the effects of weather on driving.

UNDERSTANDING OF THE RIGHT-OF-WAY LAW

Using power point and a projector, focus group participants were shown three different photo scenarios: an intersection with four marked crosswalks, an intersection with four unmarked crosswalks, and an intersection with two marked and two unmarked crosswalks. They were then asked when the pedestrian has the right-of-way under each of these scenarios.

For the intersection with four marked crosswalks, all eleven participants agreed the pedestrian has the right-of-way. When the participants were shown the picture of the intersection with four unmarked crosswalks, one person said that pedestrians always have the right-of-way and drivers have to stop. However, after one person went to the board and drew a picture with marked crosswalks, indicating that the pedestrians only have the right-of-way when there are marked crosswalks, none of the participants indicated that the pedestrian has the right-of-way when there are no marked crosswalks. When participants were shown the intersection with two marked and two unmarked crosswalks, one person indicated that pedestrians should have the right-of-way at all four crossings because it would be inconvenient for someone who uses the crosswalk a lot to have to go around. Eights persons agreed that the pedestrians has the right-of-way at both the marked and unmarked crosswalks in the situation.

YIELDING THE RIGHT-OF-WAY

Participants were then asked when drivers are less likely and more likely to yield to a pedestrian at a crosswalk. Nine persons indicated that drivers will yield to pedestrians on average. Reasons given for failing to yield to a pedestrian were: in a hurry (3), using a cell phone, listening to the radio, watching DVDs, and unfamiliar with the area. They also felt that young people and taxi and bus drivers were less likely to stop. Participants felt drivers were more likely to yield to a pedestrian if they were courteous or if there was a police car in the area.

COUNTERMEASURES

EDUCATIONAL COUNTERMEASURES

Participants were asked which of several different types of educational countermeasures would be effective to get people to understand the right-of-way law.

School Campaigns: All eleven persons thought school campaigns were effective. One person discussed a program where kids actually practiced crossing the street. Another person said that adults should learn how to cross the street also.

Driver's Manual: Ten persons thought the driver's manual was effective. Two persons said that drivers read the manual but don't retain it. One person said that some pedestrians don't drive and drivers only have to renew their license every 5-6 years. Another person said the last thing drivers think about when taking their test is pedestrians.

Radio: Ten persons thought radio was effective. One person said the radio can create a positive impact while another person said they never hear anything about crosswalks on the radio.

Print: Six persons thought print media was effective. One person thought newspapers would be most effective. Another person thought the insurance companies should mail something out that requires a response. Another person said they receive a lot of junk mail and put it in the recycling bin.

TV: All eleven persons thought TV was effective. One person said that parents watch TV a lot. Another person said the programs should be multilingual. Suggestions were to advertise the campaigns on Sesame Street, Oprah, and soap operas.

Billboards: None of the participants thought billboards were an effective means of educating people about the right-of-way. Comments were: billboards are distracting, people only notice billboards when they are changing, adults are conditioned to overlook billboards, children are more cognizant and would remember billboard messages better, people are driving too fast to see them, there aren't many billboards up anymore, and pedestrians will see the billboards.

Bus/bus stop signage: All eleven persons thought bus/bus stop signage was effective. Two persons said they are really visible and people stop to read them. However, one person said they don't work for people with a visual disability.

Other ideas: Other suggestions were PSAs, Braille signs at crosswalks, multilingual signs, children's websites, shopping bags, and milk cartons.

ENGINEERING COUNTERMEASURES

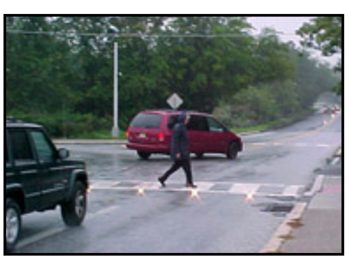
Participants were shown two local intersections in their community (Exhibits A and B) and asked what they liked and disliked about the intersection with regard to pedestrian safety when crossing the street. Participants were then shown several pictures of engineering devices and asked which devices would be effective for improving pedestrian safety at those intersections. Participants were also asked why they thought a particular device was or was not effective.

Crosswalk Exhibit A:[7] Seven persons were familiar with this intersection. Comments about this intersection were: There is only one stop sign at the intersection, they don't have the crosswalk painted—it's only two lines, I wish they had 4-way crosswalks, there's a school nearby and kids should have a crosswalk, it needs a sign that says "you should be more cautious."

Vivid Striping All eleven persons felt the v vid striping would i prove safety at the crosswalk in Exhibit A. Comments were drive s can see that it is a crosswalk. It's much more visible from far away you are able to see that yellow sign from far away I like the islands there's a light there

Bulb-out: Participants were told the purpose of the bulb-out is to extend the curb and make it a shorter distance to cross the street Five persons felt the bulb-out would improve safety at the crosswalk. Reasons people thought it was effective were: I like how the sign is yellow and black from the bottom up, the island works perfectly, it makes it easier to walk because the crossing area is smaller, you can make it faster across the street. Other comments were: it would back up traffic, cars still go by, it makes it look like the pedestrian is crossing the street faster so drivers don't have to slow down as much it only works if there's a light, it scares drivers because they may bump into the side a sign might help (2) and it's not good for drivers.

Flashing Beacon: Seven persons thought the flashing beacon would improve safety at the intersection One person said they have a lot of visibility. Another person said it's better than not having a crosswalk at all. Other comments were: drivers don't understand or ignore it, it's not safe, the pedestrian is not sure if the driver will stop, it would be better to have cars go slower, it's expensive, rural areas are more apt to have this besides lights, It's unfamiliar and confusing, it would take people awhile to adjust to it because it is new, and it may be difficult to see it at night.



In-Pavement Lighting: All eleven participants felt in-pavement lighting would improve safety at the intersection. Comments were: it would be good when it's raining and dark or nighttime, it's more visible, the striping defines the crosswalk and is better, another color would make it more visible, and the blinking light reminds drivers that there are pedestrians crossing. One person commented on how inconsistent crosswalks are.

[7] Location: Walnut and Cedar in Berkeley, CA

Roundabout: Seven persons thought roundabouts would improve safety at the intersection. Comments were: it depends on the area, people do 'donuts' around them, it 's confusing if you don't know what it is (3), it could be a problem for merging, it might be best in a small town, and it shouldn't be used in commercial areas.

Crosswalk Exhibit B:[8] Those familiar with the intersection said: there are many accidents at this intersection drivers don't care about pedestrians, it's unsafe if you get stuck on the island, it's very scary, there needs to be crosswalk lines, there are no signs to alert drivers that there are two schools there.

Angled Crosswalk: Participants were told the purpose of the angled crosswalk is to allow pedestrians to see on-coming traffic before they cross the street. Positive comments were: it makes it safer to cross the intersection (2), I like the island, and it would shorten the period of time the pedestrian is in the crosswalk. Other comments were people might just keep walking straight (2), it takes too long to use it (2), it's difficult for wheelchairs, people who walk slow, and people with strollers, it would be difficult to teach people how to use these, and there are too many signs.

Advanced Yield Marking: Participants were told the purpose of the yield marking is to stop traffic before the crosswalk so that pedestrians in the crosswalk would be in the driver's line of sight. Only one participant felt the advanced yield marking would improve safety at the intersection. Comments were: the sign is not understandable, the sign would be better if it said "yield here," the pedestrian may think they should cross at the yield markings (4), it is okay in theory, it's unfamiliar, and people would need to be educated about it.

Lane Reduction / Road Diet: One participant thought the lane reduction would improve safety at the intersection. One person said if people used it the right way it would be perfect. Other comments were: it backs up traffic when drivers have to turn left, it's a good idea for drivers but not for pedestrians (2), and delivery trucks park in the turn lane (3).

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8 Location: Carleton and Sacramento in Berkeley, CA.

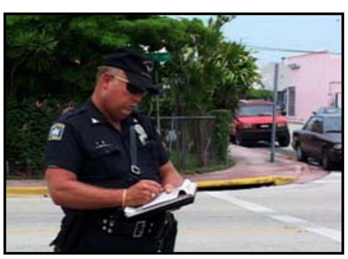
Count Down Signal Crossing: Ten persons thought the countdown signal was effective for improving crosswalk safety Three persons liked it because both drivers and pedestrians know how much time s left Other comments were: there isn't enough time to cross—especially for seniors, the disabled, pregnant women, and people in wheelchairs, it's better with sound, a camera or sensors would be better than buttons, and there should be a sign that says cars must yield to pedestrians when making a left turn.

ENFORCEMENT COUNTERMEASURES

The last of the three countermeasures considered by the focus group was enforcement Participants were asked if they thought pol ce presence would enforce the right-of way and which of three types of enforcement (community enf r ement police warnings, fines) would be effective at getting drivers to obey the right-of-way. All eleven participants thought the presence of a police car in the area would enforce the right-of-way.

Community Enforcement: Ten persons thought community enforcement was a good countermeasure for getting drivers to obey the right-of-way. Comments were: It could be really effective if they have a log and turn people in, drivers will be more cautious if drivers see them on the side of the road (2), lawn signs give the impression that people care if drivers speed and may be watching (2), it makes a difference in residential areas, and bright colored signs would be effective. One person said it doesn't work on young people.

Police Warnings: All eleven participants thought that police warnings would be effective. Comments were: it depends on the number of warnings, drivers will think they may get a ticket the next time, there should be a limit on how many warnings are given out (2), warnings remind the driver when they've done something wrong, it might stay in the driver's consciousness longer than actually getting a ticket, it needs be nation w de so everyone knows the law when they travel out of state.



Fines: All eleven persons felt that fines were an effective means of getting drivers to obey the right-of-way. One person said that once you get a citation you don't think about it again. Another person said that a sting operation in multiple locations would be good.

FOCUS GROUP METHODOLOGY AND LIMITATIONS

Recruitment for the Oakland focus group consisted of on-site recruitment. A phone interview was used to screen for participants who regularly made trips by driving and walking and who had varied opinions regarding the subject of crosswalk safety. The most challenging aspect of recruitment for this focus group was a language barrier. Many of the individuals were Spanish speaking with very little English. This was especially true of the senior population; therefore a senior focus group was not possible. The Oakland focus group consisted of 10 adult individuals. All but one person was fully able to understand and respond to all of the questions. One person, of Italian descent, required additional attention when answering the questions.

FOCUS GROUP SUMMARY SIX

ALBANY: SENIOR FOCUS GROUP

JUNE 13, 2006, 12:45 – 2:45 PM
ALBANY CENTER FOR OLDER ADULT SERVICES
JEWISH FAMILY & CHILDREN'S SERVICES OF THE EAST BAY

Driver/pedestrian concerns and experiences at crosswalks, understanding of the right-of-way law at crosswalks, and opinions regarding countermeasure effectiveness were explored in a focus group conducted on June 13, 2006 at the Center for Older Adult Services in Albany, California. There were 10 participants in the focus group, between the ages of 65 and 84. This summary describes the findings from the focus group. Meghan Mitman, a graduate student researcher from the University of California Berkeley, facilitated the focus group with researchers assisting and taking notes.

BACKGROUND SURVEY RESULTS

At the beginning of the focus group, Traffic Safety Center researchers administered a survey that explored the socio-demographic attributes of focus group participants, their travel patterns, and knowledge of right-of-way. This questionnaire was identical to the one distributed at the Berkeley and Fruitvale focus groups. Three of the participants did not complete the reverse side of the questionnaire, as noted below. One of the participants did not complete the questionnaire, as she arrived late.

SOCIO-DEMOGRAPHIC ATTRIBUTES

- Gender: Seven participants were women, and three were men.
- Of the six participants answering, three individuals were married, two were widowed, and one was divorced.
- Of the six participants answering, one individual was between the ages of 65 and 69, three were between the ages of 75 and 79, and two were between the ages of 80 and 84.
- Of the six participants answering, one person had a high school diploma, two had a bachelor's degree, two had a master's degree, and one had a PhD or higher.
- Of the six participants answering, three persons had an income in the $20,000 - $49,999 range, one had an income in the $50,000 - $79,999 range, and two declined to respond.

Participants' responses to questions about their travel patterns indicated that all used driving as a mode of travel, with walking and then transit as supplemental modes for most, but primary for some:

- All 9 survey respondents owned an automobile;
- Five respondents indicated driving is their primary mode of travel, one respondent indicated walking, and three respondents had an equal number of driving and walking trips in the last week;
- Respondents use transit 0 to 2 times per week
- As a whole, respondents estimated that their travel in the week preceding the focus group was approximately 56% by driving, 39% by walking, and 4% by transit.

KNOWLEDGE OF RIGHT-OF-WAY

There were two questions on the survey to assess knowledge of pedestrian right-of-way at both marked and unmarked crosswalks.

- All 9 respondents felt the pedestrian has the right-of-way at any crossing within a four-way intersection when all four crosswalks are marked.
- One individual felt the pedestrian has the right-of-way at any crossing within a four-way intersection when there are no marked crossings.
- Eight individuals felt the pedestrian only has the right-of-way in the marked crosswalks of a four-way intersection when two crossings are marked and two crossings are unmarked.
- Eight individuals felt the pedestrian has the right of way when there is a marked crosswalk midblock of an intersection (Scenario 1D), while one of the participants felt the pedestrian has the right-of-way when there is no marked crosswalk midblock.
- Six individuals felt the pedestrian has the right of way once he/she is in the street, and none of the participants thought the pedestrian has the right-of-way while still on the curb.
- Of the six participants answering, three persons felt it was illegal to cross midblock between two signalized intersections, three persons thought it was illegal to cross midblock if there was no signal at the intersection, two of the respondents felt it was illegal to cross at an intersection with no marked crosswalk, and three persons felt it was illegal to step out in front of a vehicle even in a marked crosswalk.

LIKES AND DISLIKES OF WALKING

Participants were asked what they liked and disliked about walking. Exercise was give as a reason one participant liked walking. Dislikes of walking given by participants were: health issues limit ability; bicyclists on sidewalks; short crossing times provided at signalized intersections; and uneven sidewalks. One participant noted that it is important to wear light-colored clothes to increase visibility when walking.

UNDERSTANDING OF THE RIGHT-OF-WAY LAW

Using power point and a projector, focus group participants were shown three different photo scenarios: an intersection with four marked crosswalks, an intersection with four unmarked crosswalks, and an intersection with both marked and unmarked crosswalks. They were then asked when the pedestrian has the right-of-way under each of these scenarios.

For the intersection with four marked crosswalks, all ten participants agreed the pedestrian has the right-of-way at all crossings. Comments included: marked crosswalks give the indication that a driver has to stop; and pedestrians have the right of way but they can't always trust drivers to stop.

When the participants were shown the picture of the intersection with four unmarked crosswalks, five persons said that pedestrians have the right-of-way at all crossings. Comments for this scenario included: whether there is marking or not, the pedestrian should always have the right of way; drivers don't know the law; pedestrians should go to the next block/ marked crosswalk for safety; it is illegal for drivers not to stop for pedestrians even if there's no marking.

When participants were shown the intersection with both marked and unmarked crosswalks, eight persons indicated that pedestrians should have the right-of-way in the marked crossing only. Comments included: the pedestrian should know when to cross and when not to (when it's safe to do so); it is illegal not to yield to pedestrians; is it better to be right or to be safe?; "foreigners" don't know crosswalk laws; right turns on red are confusing and dangerous for pedestrians; pedestrians don't stop and pay attention because they think they have the right of way; and pedestrians always have the right of way.

COUNTERMEASURES

EDUCATIONAL COUNTERMEASURES

Participants were asked which of several different types of educational countermeasures would be effective in enhancing pedestrian safety.

School Campaigns: All ten persons thought school campaigns would be effective. Comments included: teach kids as soon as possible so they can learn early (sooner than they are taught now); and parents need to be better role models for their children.

Driver's Manual: Nine persons thought that including pedestrian safety laws and practices in the driver's manual would be effective. Comments included: driver's manuals and tests are available in other languages, but road signs are not – this is a problem; many people drive with international driver's licenses (and thus many not know the local laws); and drivers drive differently during the driver's license test that they will on the road.

Radio: Five persons thought radio advertising campaigns would be effective. Comments included: people listen to the radio while driving, so it's good timing; listening to messages won't help, visuals are needed; and public service-type announcements would be good.

Print: No persons thought print media (i.e., newspaper and magazine ads) would be effective. Comments included: no one will pay attention; and people will ignore the messages.

TV: Six persons thought TV ads would be effective. Comments included: a lot of people watch TV; messages should be targeted toward drivers; messages should target drivers and pedestrians; TV helps people visualize situations; and this would be effective for children.

Billboards: Six of the participants thought roadside billboards would be an effective means of educating people and enhancing pedestrian safety. Comments included: billboards are too distracting for drivers; billboards should inform drivers about fines associated with not obeying right of way laws; and these are needed close to schools.

Bus/Bus Stop Signage: Seven persons thought bus/bus stop signage would be effective. Comments included: signs should be inside buses; as well and signs at bus stops are effective.

Other ideas: Other suggestions were short films for children in schools; stronger penalties are the only way to educate; and flyers.

ENGINEERING COUNTERMEASURES

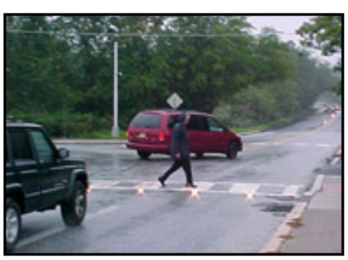
Participants were shown photos of two local intersections in their community (Exhibits A and B) and were then shown several pictures of engineering devices and asked which devices would be effective for improving pedestrian safety at those intersections. Participants were also asked why they thought a particular device would or would not be effective.

Crosswalk Exhibit A:[9] The participants were familiar with this intersection or this type of intersection. Participants were informed that the countermeasures they would be shown next were those applicable to this type of intersection; i.e., a smaller-scale intersection with 2 lane roads.

Vivid Striping: Eight persons felt the vivid striping would improve safety at the crosswalk in Exhibit A. Comments were: “blocks” are more visible than just 2 lines; wide stripes help; this may make the crosswalk more visible, but drivers still won’t slow down; and this could give pedestrians a false sense of security.

Bulb-out: Participants were told the purpose of the bulb-out is to extend the curb and make it a shorter distance to cross the street Two persons felt the bulb-out would improve safety at the crosswalk Comments included: this would make it difficult for drivers to navigate the roadway; and this would make drivers slow down wh ch would improve pedestrian safety.

Flashing Beacon: All ten persons thought the flashing beacon would improve safety at the intersection. Comments included: the flashers should only be on when a pedestrian is present – if on permanently, the beacon would not be as effective; and flashers should be button-operated.



In-Pavement Lighting: Nine of the participants felt in-pavement lighting would mprove safety at the intersection Comments were: this would be appropriate for a slower speed area; it’s hard for a car to stop quickly on a high-speed road; this would be helpful at night but might be hard to see in the rain; and this would help drivers see pedestrians at night

[9] Location: Walnut and Cedar in Berkeley, CA.

Roundabout: Five persons thought roundabouts would improve safety at the intersection. Comments were: roundabouts slow cars down so it's safer; they are too confusing with too many entrances; the refuge island (shown in the picture) gives pedestrians a break; roundabouts are too uncontrolled; roundabouts help the road seem more "relaxed."

Crosswalk Exhibit B:[10] The participants were familiar with this intersection or this type of intersection. Participants were informed that the countermeasures they would be show next were those applicable to this type of intersection; i.e., a larger-scale intersection with crosswalks across a multi-lane, major road.

Angled Crosswalk: Participants were told the purpose of the angled crosswalk is to allow pedestrians to see on coming traffic before they cross the street. Six of the participants thought this would improve safety for pedestrians. Comments included: it is too complicated; the angled portion is too long (makes the crossing, which is already long even longer); it's nice because you can take your time while crossing; it is confusing where this is located relative to the intersection; it takes up a lot of space in the road; and people would be tempted to ignore it and just walk though the island.

Advanced Yield Marking: Participants were told the purpose of the yield marking is to stop traffic before the crosswalk so that pedestrians in the crosswalk would be in the driver's line of sight. Six participants felt the advanced yield marking would improve safety at the intersection. Comments were: the sign is confusing; it makes sense that this would help cars see pedestrians better; the sign should say "stop here for pedestrians", and signs that say "watch for pedestrians" would be more effective. Those participants who did not think the countermeasure would be effective stated it likely would be effective if the sign were made less confusing.

Lane Reduction / Road Diet: Six participants thought the lane reduction would improve safety at the intersection. Comments included: it gets a little confusing whereas the "before" is straight-forward; the road diet will slow down traffic; and the island in the "after" crosswalk is helpful

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[10] Location: Carleton and Sacramento in Berkeley, CA.

Count Down Signal Crossing: Eight persons thought the countdown signal was effective for improving crosswalk safety. Comments included: there is not enough time provided for slow walkers; the countdown creates anxiety; the signals are not beneficial for seniors; some people don't know how to judge how much time they need; and it's confusing how they work.

ENFORCEMENT COUNTERMEASURES

The last of the three countermeasures considered by the focus group were enforcement-related. Participants were asked whi h of th ee types of enforcement (community enforcement, police warnings, and fines) would be effective at getting drivers to obey the right-of-way laws.

Community Enforcement: Six persons thought community enforcement was a good countermeasure for getting drivers to obey the right-of-way. Comments were: it would depend on what happened with the enforcement (were the drivers reported to the police, etc.); and many were unsure how effective


MIAMI BEACH POLICE

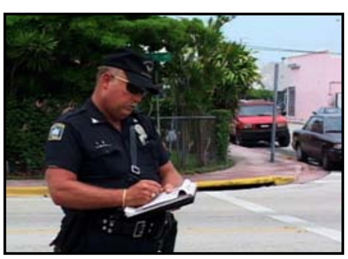
You have just failed to yield to a pedestrian at a crosswalk in

MIAMI BEACH

We are trying to make your streets safer for you and your family.
Help us by cooperating and by encouraging others to do the same.

A SAFETY MESSAGE FROM THE MIAMI BEACH POLICE DEPARTMENT

Police Warnings: Eight participants thought that police warnings would be effective. Comments included: only a fine would be effective.



Fines: Al ten persons felt that fines were an effective means of getting drivers to obey the right of-way.

APPENDIX B-2:
CROSSWALK FOCUS GROUP PROTOCOL

PRE-FOCUS GROUP INFORMATION

- Permission to video record
- Consent to participate (focus group participation waiver)
- Questionnaire

INTRODUCTION AND BACKGROUND QUESTIONS

INTRODUCTION

Moderator Introduction: My name is [first] [last], and I am a researcher at the University of California Berkeley. I will be moderating today's focus group. I'd like to thank you all for taking the time to participate in our study.

Focus Group Overview and Purpose: The purpose of today's focus group is to explore your experiences at cross-walks in California. The results of this focus group will be used to help improve crosswalk safety in California.

Discussion Guidance:

- Your participation is voluntary, and you may choose not to answer a question.
- The video-taping will provide a transcript of the discussion.
- Everything you say here will be kept confidential.
- Ground rules:
  - It's important we hear from everyone. Please give others a chance to talk.
  - I may at times suggest that we move on to another person.
  - I may suggest we return to a question or move on in the interest of time.
  - Please refrain from side conversations so we may hear what is said.
  - Most importantly, we are not looking for any particular answers.
  - Please tell us whatever it is you're thinking.
  - Everyone in this group is an expert on this topic.
  - It's OK to repeat what others have already said.
  - It's OK to have a completely different response.
  - Participant introductions: Before we start the questions, let's go around the room and briefly introduce ourselves. Please tell us your name and briefly describe the one thing you like most about walking, and the one thing you like least about walking.

EXPERIENCES, CONCERNS, AND CONFLICTS

- When you walk in and around a crosswalk (marked or unmarked), do you ever have concerns about drivers? If so, what are your concerns?
  - The objective of this question is to examine his or her experience around driver and pedestrian conflict, for example, a collision, near miss, or a misunderstanding that involved a potentially dangerous situation or caused someone to feel angry or disrespected.

    - Other possible prompts, if necessary: What don't you like about walking through a crosswalk? What makes you like one crosswalk better than another? What do you notice about the crosswalks that you prefer? Are there certain things that make you feel "safer" as a pedestrian when you are walking in one location vs. another?

CROSSWALK RULES AND BEHAVIOR: RIGHT-OF-WAY

- I am going to show you some pictures and I would like you to tell me when you think pedestrians trying to cross the street have the right-of-way. In other words – do drivers have to yield to pedestrians in these situations?
  - Marked Crosswalk (yes, no), Why?
  - Unmarked Crosswalk (yes, no), Why?
  - Marked and Unmarked Crosswalk (one or the other, both, neither), Why?
- When you cross the street, do drivers typically yield to you?
- Under what circumstances are drivers less likely to stop for you when you try to cross the street?
    - For example, speed, pedestrian age, location, number of pedestrians, likelihood of getting a ticket, in a hurry, or behavior of other drivers
- Under what circumstances are drivers more likely to stop for you when you try to cross the street?
    - For example, speed, pedestrian age, location, number of pedestrians, likelihood of getting a ticket, in a hurry, or behavior of other drivers

COUNTERMEASURES

EDUCATION CAMPAIGNS:

Are you more likely to respond to Public Service Announcements on?

- Teaching school children in classrooms
- Driver's Manual/ Driver's License Test Questions
- Radio Advertising
- Print Advertising
- Television Advertising
- Billboards on Roadsides
- Billboards on buses/ at bus stops
- Other?

Why did you choose ___________?, Why didn't you choose __________?

ENGINEERING DEVICES:

- Which of the following devices have you seen? (SHOW ALL)
- For each one, please rate their effectiveness as low, medium, or high
- For those you rated as high, vote for the one that is most effective.

ENFORCEMENT:

- Do you think drivers would give pedestrians the right of way in crosswalks more often if they knew the area was frequently patrolled?
- For each of the following enforcement scenarios, please rate their effectiveness as low, medium, or high. (SHOW ALL)
- For those you rated as high, vote for the one that is most effective.

ADJOURN AND ADMINISTRATIVE DETAILS

- Incentives (signature)

APPENDIX B-3:
FOCUS GROUP QUESTIONNAIRE

CROSSWALK FOCUS GROUP QUESTIONAIRE

Please complete this questionnaire without help from other participants.
All answers are completely confidential.

First, we have a few travel related questions.

1. **Do you have access to an automobile whenever you need to use one?**
   - ❏ Yes, I own an automobile
   - ❏ Yes, I can borrow an automobile
   - ❏ No, I don't have access whenever I need an automobile

For the questions below, we define a trip as travel to a location away from your home, work, or previous destination. Each stop (excluding signals, etc.) you make is a separate trip even if you stop for an errand or a visit enroute to your final destination.

Be sure to count all separate trips when walking, biking, driving, taking transit, etc. or when they involve switching from one of these modes to the other.

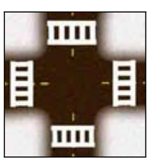
2. **Approximately, how many trips did you make last week by driving? ___________**

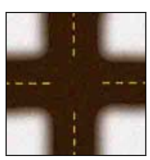
3. **Approximately, how many trips did you make last week by walking? ___________**

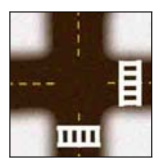
4. **Approximately, how many trips did you make last week by transit? ____________**

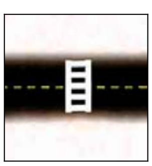
Next, we have a question regarding right-of-way at crosswalks.

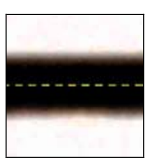
3) When do pedestrians trying to cross the street have the right of way (check all that apply in the box below)?


At intersections with a marked crosswalk
❏


At intersections *without* a marked crosswalk
❏


Only in the marked crosswalk in this situation
❏


Midblock with a marked crosswalk
❏


Midblock *without* a marked crosswalk
❏

When the pedestrian is in the street
❏

When the Pedestrian is on the curb
❏

4) Which of the following, if any, are illegal in California:

Crossing midblock between two signalized intersections	Crossing midblock if there's no signal at the intersection	Crossing at an intersection with no marked crosswalk	Stepping out in front of a vehicle, even in a marked crosswalk
❑	❑	❑	❑

Finally, we have a few demographic questions that help us categorize our data.

5. **Are you?** ❑ Female ❑ Male

6. **What is your current marital status?**

Single ❑ Married ❑ Separated ❑ Divorced ❑ Widowed ❑

7. **What is your age?**

18-24 25-29 30-34 35-39 40-44 45-49 50-54 55-59

60-64 65-69 70-74 75-79 80-84 85-89 90 or older

8. **What is the last level of school that you completed?**

Grade School Graduated High School Associate's Degree

Bachelor's Degree Master's Degree Ph.D. or Higher

Other, Please Specify____

9. **What was your household's 2005 pre-tax income?**

Under $10,000 $10,000- $19,999 $20,000 - $49,999 $50,000 - $79,999

$80,000- $109,999 More than $110,000 Decline to Respond

Thank you for completing this questionnaire!

APPENDIX C:

STATED BEHAVIOR AT CROSSWALKS

PEDESTRIAN AND DRIVER SURVEY RESPONSES

SUMMARY OF SURVEY RESULTS

A survey research company conducted the intercept surveys, under contract with the TSC. The surveys were self-administered, designed to take approximately ten minutes, and were completed by participants under close supervision by the field staff. Pedestrian participants were intercepted immediately after crossing unsignalized intersections in one of four urban pedestrian areas. Two of the areas were highly frequented by elderly residents, and the other two areas were associated with high alternative mode-share. The census tracts targeted were:

- **ELDERLY URBAN:** Census tract 4030 (Alameda County) and census tract 114 (San Francisco)
- **URBAN HIGH ALTERNATIVE (NON-AUTO) MODE-SHARE:** Census tracts 115 and 176 (San Francisco)

Drivers were surveyed while purchasing fuel at gas stations or while accessing their vehicles in parking lots in Census Tract 4088 (Alameda County). Surveyors screened for local drivers (people who regularly drive locally) before administering the survey.

The survey was completed by 192 people, comprising 133 pedestrians and 59 drivers. Seventy-five percent of the drivers surveyed estimated they spend a majority (50 percent or more) of their local travel time driving as opposed to using other modes. In contrast, only 61 percent of pedestrians surveyed drive a majority of the time. The median driver and pedestrian age range was 30 to 39. Driver respondents were 64 percent male and pedestrian respondents were 54 percent male.

RESULTS OF PEDESTRIAN SURVEY (N = 133)

Participants between the ages of 18-19 are more likely to agree to he statement that they usually begin to cross the street regardless of whether the cars are already slowing down. (p-value = 0.03)

Participants between the ages of 60 and 75 are less likely to report crossing a street outside a marked crosswalk. (p-value = 0.05)

When asked how often drivers yield to them when they are waiting to cross the street a marked crosswalk, pedestrian participants answered as follows:

Almost always: 8%

Frequently: 23%

Sometimes: 41%

Rarely: 21%

Almost never: 7%

Pedestrian participants responded that, in general, drivers yield to them when they are crossing the street in a marked crosswalk:

Almost always: 36%

Frequently: 33%

Sometimes: 19%

Rarely: 8%

Almost never: 4%

When asked "how assertive are you as a pedestrian?," pedestrian participants responded as follows:

Always wait for gaps: 28%

Usually wait for gaps: 39%

Sometimes cross without waiting for someone to slow down: 21%

Usually begin to cross regardless of whether cars are slowing: 28%

Always begin to cross regardless of whether cars are slowing: 2%

Pedestrian participants when asked, "Are there places you know of where drivers seem to yield to pedestrians more often?" responded as follows:

No: 51%

Yes: 49%

When asked how many times they have experienced a pedestrian/vehicle conflict, pedestrian participants responded as follows:

None: 13%

Barely any: 30%

A few times: 35%

A fair number: 11%

Many: 8%

NA: 3%

When asked if they agree with the statement, "I always wait for gaps for someone to stop before crossing," pedestrian participants responded as follows:

Strongly agree: 35%

Agree: 47%

Disagree: 12%

Strongly disagree: 3%

Undecided: 3%

When asked if they agree with the statement, "If traffic is moving slower than 25 mph, I usually begin to cross the street regardless of whether the cars are already slowing down," pedestrian participants responded as follows:

Strongly agree: 5%

Agree: 29%

Disagree: 30%

Strongly disagree: 19%

Undecided: 17%

When asked if they agree with the statement "If traffic is moving faster than 25 mph, I usually begin to cross the street regardless of whether the cars are already slowing down," pedestrian participants responded as follows:

Strongly agree: 4%

Agree: 8%

Disagree: 34%

Strongly disagree: 41%

Undecided: 13%

Pedestrians were asked what they think would increase driver yielding to pedestrians at the crosswalk. They responded as follows:

Signage: 83%

Enforcement: 75%

High visibility striping: 65%

In-pavement lighting: 58%

Driver education: 45%

More assertive pedestrians: 18%

Narrower roads: 15%

Other: 16%

Pedestrian participants were asked what they normally do as a pedestrian wanting to cross at a marked cross-walk with no signal or stop sign. They responded as follows:

Make eye contact with driver: 65%

Wait on the curb: 55%

Take one step into the street: 43%

Put your hand out make another signal: 22%

Take 2-3 steps into the street: 21%

Other: 5%

When asked "As a pedestrian, how often do you cross outside a marked crosswalk?", pedestrian participants answered as follows:

Almost always: 3%

Frequently: 29%

Sometimes: 43%

Rarely: 16%

Almost never: 9%

5.1.2. RESULTS OF DRIVER SURVEY (N = 59)

Female participants were more likely than male participants to respond that they often yield to a pedestrian on the curb waiting to cross the street at a crosswalk. (p value = 0.03)

Male participants were more likely than female participants to report spending more time walking as a form of travel. (p-value = 0.02)

Following are responses from driver participants, by percentage:

"As a driver, how often to do you stop for a pedestrian who has entered a marked crosswalk in front of you?"

Almost always: 79%

Frequently: 10%

Sometimes: 9%

Almost never: 2%

"As a driver, how often to you stop for a pedestrian who enters an intersection without a marked crosswalk?"

Almost always: 50%

Frequently: 26%

Sometimes: 19%

Rarely: 5%

"When slowing for a pedestrian in a marked crosswalk, what are things you usually do?"

Stop completely before the crosswalk: 48%

Stop a car length before the crosswalk: 24%

Make a hand or other signal to the pedestrian: 20%

Slow down so the pedestrian can pass, but don't stop: 5%

Other: 3%

"I always stop for pedestrians under any circumstance."

Strongly agree: 40%

Agree: 52%

Disagree: 4%

Undecided: 4%

"I never stop for pedestrians who are waiting on the sidewalk, only those already crossing."

Strongly agree: 10%

Agree: 22%

Disagree: 36%

Strongly disagree: 24%

Undecided: 8%

"I always stop for pedestrians under any circumstance."

Strongly Agree: 43%

Agree: 47%

Disagree: 5%

Undecided: 5%

"If traffic is moving faster than 25 mph, I always for stop for pedestrians waiting on the sidewalk."

Strongly agree: 15%

Agree: 23%

Disagree: 25%

Strongly disagree: 13%

Undecided: 24%

"If traffic is moving slower than 25 mph, I always for stop for pedestrians waiting on the sidewalk."

Strongly agree: 23%

Agree: 50%

Disagree: 6%

Strongly disagree: 2%

Undecided: 19%

"If traffic is moving faster than 25 mph, I always for stop for pedestrians already crossing in the roadway."

Strongly agree: 58%

Agree: 30%

Disagree: 6%

Strongly disagree: 2%

Undecided: 4%

"If traffic is moving slower than 25 mph, I always for stop for pedestrians already crossing in the roadway."

Strongly agree: 56%

Agree: 38%

Undecided: 6%

"What effects whether your stop for a pedestrian in a marked crosswalk?"

The age of the pedestrian (young, old, teen, adult older): 55%

How much of a hurry you're in: 48%

The likelihood of getting a ticket: 35%

If the pedestrian steps into the road (vs. waiting at curb): 30%

Whether the driver next to you stops or not: 35%

If there are vehicles close behind you: 28%

The number of pedestrians in the crosswalk: 23%

If the pedestrian waves an arm or makes a signal: 18%

"What do you think would increase driver yielding to pedestrians in the crosswalk?"

Signage: 58%

High-visibility striping: 55%

Enforcement: 48%

Driver education: 45%

In-pavement lighting: 35%

More assertive pedestrians: 10%

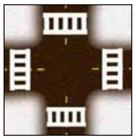
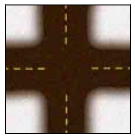
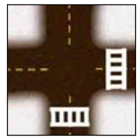
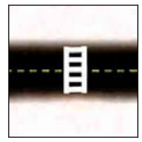
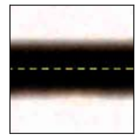
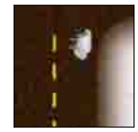
Narrower roads: 7%

Other: 8%

Pedestrian Survey

Traffic Safety Center, UC Berkeley   Survey #:_________________

1. When do pedestrians trying to cross the street have the right of way (check all that apply)?

						
At marked crosswalks at intersections	*At intersections without a marked crosswalk*	*If there is an intersection with a marked crosswalk on one side of the street, only in the marked crosswalk*	*At marked crosswalks midblock*	*Midblock without a marked crosswalk*	*When pedestrian is on the curb*	*When pedestrian is in the street*
1	2	3	4	5	6	7

2. In general, how often do drivers yield to you when you are on the curb WAITING to cross the street at a marked crosswalk?

Almost Never	**Rarely**	**Sometimes**	**Frequently**	**Almost Always**	**NA**
Less than 1 time out of 10	*1–2 times out of 10*	*3–5 times out of 10*	*6–8 times out of 10*	*9–10 times out of 10*	
1	2	3	4	5	6

3. In general, how often do drivers yield to you when you are CROSSING the street in a marked crosswalk?

Almost Never	**Rarely**	**Sometimes**	**Frequently**	**Almost Always**	**NA**
Less than 1 time out of 10	*1–2 times out of 10*	*3–5 times out of 10*	*6–8 times out of 10*	*9–10 times out of 10*	
1	2	3	4	5	6

4. How assertive are you as a pedestrian?

I **always** wait for gaps or for someone to stop before crossing	I **usually** wait for gaps or for someone to stop before crossing	I sometimes cross the street without waiting for someone to slow down for me, and sometimes I wait for gaps in traffic.	I **usually** begin to cross the street regardless of whether cars are already slowing down	I **always** begin to cross the street regardless of whether cars are already slowing down	*NA*
1	2	3	4	5	6

5. Are there places you know of where drivers seem to yield to pedestrians more often? 1Yes 2No

If so, where? And why do you think that is?____

____

6. How many times have you experienced a pedestrian/vehicle conflict at an intersection?

None	Barely any	A few times	A fair number	Many	*NA*
1	2	3	4	5	6

If more than none, what usually happens that causes the conflict?

____

7. How much do you agree or disagree with the following statements?

	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
I always wait for gaps or for someone to stop before crossing	1	2	3	4	5
If traffic is moving slower than 25mph, I usually begin to cross the street regardless of whether cars are already slowing down	1	2	3	4	5
If traffic is moving faster than 25mph, I usually begin to cross the street regardless of whether cars are already slowing down	1	2	3	4	5

8. What do you think would increase driver yielding to pedestrians in crosswalks (check all that apply)?

1 signage (ie "Yield to Pedestrians")
2 high-visibility crosswalk striping
3 in-pavement crosswalk lighting
4 enforcement/fines for violations
5 driver education
6 narrower roads or slower road design
7 more assertive pedestrians crossing more often
8 Other: ___________________________(please explain)

9. Which of the following, if any, are illegal for pedestrians to do in California:

Crossing midblock between two signals	Crossing midblock if there's no signal nearby	Crossing at an intersection with no marked crosswalk	Stepping out in front of a vehicle, even in a marked crosswalk
1	2	3	4

10. As a pedestrian wanting to cross at a marked crosswalk with no signal or stop sign, what do you normally do? (check all that apply)

Wait on the curb	Take one step into the street	Take 2-3 steps into the street	Make eye contact with the driver	Put your hand out or make other signal	Other: _______________

11. As a pedestrian, how often do you cross outside of a marked crosswalk?

Almost Never	**Rarely**	**Sometimes**	**Frequently**	**Almost Always**	**NA**
Less than 1 time out of 10	1–2 times out of 10	3–5 times out of 10	6–8 times out of 10	9–10 times out of 10	

12. What affects whether you cross outside of a crosswalk or not (check all that apply)?

Distance to crosswalk or intersection
Amount of traffic on the road
Whether other pedestrians are doing the same thing
Speed of traffic on the road
Likelihood of getting a ticket
Being in a hurry
. Other: ____________________

13. What percentage of time on average would you estimate you spend using an **automobile** for your local travel? (Circle the appropriate percentage)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|

14. What percentage of your travel time do you spend using other forms of travel?

Walking________ Transit_________ Biking________ Other________

15. Are you willing to participate in a focus group about driver and pedestrian behavior? Yes No

If Yes, Contact info: First Name: ____________________ phone: ____________________
Email: ________________________

16. Age: 1 18-29 2 30 – 39 3 40 – 59 4 60 – 75 5 75 or older

17. Sex: 1 Male 2 Female

Any Comments?

____

____

____

THANK YOU!

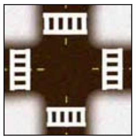
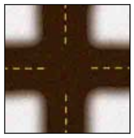
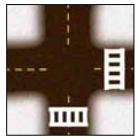
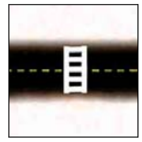
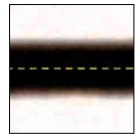
Location: ________________	**Time:** _______
Day: ________________	**Initials:** ________

Driver Survey

Traffic Safety Center, UC Berkeley

Survey #:____________________

1. When do pedestrians trying to cross the street have the right of way (check all that apply in the box below)?

						
At marked crosswalks at intersections	At intersections without a marked crosswalk	an intersection with a marked crosswalk on one side of the street, only in the marked crosswalk	At marked crosswalks midblock	Midblock without a marked crosswalk	When pedestrian is on the curb	When pedestrian is in the street
❑1	❑2	❑3	❑4	❑5	❑6	❑7

2. As a driver, how often do you stop for a pedestrian who has entered a **marked** crosswalk in front of you?

Almost Never	**Rarely**	**Sometimes**	**Frequently**	**Almost Always**	**NA**
Less than 1 time out of 10	*1–2 times out of 10*	*3–5 times out of 10*	*6–8 times out of 10*	*9–10 times out of 10*	
1	2	3	4	5	6

3. As a driver, how often do you stop for a pedestrian who enters an intersection **without a marked crosswalk**?

Almost Never	**Rarely**	**Sometimes**	**Frequently**	**Almost Always**	**NA**
Less than 1 time out of 10	*1–2 times out of 10*	*3–5 times out of 10*	*6–8 times out of 10*	*9–10 times out of 10*	
1	2	3	4	5	6

4. As a driver, how often do you yield to a pedestrian on the curb **waiting to cross the street** at a crosswa k?

Almost Never	**Rarely**	**Sometimes**	**Frequently**	**Almost Always**	**NA**
Less than 1 time out of 10	*1–2 times out of 10*	*3–5 times out of 10*	*6–8 times out of 10*	*9–10 times out of 10*	
1	2	3	4	5	6

5. When slowing for a pedestrian in a marked crosswalk, what are things you usually do (check all that apply)?

Stop a car length before crosswalk	Stop completely before the crosswalk	Slow down so the pedestrian can pass, but don't stop	Make a hand or other signal to the pedestrian	*Other:* ________________
1	2	3	4	5

6. Are there places you know of where pedestrians are more assertive in crossing the street? Yes No

If so, where? ____

Why? ____

7. How much do you agree or disagree with the following statements?

Statement	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
I always stop for pedestrians under any circumstance.	1	2	3	4	5
I never stop for pedestrians who are waiting on the sidewalk, only those already crossing.	1	2	3	4	5
I always stop for pedestrians under any circumstance	1	2	3	4	5
If traffic is moving faster than 25mph, I always stop for pedestrians waiting on the sidewalk	1	2	3	4	5
If traffic is moving faster than 25mph, I always stop for pedestrians already crossing in the roadway	1	2	3	4	5
If traffic is moving slower than 25mph, I always stop for pedestrians waiting on the sidewalk	1	2	3	4	5
If traffic is moving slower than 25mph, I always stop for pedestrians already crossing in the roadway	1	2	3	4	5

8. How many times have you experienced a pedestrian/vehicle conflict at an intersection?

None	Barely any	A few times	A fair number	Many	NA
1	2	3	4	5	6

If more than none, what usually happens that causes the conflict? ____________________________________

____

9. What affects whether you stop for a pedestrian in a marked crosswalk or not (check all that apply)?

1 How fast you're driving
2 Whether the pedestrian makes eye contact with you
3 The age of the pedestrian (young, teen, adult, older)
4 If the pedestrian steps into the road (vs. waiting at curb)
5 If there are vehicles close behind you
6 How much of a hurry you're in
7 The likelihood of getting a ticket
8 If the pedestrian waves an arm or makes a signal
9 The number of pedestrians in the crosswalk
10 Whether the driver next to you stops or not
11 Other: ____________________

10. What do you think would increase driver yielding to pedestrians in crosswalks (check all that apply)?

1 signage (ie "Yield to Pedestrians")
2 high-visibility crosswalk striping
3 in-pavement crosswalk lighting
4 enforcement/fines for violations
5 driver education
6 narrower roads or slower road design
7 more assertive pedestrians crossing more often
8 Other: ___________________________(please explain)

11. Which of the following, if any, are illegal for pedestrians to do in California:

Crossing midblock between two signals	Crossing midblock if there's no signal nearby	Crossing at an intersection with no marked crosswalk	Stepping out in front of a vehicle, even in a marked crosswalk
1	2	3	4

12. What percentage of time on average would you estimate you spend using an **automobile** for your local travel? (Circle the appropriate percentage)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|

13. What percentage of your travel time do you spend using other forms of travel?

Walking________ Transit_________ Biking________ Other________

14. Are you willing to participate in a focus group about driver and pedestrian behavior? Yes No

If Yes, Contact info: First Name: ____________________ phone: ____________________
Email: ________________________

15. Age: 1 18-29 2 30 – 39 3 40 – 59 4 60 – 75 5 75 or older

16. Sex: 1 Male 2 Female

Any Comments?

____

____

____

THANK YOU!

Location: ________________ **Time:** _______
Day: ________________ **Initials:** ________

Traffic Safety Center
Setting New Directions in Traffic Safety

CALIFORNIA PATH