Evaluation of Driver Yielding to Pedestrians at Uncontrolled Crosswalks

University of Wisconsin-Milwaukee
Robert J. Schneider, PhD
Xiao Qin, PhD
Mohammad Razaur Rahman Shaon
Aida Sanatizadeh
Zhaoxiang He
Peter Wykhuis
Benjamin Block

University of Wisconsin-Madison Traffic Operations and Safety (TOPS) Laboratory
Kelvin Santiago
Andrea Bill

Prepared for Wisconsin Department of Transportation

FINAL DRAFT
December 2017

Table of Contents

Executive Summary

Annual pedestrian fatalities have increased sharply in the United States since 2009, reaching their highest levels in nearly three decades, and Wisconsin is currently experiencing an increase in pedestrian fatalities. Reversing this trend is critical, especially as Wisconsin seeks to move toward zero traffic fatalities. The failure of drivers to yield the right-of-way to pedestrians in crosswalks[1] was the most common contributing circumstance cited in Wisconsin pedestrian crash reports between 2011 and 2015, so improving driver yielding is likely to reduce pedestrian crashes, injuries, and fatalities.

In response to this problem, this research report presents an exploratory survey from the Milwaukee, Madison, and La Crosse communities to document public knowledge of pedestrian right-of-way laws and public perceptions of driver yielding and pedestrian crossing behavior at uncontrolled intersections. It also analyzes driver yielding rates from field observations at 20 uncontrolled crosswalks (i.e., crosswalk locations without a traffic signal or stop sign for the driver) in Milwaukee and explores the relationship between driver assertiveness and pedestrian assertiveness by reviewing detailed video data at two uncontrolled crosswalks in Milwaukee and Madison. Overall, the research found low driver yielding rates. Further, pedestrians are often cautious, not assertive, when crossing at uncontrolled intersections[2].

Key findings include:

- **Most survey respondents perceived that drivers do not yield to pedestrians in crosswalks on major (i.e., arterial and collector) roadways.** Of approximately 420 online survey respondents, most perceived that local drivers do not yield to pedestrians at legal, uncontrolled crossings of major four-lane roadways:
    - Only 36% thought that drivers yield if there is a marked crosswalk.
    - 22% thought that drivers yield if there is an unmarked crosswalk.
    - Even on two-lane residential roadways, only 60% perceived that drivers yield to pedestrians in marked crosswalks at uncontrolled intersections.
- **Driver yielding rates were low on major roadways in Milwaukee.** Overall, drivers yielded 60 times out of 364 opportunities where the pedestrian wished to cross (16% driver yielding rate)[3]. Yielding rates differed between intersections, ranging from a high of 60% to a low of 0%. Four intersections that had more than 10 yielding opportunities during the two-hour observation period had 0% driver yielding rates.
- **Drivers were more likely to yield to pedestrians crossing roadways with lower posted speed limits and less motor vehicle traffic.** These roadway characteristics were significant in a statistical model of 364 yielding opportunities in Milwaukee. When vehicles are traveling faster, yielding to a pedestrian requires more distance and time. On roadways with more traffic,

[1] According to State Statute 340.01(75), "'Yield the right-of-way to a pedestrian' means the operator of a vehicle is required to reduce speed, or stop if necessary, to avoid endangering, colliding with or interfering in any way with pedestrian travel.

[2] There is no nationally-accepted definition of pedestrian assertiveness. For initial field data collection, this study recorded pedestrians as "acting assertively" if they exhibited any one of the following characteristics: 1) the pedestrian actively leaned toward the opposite side of the roadway when in the crosswalk, 2) the pedestrian directed his or her eyes toward approaching drivers for more than 3 seconds, or 3) the pedestrian pointed his or her arms or fingers toward the crosswalk. Later phases of the study used video observations to develop a more detailed definition of assertiveness, described in Section 4.3 and Section 5.5.

[3] Narrowing the definition of driver yielding opportunities to match the state law exactly (when the pedestrian put at least one foot in the roadway) shows a driver yielding rate of 18% (54 drivers yielded out of 298 opportunities).

drivers may be hesitant to yield due to concerns about being struck from behind by another vehicle.

- **Drivers were more likely to yield when the pedestrian crossing distance was shorter.** This roadway characteristic was significant in the model of 364 yielding opportunities in Milwaukee. Wider roads may be associated with higher travel speeds, regardless of speed limit, making it more difficult for drivers to yield.
- **Drivers were more likely to yield when pedestrians indicated their intention to cross more clearly.** According to State Statute 326.43(2), drivers shall yield the right-of-way to pedestrians who have started to cross the roadway in a crosswalk. Correspondingly, pedestrians who waited in the street and pedestrians who approached the crossing more assertively experienced a significantly higher probability of drivers yielding in the statistical model than pedestrians who did not look at oncoming traffic or stood away from the crosswalk. Video collected at one crosswalk in Madison and one crosswalk in Milwaukee showed:
    - 71% (48 of 68) of drivers yielded to pedestrians who entered the crosswalk without changing their walking pace.
    - 30% (25 of 82) of drivers yielded to pedestrians who stood in the street or at the curb or indicated that they wanted to cross by looking directly at oncoming traffic or making a gesture with their hand or body.
    - Only 3% (1 of 29) of drivers yielded to pedestrians who did not look at oncoming traffic or stood away from the crosswalk.
- **Higher driver yielding rates were associated with fewer pedestrian crashes.** The statistical model showed that intersections with no reported pedestrian crashes in the last five years had higher driver yielding rates than intersections with at least two reported pedestrian crashes.
- **Many survey respondents reported that pedestrians are cautious when crossing at uncontrolled intersections.** Of approximately 390 people who responded about their local community, 39% perceived that local pedestrians would not cross the street in an uncontrolled, marked crosswalk on a residential two-lane road with a motor vehicle approaching (even though the driver is required to yield the right-of-way). 70% perceived that pedestrians would not cross the street in a similar situation on a major four-lane road. Compared to Madison and La Crosse, fewer Milwaukee respondents thought that pedestrians would cross if a motor vehicle was approaching. This result should be interpreted cautiously because the survey did not clarify that the driver had sufficient time to stop if the pedestrian entered the crosswalk[4].
- **The general public is confused about how drivers should respond to pedestrians in unmarked crosswalks.** Of approximately 450 online survey respondents from the Milwaukee, Madison, and La Crosse regions:
    - Only 87% answered correctly that the driver must yield the right-of-way to a pedestrian in an unmarked crosswalk on a residential two-lane roadway.
    - Only 66% answered correctly that the driver must yield the right-of-way to a pedestrian in an unmarked crosswalk on a four-lane roadway.

[4] According to State Statute 346.24(2), "No pedestrian, bicyclist, or rider of an electric personal assistive mobility device shall suddenly leave a curb or other place of safety and walk, run, or ride into the path of a vehicle which is so close that it is difficult for the operator of the vehicle to yield."

These research findings support the following education and enforcement strategies to increase driver yielding:

- **Increase the reach of pedestrian safety education programs.** Pedestrian safety programs, such as the statewide Share and Be Aware campaign, help educate drivers, pedestrians, and bicyclists about laws and behaviors that promote safety for all roadway users, especially pedestrians and bicyclists. Ensure that effective pedestrian safety programs and messages continue to educate drivers on their responsibility to yield to pedestrians in marked and unmarked crosswalks, educate pedestrians about legal rights and responsibilities when crossing the street, and encourage pedestrians to indicate their intent to cross the street.
- **Ensure that laws to yield the right-of-way to pedestrians in crosswalks are emphasized in driver education courses.** Driver education classes are required prior to taking driving tests and obtaining a driver license. Therefore, driver education curricula should emphasize that it is a driver's responsibility to yield the right-of-way to pedestrians (as well as bicyclists and users of personal assistive mobility devices) in crosswalks.
- **Foster a safety culture of yielding the right-of-way among professional drivers.** Professional drivers include bus and shuttle drivers, truck drivers, law enforcement officers, first responders, delivery workers, taxi and transportation network company (TNC) operators, and other company drivers. These professionals can help demonstrate exemplary driving behavior, potentially leading to a tipping point where yielding to pedestrians is seen as the normal behavior in Wisconsin. The need to create a safety culture of yielding is not unique to professional drivers. Staying alert and reducing speed improves conditions for all roadway users, especially for people who are walking and crossing the roadway. However, professional drivers are a logical initial audience for crosswalk right-of-way education and enforcement because they may be reached more quickly through job training and their jobs depend on good driving behavior.
- **Conduct sustained high-visibility enforcement (HVE) programs in multiple communities.** Previous studies have shown that HVE programs can change driver yielding behavior and increase pedestrian safety over time (Van Houten et al. 2013; Van Houten et al. 2017). Evaluation of HVE program in Gainesville, FL (Van Houten et al. 2013) shows the importance of sustained enforcement and media outreach efforts. This study found a slight increase in driver yielding after the limited HVE efforts in Milwaukee and Madison in 2016, though this was not statistically significant. The longer-term Gainesville study shows promise. HVE should be complemented by other enforcement, education, and engineering strategies to increase driver yielding and ultimately improve pedestrian safety in Wisconsin.

The statistical model results support the following engineering strategies to increase driver yielding:

- **Reduce roadway design speeds and reduce posted speed limits.** This may include minimizing the total number of motor vehicle lanes, minimizing motor vehicle lane widths, and introducing other features to roadways that provide visual cues to travel slowly. Since reducing vehicle speeds provides more time for drivers to react to pedestrians and to come to a stop, consider reducing all posted speed limits to 25 miles per hour on two-lane roadways in urban and other areas where pedestrian crossings are frequent. Also consider posting speed limits lower than 25 miles per hour in areas with very high pedestrian activity.
- **Reduce pedestrian crossing distances.** This may include installing curb extensions, installing median islands, reducing the number of motor vehicle lanes, and reducing motor vehicle lane widths.

The review of previous studies and guidelines also supports the following engineering strategies to increase driver yielding:

- **Install pedestrian crossing signs and beacons.** These signs include MUTCD R1-6 "State Law: Yield to Pedestrian" signs and MUTCD W11-2 pedestrian crossing signs with rapid flashing beacons. Locations for these devices should be chosen carefully and combined with other engineering, education, and enforcement treatments to ensure that they translate the message of driver yielding to all pedestrian crossings in a community.
- **Test the Gateway Treatment at pilot locations in several communities.** The Gateway Treatment uses a set of three to four MUTCD R1-6 "State Law: Yield to Pedestrian" signs placed on the centerline or median island and at both curbs to emphasize a crosswalk. On multilane roadways, high-visibility bollards can be placed on lane lines. Michigan DOT has experimented with this treatment and has shown positive results (Bennett and Van Houten 2016; Van Houten and Hochmuth 2016).
- **Follow FHWA guidelines for marked crosswalks and utilize Safe Transportation for Every Pedestrian (STEP) proven safety countermeasures.** When simple painted markings are used to designate the crosswalk on major roadways, drivers and pedestrians may learn that these markings have little practical meaning. This does not mean that marked crosswalks should be eliminated; it means that marked crosswalks on major roadways should be supplemented with specific crossing treatments (e.g., median islands, pedestrian hybrid beacons) or roadway redesigns that produce safer crossings where drivers will be more likely to yield. Many of the possible safety treatments are identified by FHWA as STEP proven safety countermeasures for uncontrolled crossing locations.

This exploratory study has several limitations that should be considered. The online survey was distributed by the research team to professional and social contacts who then shared it with others. A larger and randomly-selected set of respondents would provide an even better understanding of public knowledge and perceptions related to driver and pedestrian interactions.

Driver yielding behavior was only observed at 20 intersections on major two-lane roadways in Milwaukee. Posted speed limits were either 25 or 30 miles per hour. Future studies could increase the sample size and collect driver yielding behavior in other urban, suburban, and small village areas. Observations could also be collected on roadways with a wider range of speeds, functional classifications, different numbers of travel lanes, and a variety of pedestrian crossing treatments, such as median islands, curb extensions, and rapid flashing beacons. Driver yielding should also be observed at night during dark conditions.

Future studies could test the effect of overall pedestrian volumes on driver yielding. They could also use high-definition video from multiple sites to quantify vehicle and pedestrian trajectories and identify which particular body gestures or movements communicate the intention to cross most effectively to drivers.

1. Introduction

Wisconsin State Statutes 346.23 and 346.24 require drivers to yield the right-of-way to pedestrians who are crossing a roadway (i.e., have left the curb) within a marked or unmarked crosswalk[5]. Pedestrians are not to suddenly leave the curb or other place of safety so that it is difficult for the operator of the vehicle to yield (see statutory language below). A driver is to yield the right-of-way at both controlled and uncontrolled intersections (though there are additional conditions that apply to pedestrians at controlled intersections before proceeding to cross). Overall, the crosswalk right-of-way law is not followed consistently in many communities throughout the state, which has led to pedestrian crashes, injuries, and fatalities. Driver "failure to yield the right-of-way" was the most common contributing circumstance mentioned in police reports, cited in 1,735 (22%) of the 8,020 pedestrian crashes at controlled and uncontrolled intersections reported in Wisconsin between 2011 and 2015 (Wisconsin TOPS Lab 2017).

Wisconsin State Statute 346.23. Crossing controlled intersection or crosswalk.

(1) At an intersection or crosswalk where traffic is controlled by traffic control signals or by a traffic officer, the operator of a vehicle shall yield the right-of-way to a pedestrian, or to a person who is riding a bicycle or electric personal assistive mobility device in a manner which is consistent with the safe use of the crosswalk by pedestrians, who has started to cross the highway on a green signal or a pedestrian signal authorizing crossing and in all other cases pedestrians, bicyclists, and riders of electric personal assistive mobility devices shall yield the right-of-way to vehicles lawfully proceeding directly ahead on a green signal. No operator of a vehicle proceeding ahead on a green signal may begin a turn at a controlled intersection or crosswalk when a pedestrian, bicyclist, or rider of an electric personal assistive mobility device crossing in the crosswalk on a green signal or a pedestrian signal authorizing crossing would be endangered or interfered with in any way. The rules stated in this subsection are modified at intersections or crosswalks on divided highways or highways provided with safety zones in the manner and to the extent stated in sub. (2).

(2) At intersections or crosswalks on divided highways or highways provided with safety zones where traffic is controlled by traffic control signals or by a traffic officer, the operator of a vehicle shall yield the right-of-way to a pedestrian, bicyclist, or rider of an electric personal assistive mobility device who has started to cross the roadway either from the near curb or shoulder or from the center dividing strip or a safety zone with the green signal or a pedestrian signal authorizing crossing in the favor of the pedestrian, bicyclist, or rider of an electric personal assistive mobility device.

Wisconsin State Statute 346.24. Crossing at uncontrolled intersection or crosswalk.

(1) At an intersection or crosswalk where traffic is not controlled by traffic control signals or by a traffic officer, the operator of a vehicle shall yield the right-of-way to a pedestrian, or to a person riding a bicycle or electric personal assistive mobility device in a manner which is consistent with the safe use of the crosswalk by pedestrians, who is crossing the highway within a marked or unmarked crosswalk.

(2) No pedestrian, bicyclist, or rider of an electric personal assistive mobility device shall suddenly leave a curb or other place of safety and walk, run, or ride into the path of a vehicle which is so close that it is difficult for the operator of the vehicle to yield.

(3) Whenever any vehicle is stopped at an intersection or crosswalk to permit a pedestrian, bicyclist, or rider of an electric personal assistive mobility device to cross the roadway, the operator of any other vehicle approaching from the rear shall not overtake and pass the stopped vehicle.

Wisconsin State Statute 340.01(75)

"Yield the right-of-way to a pedestrian" means the operator of a vehicle is required to reduce speed, or stop if necessary, to avoid endangering, colliding with or interfering in any way with pedestrian travel.

Source: Wisconsin State Statutes. https://docs.legis.wisconsin.gov/statutes/statutes/346/IV/23, 2017.

[5] According to State Statute 340.01(10), a "marked crosswalk" is "any portion of a highway clearly indicated for pedestrian crossing by signs, or pavement markings" (part a), and an "unmarked crosswalk" is "in the absence of signs or pavement markings, that part of a roadway, at an intersection, which is included within the transverse lines which would be formed on such roadway by connecting the corresponding lateral lines of the sidewalks opposite sides of such roadway or, in the absence of a corresponding sidewalk on one side of the roadway, that part of such roadway which is included within the extension of the lateral lines of the existing sidewalk across such roadway at right angles to the center line thereof, except in no case does an unmarked crosswalk include any part of the intersection in no case is there an unmarked crosswalk across a street at an intersection of such street with an alley" (part b).

This study focuses on pedestrians crossing at uncontrolled crosswalks—locations without a traffic signal or stop sign for the driver. These locations are particularly important because they often involve interactions between pedestrians crossing the roadway and drivers traveling straight. Vehicles going straight tend to travel at higher speeds than turning vehicles, leading to more severe pedestrian injuries when collisions occur. A sample of Wisconsin pedestrian crashes from 2011 to 2013 showed that 77% of fatal crashes involved a vehicle going straight but only 49% of non-severe crashes involved a vehicle going straight (Schneider and Stefanich 2015).

This study investigates several questions related to driver yielding behavior in Wisconsin:

- How well does the general public understand laws that require drivers to yield the right-of-way to pedestrians?
- What are the social norms associated with driver and pedestrian interactions in different communities?
- How often do drivers yield to pedestrians in specific locations?
- What characteristics of drivers, pedestrians, and crosswalk locations are associated with whether or not drivers yield to pedestrians?
- How important are pedestrian assertiveness and driver assertiveness in determining whether or not drivers yield to pedestrians?[6]
- Can a High-Visibility Enforcement pilot program change behavior and improve pedestrian safety?

We used several approaches to evaluate driver and pedestrian interactions at uncontrolled crossings with marked and unmarked crosswalks, including a public survey in the Milwaukee, Madison, and La Crosse regions; short-duration field observations at 20 marked crosswalk sites in Milwaukee; and detailed field measurements at one marked crosswalk site in Milwaukee and one marked crosswalk site in Madison. It was not possible to gather comprehensive data from throughout the state to analyze each of these questions. Therefore, this should be considered a pilot study of driver and pedestrian interactions at uncontrolled crossings. The methods used here can be expanded upon in future studies to provide a more comprehensive assessment of driver yielding and pedestrian safety throughout Wisconsin.

This study comes at a critical time for pedestrian safety. Wisconsin averaged approximately 51 pedestrian fatalities per year between 2007 and 2016 (ranging from 40 in 2009 to 62 in 2011) (Wisconsin TOPS Laboratory 2017). However, preliminary 2017 data show a notable increase in Wisconsin pedestrian fatalities: the number of pedestrian fatalities between January 1 and December 10 increased from 47 in 2016 to 59 in 2017 (a 26% increase) (WisDOT 2017a). This increase is consistent with a disturbing national trend. United States pedestrian fatalities have increased from approximately 4,100 in 2009 to approximately 6,000 in 2016 (a 46% increase) (NHTSA 2017; Retting 2017). Reversing this trend is critical, especially as Wisconsin seeks to move toward zero traffic fatalities.

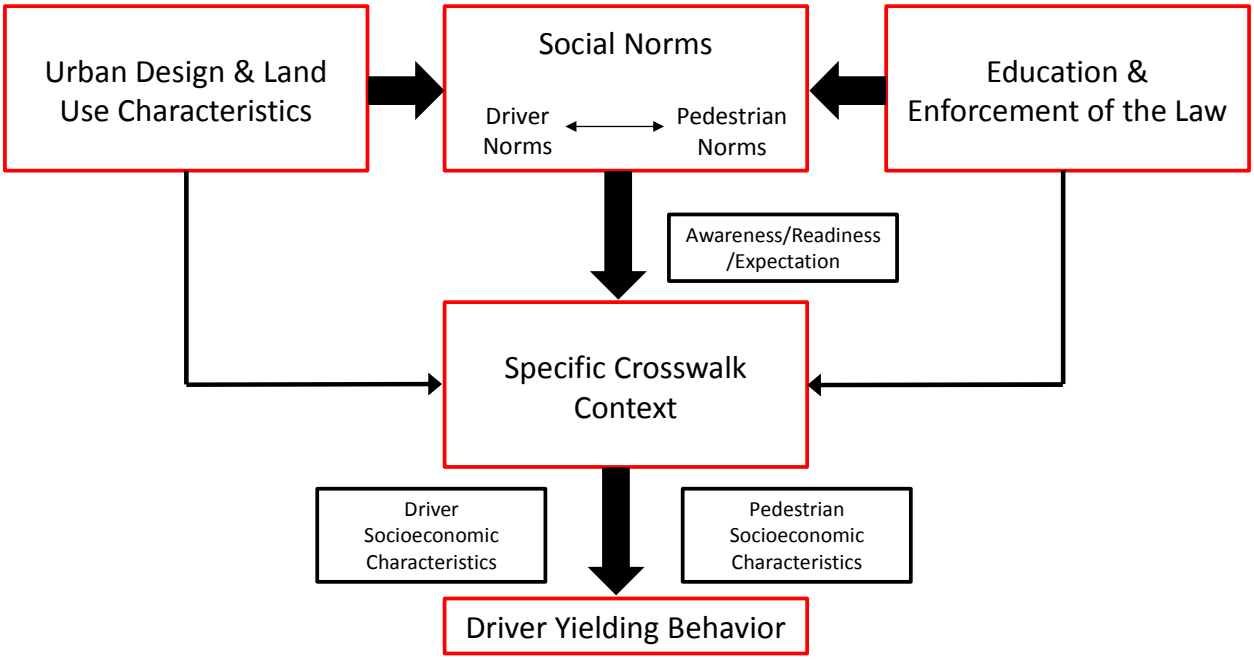
[6] There is no nationally-accepted definition of pedestrian assertiveness. For initial field data collection, this study recorded pedestrians as "acting assertively" if they exhibited any one of the following characteristics: 1) the pedestrian actively leaned toward the opposite side of the roadway when in the crosswalk, 2) the pedestrian directed his or her eyes toward approaching drivers for more than 3 seconds, or 3) the pedestrian pointed his or her arms or fingers toward the crosswalk. Later phases of the study used video observations to develop a more detailed definition of assertiveness, described in Section 4.3 and Section 5.5.

2. Previous Research

Previous studies suggest that there are a variety of factors that influence whether or not drivers yield to pedestrians in crosswalks. Schneider and Sanders (2015) developed a conceptual framework to suggest how community social norms and the specific crosswalk context lead to yielding behavior (Figure 1). This framework is useful for our study because it helps organize the factors associated with driver yielding. It also suggests that safety interventions such as roadway design and education and enforcement actions can influence both the community social norms (which help prepare drivers to be ready to yield) and the interactions between drivers and pedestrians at a specific crosswalk location (which ultimately leads to driver yielding). Interestingly, the study suggested that social norms differ among communities throughout North America, with higher rates of driver yielding in the northwestern part of the United States and southwestern part of Canada.

The following sections provide a brief overview of driver yielding studies. Many studies have explored specific community characteristics, roadway design features, and individual pedestrian and driver characteristics that associated with driver yielding behavior. Other studies have evaluated the effectiveness of high-visibility enforcement and other programs at improving driver yielding behavior.

Figure 1. Conceptual Framework Showing Influences on Driver Yielding Behavior



Source: Schneider, R.J. and R.L. Sanders. "Pedestrian Safety Practitioners' Perspectives of Driver Yielding Behavior across North America," Transportation Research Record: Journal of the Transportation Research Board, Volume 2519, pp. 39-50, 2015.

2.1. Design and Behavior Factors Associated with Driver Yielding Behavior

Many studies have focused on identifying roadway design and pedestrian and driver characteristics that are associated with driver yielding behavior.

2.1.1. Roadway Design Characteristics

A survey of nearly 400 pedestrian safety professionals throughout North America suggested that lower speed limits and fewer lanes along a roadway corridor were associated with higher driver yielding rates

in the communities where these professionals worked (Schneider and Sanders 2015). Lower posted speed limits were associated with higher driver yielding rates for several pedestrian crossing treatments (Fitzpatrick et al. 2006). Lower actual motor vehicle approach speeds were associated with higher rates of driver yielding in Massachusetts (Bertulis and Dulaski 2014). Further, shorter crossing distances were associated with higher yielding rates in a multi-state study (Fitzpatrick et al. 2016). In general, these studies suggest that roadways designed primarily to move large amounts of motor vehicle traffic quickly are less conducive to yielding than narrower, lower-speed roadways.

Many studies have tested how drivers respond to individual pedestrian design treatments at specific crosswalk sites. Driver yielding rates tend to be higher at crossings with MUTCD R1-6 in-street pedestrian crossing signs (Huang et al. 2000; Stapleton et al. 2017), gateway treatments (i.e., MUTCD R1-6 in-street signs at the center of the roadway and on the curbs near either end of the crosswalk) (Bennett and Van Houten 2016), advance yield markings (Van Houten, Malenfant, and McCusker 2001), median islands (Fitzpatrick et al. 2016), rapid flashing beacons (Van Houten, Ellis, and Marmolejo 2008; Shurbutt and Van Houten 2010; Ross, Serpico, and Lewis 2011), pedestrian hybrid beacons (Fitzpatrick et al. 2011), and leading pedestrian intervals at signalized intersections (Van Houten et al. 2000).

2.1.2. Pedestrian and Driver Characteristics

Many other studies have found connections between the characteristics of pedestrians and drivers and driver yielding behavior. Overall, higher pedestrian volumes may be associated with higher rates of driver yielding (Stapleton et al. 2017). Specific pedestrian characteristics may also relate to driver yielding. Drivers tend to yield more often to pedestrians holding a cane (Harrell 1992; Salamati et al. 2013) and pedestrians wearing brighter clothing (Harrell 1993). Several studies suggest that drivers yield more often to pedestrians who are white than to pedestrians of color (Goddard, Khan, and Adkins 2015; Coughenour et al. 2017). One study suggests that drivers of more expensive automobiles may yield less often to pedestrians than drivers of less expensive automobiles (Piff et al. 2012).

Studies also suggest that there is a relationship between pedestrian behavior and driver yielding behavior. Pedestrians who are more assertive tend to produce higher driver yielding rates (Schneider and Sanders 2015). Pedestrian assertiveness has also been identified as a significant factor in several other studies (Harrell 1993; Schroeder 2008; Schroeder and Rouphail 2011; Crowley-Koch and Van Houten 2011). However, studies do not use a consistent measure of "assertiveness." For example, pedestrian assertiveness has been defined as waiting in the street (rather than on the curb) (Harrell 1993), walking quickly toward the crossing (Schroeder 2008), and extending an arm in the direction of crossing (Crowley-Koch and Van Houten 2011).

2.2. Impact of Education and Enforcement Programs on Driver Yielding Behavior

Previous studies have indicated that there is general public confusion about how drivers and pedestrians should behave at crosswalks. In particular, many drivers and pedestrians have difficulty understanding the concept of an unmarked crosswalk (Mitman and Ragland 2007). Educational programs have been designed to improve pedestrian safety. An evaluation of a campus-based program that instructed drivers to "drive carefully" (among other messages targeted toward pedestrians and bicyclists) found a small increase in pedestrian and bicyclist perceptions that drivers yield to them after the campaign was conducted (Zhang et al. 2013).

Several studies of enforcement programs have shown improvements in driver yielding behavior. For example, Van Houten and Malenfant (2004) studied an enforcement program that issued tickets and warnings to drivers who did not yield to plainclothes police in crosswalks. Enforcement was targeted in

two roadway corridors, with more than 1,200 drivers stopped during a two-week period. The program also distributed educational materials to increase public awareness at the start of enforcement activities and used feedback signs to show the percentage of drivers who yielded to pedestrians in the previous week. Yielding rates in one corridor increased from lower than 5% in one corridor and lower than 20% in the other corridor to approximately 30% in both corridors. While the most intense enforcement was conducted for two weeks, the higher driver yielding rates were sustained for a full year afterward.

High-visibility enforcement (HVE) combines enforcement activities with public messaging and media outreach. A study for the National Highway Traffic Safety Administration (Van Houten et al. 2013) showed that HVE conducted over a full year led to significant increases in driver yielding rates in Gainesville, FL. During the initial phase of the study, nearly 1,200 warnings were issued to drivers for failure to yield. In subsequent months, nearly 400 tickets were issued. Yielding increased at the six crosswalks that received targeted enforcement (32% to 62% for staged crossings; 54% to 83% for regular crosswalk users) as well as at comparison sites with no targeted enforcement (37% to 59% for staged crossings; 50% to 73% for regular crosswalk users). The National Highway Traffic Safety Administration (NHTSA) conducted a follow-up study in Gainesville to document driver yielding rates at the same study sites four years after the HVE program (Van Houten et al. 2017). Far fewer failure-to-yield citations were issued in the years following the HVE program. Still, this study found that driver behavior continued to improve, producing significantly higher rates of driver yielding than when the HVE program ended four years earlier (77% at sites that had received targeted enforcement and 77% at comparison sites). Further, Gainesville's higher driver yielding rates were related to positive pedestrian safety outcomes. The number of annual pedestrian crashes in Gainesville decreased from 101.2 during 2006 to 2010 to 83.0 during 2012 to 2014. This decrease was statistically significant.

The Gainesville program was sustained over multiple months and included a large amount of media coverage. Enforcement focused on multiple crosswalks, low-cost engineering treatments were applied at some locations, and the program used feedback signs to report the percentage of drivers yielding in the community during the previous week. The importance of media attention to increase the perceived probability of receiving a ticket has been stressed for several types of traffic safety programs, including increasing safety belt use and reducing alcohol-impaired driving (Waller et al 1984; Elder et al. 2004; Van Houten et al. 2013).

The effectiveness of enforcement program duration and intensity has not been researched thoroughly. One of the only studies to examine these attributes tested different levels of crosswalk enforcement within a six-month period at five Raleigh, NC crosswalks (Findley et al. 2016). The crosswalks were categorized as high-intensity, short-duration; high-intensity, long-duration; medium-intensity, long-duration; low-intensity, long-duration; and control. The site with medium-intensity, long duration enforcement showed the greatest increases in driver yielding rates (from approximately 30% to 50%). Other sites did not appear to show large changes in driver yielding relative to the control site. More data are needed to test the effects of enforcement program duration and intensity, but this preliminary study suggests the importance of long-duration enforcement for increasing driver yielding.

2.3. Comprehensive Programs to Change Driver Yielding Behavior

Many safety strategies recommend a comprehensive approach involving engineering, education, and enforcement treatments, but few studies have quantified the impacts of coordinated efforts. One North Carolina study tested the impacts of the combination of enforcement, low-cost engineering treatments (i.e., signage and pavement markings), and broad community outreach about pedestrian safety, finding

that driver yielding rates increased 4% to 7% over a six-month period at crosswalks where treatments were focused (Sandt et al. 2016).

3. Pedestrian Safety Programs

The focus of this report is on how to change motorist and pedestrian behavior to reduce pedestrian crash risk. One strategy of particular interest is high-visibility enforcement (HVE). The WisDOT Bureau of Transportation Safety (BOTS) helped provide support for HVE efforts to be conducted near three large university campuses in Milwaukee and Madison in fall 2016. These efforts are described below. This section also summarizes several other statewide engineering and education efforts that complement HVE efforts to improve pedestrian safety.

3.1. High Visibility Enforcement Efforts

The following sections summarize the high-visibility enforcement efforts conducted by law enforcement at the University of Wisconsin-Milwaukee, the University of Wisconsin-Madison, and Marquette University.

3.1.1. University of Wisconsin-Milwaukee Police

The UW-Milwaukee Police Department (UWMPD) dedicated 136 hours in September 2016 to pedestrian safety High-Visibility Enforcement (HVE). In general, HVE was done between 8 am and 9 pm on weekdays, with most warnings and citations given between 8 am and 5 pm. Officers focused enforcement on pedestrians crossing at mid-block locations without a crosswalk and drivers not yielding to pedestrians in uncontrolled crosswalks. Most of the enforcement was done on Maryland Avenue between Kenwood Boulevard and Hartford Avenue, but enforcement was also done in the 2300 block of Hartford Avenue and 2200 Block of Kenwood Avenue (in front of the Student Union). The police department did not receive general positive or negative feedback about the HVE effort, but there were some individual drivers who had negative reactions to being stopped for not yielding to pedestrians in crosswalks (they tended to wonder why they were pulled over when most other drivers were guilty of the same thing). The HVE effort at UW-Milwaukee was covered in the UWM Report on April 14th, 2016 ("UWM Police begin extra patrols to increase pedestrian safety," by UWM News). UWMPD was also interviewed about the HVE effort by WISN, Chanel 12.

3.1.2. City of Madison Police

The City of Madison Police Department conducted pedestrian safety initiatives between June and September 2016. These pedestrian safety initiatives focused on enforcement of pedestrian right-of-way within marked crosswalks at uncontrolled locations. Drivers who did not yield to pedestrians were issued warnings and citations. An innovative aspect of these initiatives is that Madison courts provided some drivers with an opportunity to take a class covering pedestrian and bicycle safety rather than pay the fine associated with the citation. While the Madison Police Department Traffic Enforcement Team conducts crosswalk enforcement in Madison at other times, support from the WisDOT BOTS made it possible to reach more than 10 locations, including several near the University of Wisconsin-Madison campus and several in other parts of Madison. Several of the early pedestrian safety initiatives were covered by the local media.

3.1.3. Marquette University Police

High-Visibility Enforcement (HVE) was done by a team of officers at several locations on the Marquette University Campus from 6:30 pm on Friday, September 9th until 3:30 am on Saturday, September 10th. There were two main locations and purposes of the HVE effort:

- The midblock crosswalk on 16th Street between Wisconsin Avenue and Wells Street. Enforcement targeted drivers who did not yield to pedestrians using this crosswalk. The crosswalk includes pedestrian warning signs and pedestrian-activated rapid flashing beacons.

During the HVE period, 32 drivers were stopped (20 were given warnings and 12 were given citations).

- The intersection of 16th Street and Wells Street. Enforcement targeted pedestrians who crossed the intersection against the red signal. The police effort was mostly positive reinforcement. Pedestrians who waited to cross on green were given a set of three coupons that could be redeemed for food and drink items at 7-Eleven (approximately $5 value). More than 100 coupons were distributed.

Other enforcement efforts throughout the campus are included 20 warnings given to pedestrians for crossing against a red signal, 12 warnings given to pedestrians for crossing at midblock locations without a crosswalk, and 1 citation given to a pedestrian crossing at a midblock location without a crosswalk. Overall, the HVE effort was viewed positively by the campus community.

These pedestrian safety efforts received some media coverage. The Marquette University Police (MUP) posted information about the HVE efforts prior to September 9th on Facebook. In addition, the Marquette Wire (student newspaper) published stories about the September HVE effort on September 27th, 2016 ("Anti-jaywalking funding expires, MUPD to continue efforts," by Dean Bibens). It had published stories on previous efforts, including on March 3rd, 2016 ("MUPD using grant to increase pedestrian safety around campus," by Ryan Patterson).

The MUP noted that one often overlooked barrier to conducting traffic stops to warn or cite drivers for not yielding to pedestrians is that the outcome of a traffic stop can divert the officers time away from pedestrian safety enforcement. In particular, if the police stop a driver and passengers who have warrants out for their arrest, they will often need to take time to transport the suspects to a different police department for holding. This is a resource issue for a small-budget police department like the MUP.

3.2. Other Efforts to Improve Pedestrian Safety: Education and Engineering Strategies

In order to improve driver yielding behavior, enforcement programs can be complemented by education and engineering strategies. This section describes existing education and engineering efforts in Wisconsin.

3.2.1. Education Programs

The Share and Be Aware campaign is administered throughout the state by the Wisconsin Bicycle Federation in partnership with WisDOT BOTS. This program educates drivers, pedestrians, and bicyclists on rules of the road and teaches behaviors that promote safety among people using all types of transportation on Wisconsin's roadways. Educational messages include the responsibility for drivers to yield the right-of-way to pedestrians in crosswalks (Wisconsin Bicycle Federation 2017).

3.2.2. Engineering Improvements

Wisconsin has more than 115,000 miles of public roads, from freeways to local streets (WisDOT 2017b). WisDOT maintains only the state highway system, which represents just over 10% of these roadway miles (11,700 miles). The other roadways are improved and maintained by the cities, towns, counties and villages in which they are located.

WisDOT has programs and policies that include transportation facilities for people who bicycle and walk. This includes making safety improvements to improve conditions for people that are walking and crossing the roadway. Improvements may occur as part of an overall roadway project or as a standalone

project. There are various factors, such as location, crash history, adjacent land uses, project scope, and community input, which are used to determine the type and extent of facilities and improvements to include within a project. See Chapter 11 (and especially Section 11-46) of the WisDOT Facilities Development Manual (WisDOT 2016) for more details.

Local communities are instrumental in the process of incorporating pedestrian safety improvements on the state highway system. Facilities with clear benefits for pedestrian safety, such as sidewalks and pedestrian crossing facilities (e.g., median islands, rapid flashing beacons) need to be requested by local communities through officially-adopted plans or on a project-by-project basis during the design process.

Cities, towns, villages, and counties within Wisconsin also maintain most local roadways within their own jurisdictions. By constructing new and retrofitting existing roadways with pedestrian facilities and other pedestrian-friendly characteristics (e.g., slower design speeds), these communities can also create supportive environments for driver yielding and help improve pedestrian safety.

4. Data Collection and Analysis Methods

We collected and analyzed data related to driver yielding behavior using several methods. These included an online survey, naturalistic observations in the field, and detailed video analysis of pedestrian and driver interactions. The purpose of each data collection and analysis method is described below.

4.1. Driver and Pedestrian Interaction Survey

We designed an online Driver and Pedestrian Interaction Survey to gauge public understanding of pedestrian traffic laws, perceptions of traffic enforcement, and perceptions of pedestrian and driver behavior. The survey was targeted at participants living within the Milwaukee, Madison, and La Crosse regions, so the results focused on respondents who lived within 50 miles of the center of each of these cities (Figure 2). The online survey was designed to take approximately five minutes to complete and was distributed through e-mail and social media between August 5, 2016 and December 2, 2016. The survey method was approved through the University of Wisconsin-Madison Social/Behavioral Science Institutional Review Board (IRB). Since the survey was distributed through e-mail and social networks by the research team, it is likely that the respondents were somewhat more informed about traffic safety and pedestrian safety than the general public. The survey instrument is provided in Appendix A. All of the open-ended survey responses are presented in Appendix B.

We received 507 total responses to the online survey in fall 2016. After removing incomplete and duplicate responses, we analyzed 454 clean responses. Of the 454 respondents, 228 (50%) lived in Madison, 124 (27%) lived in Milwaukee, and 65 (14%) lived in La Crosse. The remaining 37 (7%) were from out of state, other parts of Wisconsin, or did not provide a zip code. All age categories were represented, with the greatest proportion of respondents between 25 and 34 years old (33%) (Figure 3).

Figure 2. Wisconsin Pedestrian and Driver Interaction Survey Target Areas

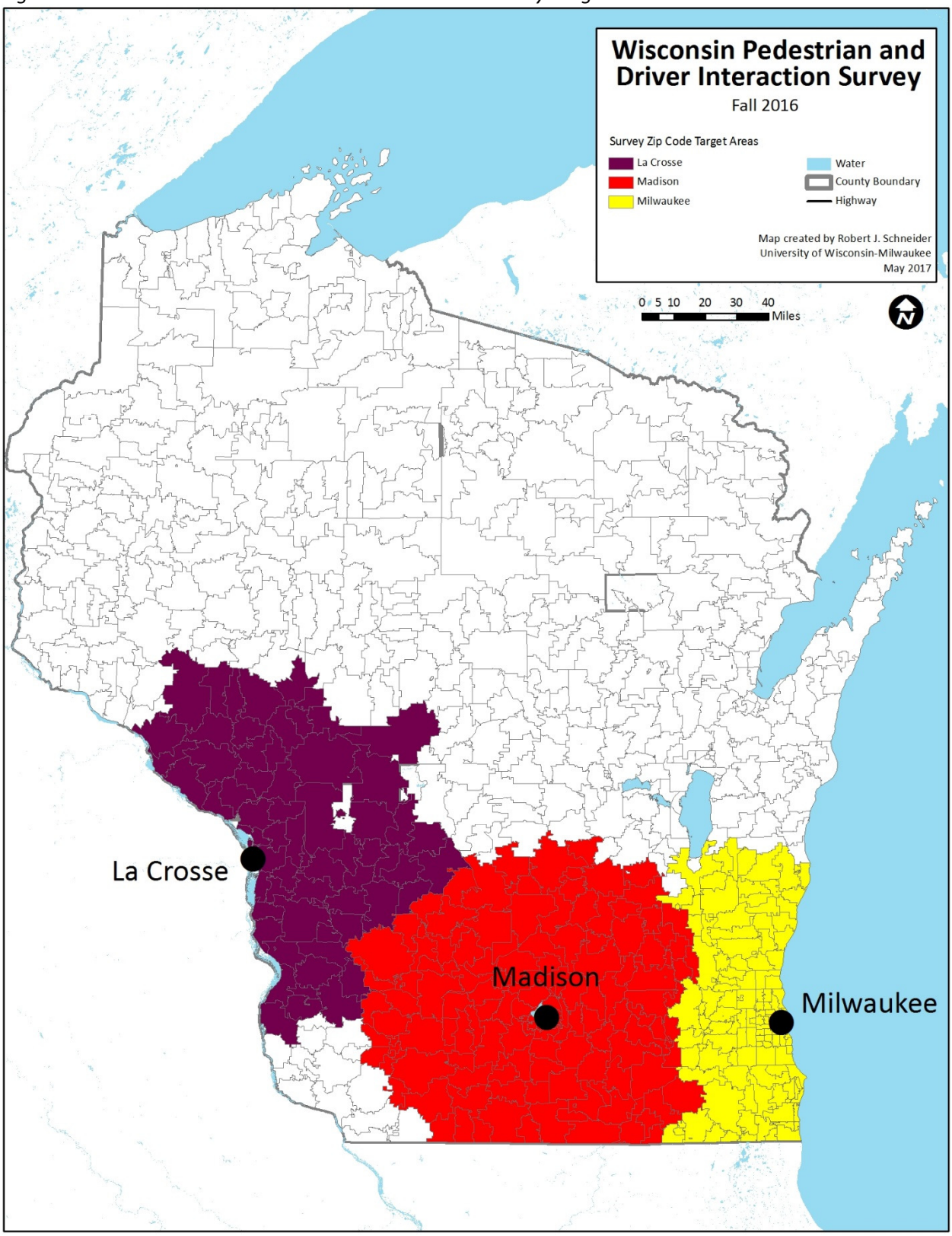
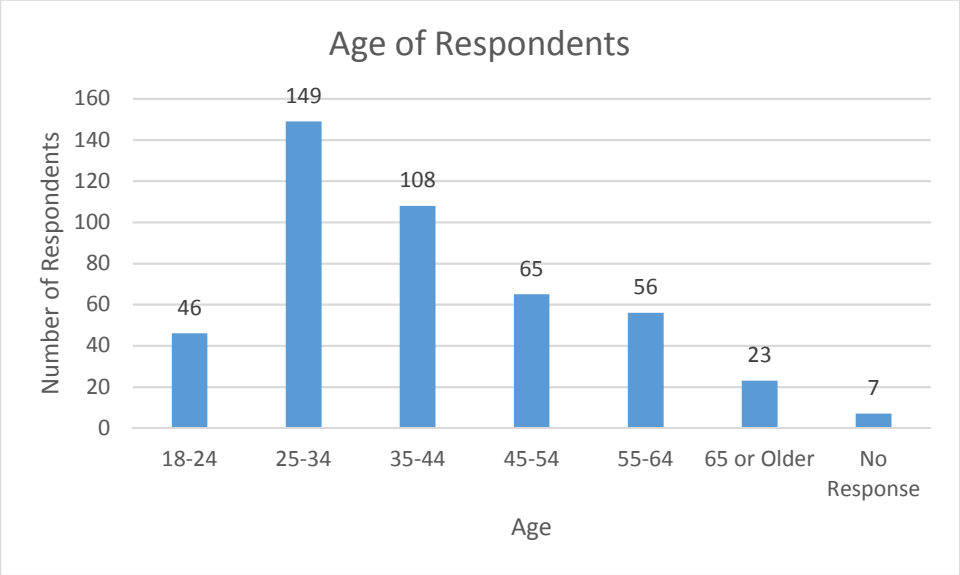


Figure 3. Driver and Pedestrian Interaction Survey: Age of Respondents



Most respondents (71%) had more than 10 years of driving experience (Figure 4), though 24% of all respondents did not drive on a typical weekday (Figure 5). Nearly all respondents had routine walking experience; 96% reported crossing at least one street on a typical weekday. More than 20% of respondents reported crossing at least 20 streets on a typical weekday (Figure 6).

Figure 4. Driver and Pedestrian Interaction Survey Respondents: Years of Driving Experience

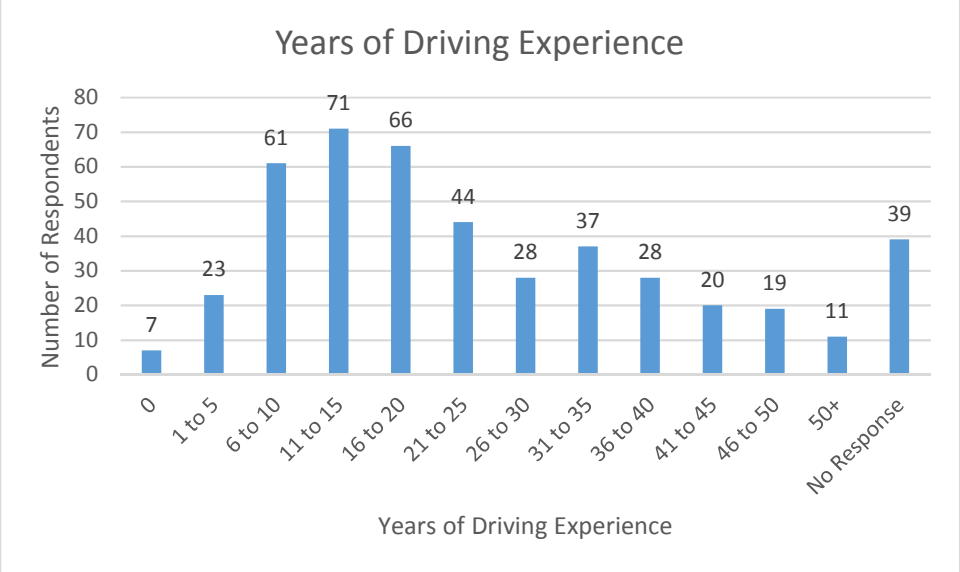


Figure 5. Driver and Pedestrian Interaction Survey Respondents: Minutes of Driving per Weekday

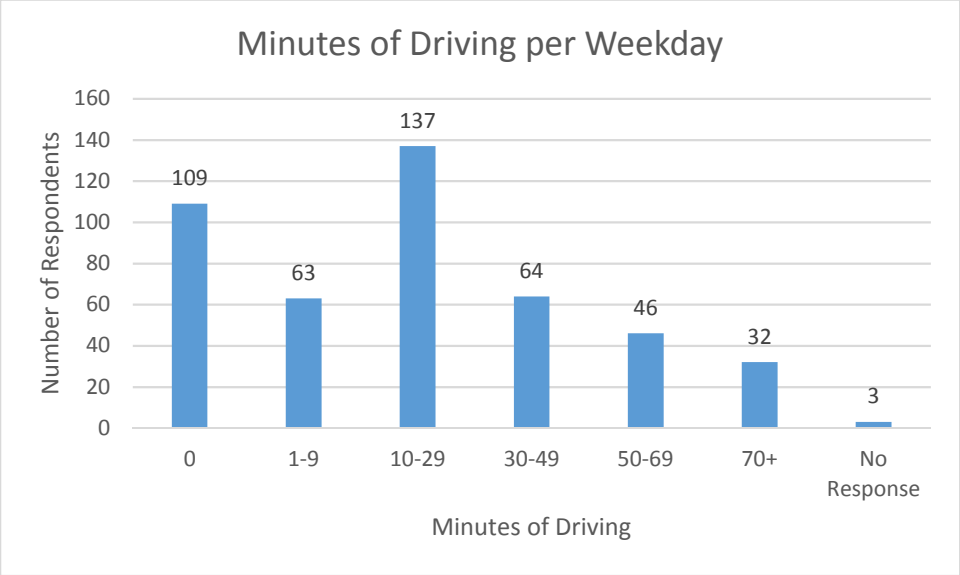
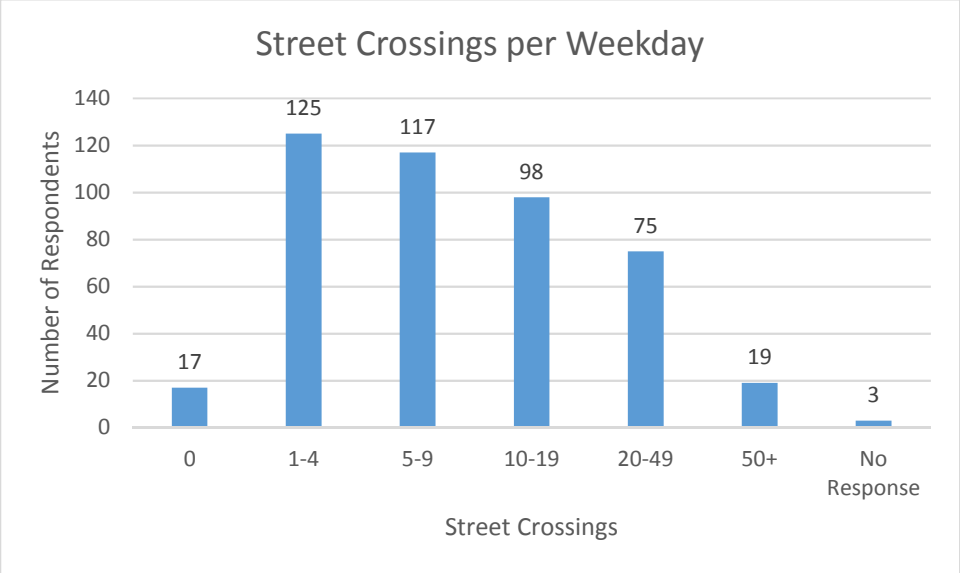


Figure 6. Driver and Pedestrian Interaction Survey Respondents: Street Crossings per Weekday



4.2. Naturalistic Observations of Driver Yielding at Uncontrolled Intersections in Milwaukee

We collected data to identify pedestrian and driver demographic characteristics, pedestrian and driver behaviors, and site characteristics that were associated with drivers yielding to pedestrians. Specifically, we observed driver yielding behavior in the field at 20 uncontrolled intersections along two-lane arterial and collector roadways in Milwaukee during fall 2016. We selected the 20 intersections from four city council districts in central Milwaukee. Ten of the intersections had experienced at least two reported daytime pedestrian crashes during a five-year period (2010-2014). We also chose ten similar intersections that had experienced one or zero reported crashes during this period (Figure 7). We focused on central Milwaukee because it tends to have moderate to high levels of pedestrian activity due to its relatively high development density, neighborhood commercial streets, proximity to the central business district, and high-frequency bus lines. Relatively high pedestrian volumes were important because they allowed us to observe a sufficient sample of pedestrian crossings during relatively short field data collection periods at each site.

Three data collectors made field observations for two hours during weekday evening travel periods (Monday through Thursday, typically 5 pm to 7 pm). We observed unstaged pedestrian crossings—pedestrians and drivers of all types of motor vehicles interacting naturally in public—rather than staging pedestrian crossings when automobiles approached. Pedestrian crossings were only observed for the mainline roadway crosswalks and were only considered when pedestrians started within the crosswalk lines. Pedestrians were observed when crossing either from the driver's left or right[7]. After a pedestrian arrived at the crossing, data collectors observed the first driver from either direction with an opportunity to yield. Drivers were considered as having an opportunity to yield if they were beyond a minimum distance away from the crosswalk when the pedestrian arrived at the curb (which is slightly different than state law: drivers must yield the right of way when a pedestrian puts at least one foot in the crosswalk). Section 5.3 describes the reasoning behind the choice to use a broader definition of yielding opportunity. The method described by Van Houten et al. (2013) was used to calculate the minimum safe stopping distance. For example, based on a driver reaction time of 2.5 seconds, the posted speed limit in feet per second, and a conservative deceleration rate of 11.2 feet (3.41 m) per second, the safe stopping distance for vehicles traveling at 30 mph (48 km/h) on a flat grade is 196 feet (59.7 m). Overall, we observed 473 pedestrian crossings across the 20 study sites, and drivers had an opportunity to yield for 364 of these crossings. The field data collection protocol for these driver yielding observations is provided in Appendix C. Note that our data collection approach builds from previous research in Gainesville, FL (Van Houten, et al. 2013) and Portland, OR (Goddard, Kahn, and Adkins 2015). Our data collection method was naturalistic—we observed pedestrians and drivers as they normally interact in public rather than using a test pedestrian to cross when automobiles approached.

4.2.1. Explanatory Variables

In addition to documenting driver yielding rates, we estimated pedestrian and driver demographic characteristics, pedestrian assertiveness, and pedestrian crossing group size. Specific design features of the roadway and crosswalk locations were also recorded.

[7] We chose to evaluate driver yielding to pedestrians from either side of the roadway in this naturalistic study because Wisconsin state law requires drivers to yield to pedestrians entering the crosswalk from either side of the roadway.

All of the data collection locations were in corridors with on-street parking[8]. Annual average daily traffic (AADT) in these corridors ranged from approximately 5,000 to 16,000 vehicles per day, and posted speed limits were either 25 or 30 miles per hour. Some corridors had bicycle lanes, while others did not. This feature was correlated with crossing distance. All study intersections had four legs. Some intersections had both crosswalks marked across the major roadway, while others only had one of the two crosswalks marked. Some intersections had standard crosswalk warning signs (MUTCD W11-2 or W11-2A), but others had no signs. There were also minor variations in curb-to-curb crossing distance, ranging from 35 to 52 feet (Table 1). None of the study intersections had designated left-turn lanes, designated right-turn lanes, far-side bus stops, in-street pedestrian crossing signs (MUTCD R1-6), curb extensions, or median-islands.

Overall, we observed 473 pedestrian crossings, and drivers had an opportunity to yield for 364 of these crossings based on the broad definition of driver yielding (or 298 of the crossings based on the narrower, legal definition of driver yielding). Table 2 summarizes the roadway feature, pedestrian and driver demographic characteristic, and pedestrian and driver behavior variables that we collected for the 364 crossings with yield opportunities. We hypothesized that these variables were related to whether or not drivers yielded to pedestrians based on previous research.

[8] All of the study intersections were two lanes with on-street parking during most times of day. However, two intersections (N. 35th Street and W. Meinecke Avenue and N. 35th Street and W. Garfield Avenue) had peak-hour parking restrictions on between 3:30 pm and 5:30 pm, so they had four operating traffic lanes and no on-street parking for part of the time when data were collected (approximately 50 minutes at N. 35th Street and W. Meinecke Avenue and approximately 10 minutes at N. 35th Street and W. Garfield Avenue).

Figure 7. Milwaukee Naturalistic Driver Yielding Study Intersections

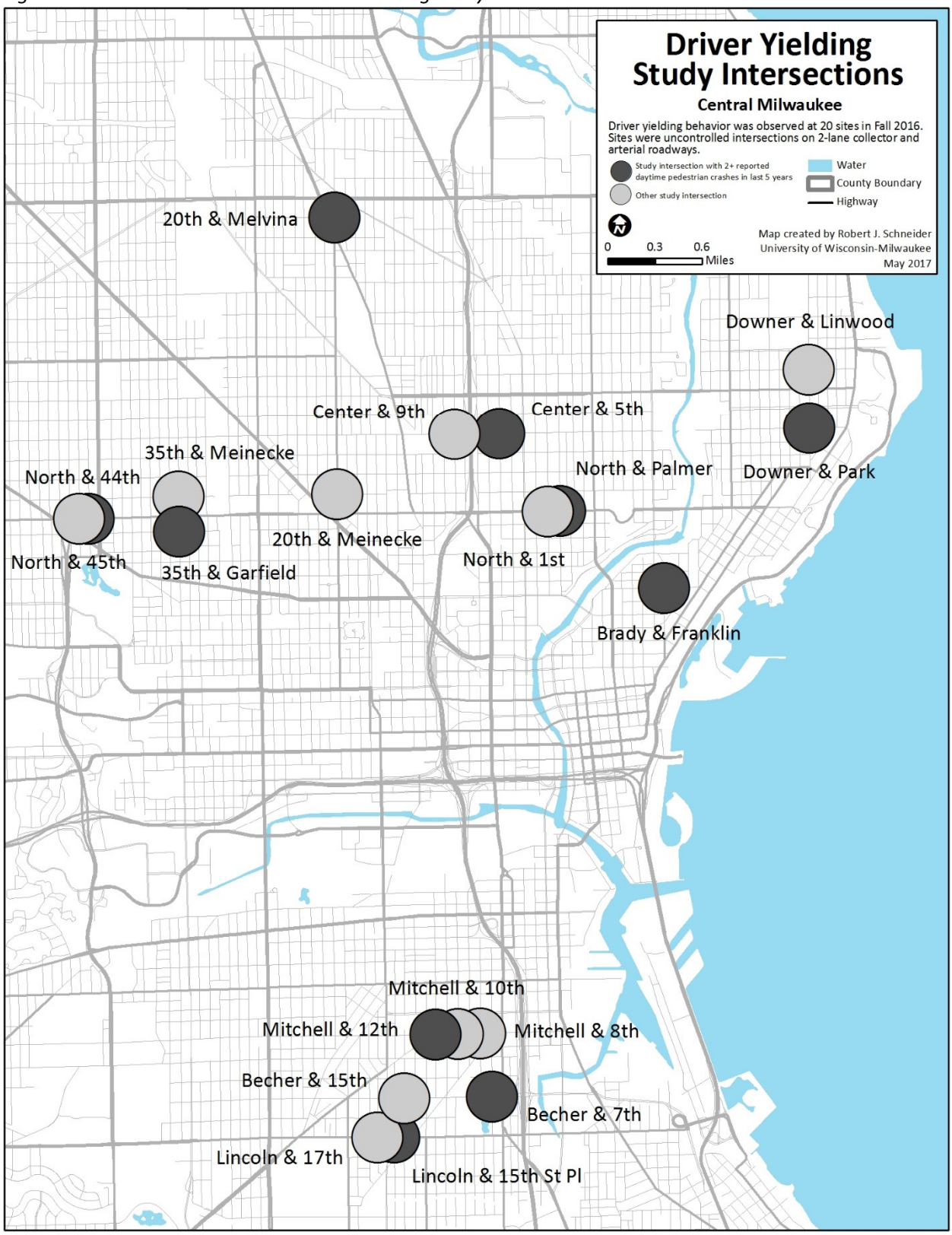


Table 1. Milwaukee Naturalistic Driver Yielding Study Intersection Characteristics

Study Intersection	Major road Annualized Average Daily Traffic (AADT)	Major road posted speed limit (miles per hour)	Crossing distance (average curb-to-curb distance for two crosswalks) (feet)	Distance to on-street parking (average distance for two mainline approaches) (feet)	Near side bus stop at the intersection (1=Yes, 0=No)	Both crosswalks marked (1=Yes, 0=No)	Crosswalk sign (MUTCD W11-2 or W11-2A) (1=Yes, 0=No)	Adjacent commercial land use (1=Yes, 0=No)	Intersection had 2+ reported crashes in 5-year period (1=Yes, 0=No)
E North Ave & N Palmer St	16400	30	51	100	0	1	1	0	1
W North Ave & N 1st St	16400	30	52	200	1	1	0	0	0
N 35th St & W Garfield Ave	14500	30	56	500	1	1	0	1	1
W Lincoln Ave & S 15th St Pl	14200	30	55	20	0	0	0	1	1
N 35th St & W Meinecke Ave	13800	30	51	400	0	1	1	1	0
W North Ave & N 44th St	13200	30	56	25	0	0	0	1	1
W Lincoln Ave & S 17th St	13000	30	51	25	0	0	0	0	0
W North Ave & N 45th St	11000	30	56	200	1	1	0	1	0
E Brady St & N Franklin Pl	10100	25	40	18	0	1	1	1	1
W Center St & N 5th St	10000	30	54	80	1	0	0	1	1
W Becher St & S 7th St	9600	30	49	300	0	0	1	0	1
W Center St & N 9th St	9100	30	59	400	0	0	1	0	0
W Mitchell St & S 8th St	9000	25	56	25	0	1	0	1	0
W Mitchell St & S 10th St	8400	25	54	30	0	1	0	1	0
N Downer Ave & E Park Pl	7200	30	50	30	1	1	1	1	1
N 20th St & W Meinecke Ave	6800	30	50	120	0	1	0	0	0
W Becher St & S 15th St	6600	30	46	200	0	0	0	0	0
W Mitchell St & S 12th St	6300	25	51	30	0	1	0	1	1
N Downer Ave & E Linnwood Ave	5100	30	58	200	1	0	0	0	0
N 20th St & W Melvina St	4900	30	49	90	0	0	0	0	1
Average of 20 Study Sites	**10280**	**29**	**52**	**150**	**0.30**	**0.55**	**0.30**	**0.55**	**0.50**

Table 2. Explanatory Variables tested in Binary Logit Models

	Mean	Std. dev.	Min	Max	Expected relationship with Yielding
Demographic Variables[1]					
Pedestrian race = White (1 = yes; 0 = no)	0.291	0.455	0	1	+
Pedestrian gender = Male (1 = yes; 0 = no)	0.632	0.483	0	1	+
Pedestrian age <25 years (1 = yes; 0 = no)	0.179	0.384	0	1	+
Driver race = White (1 = yes; 0 = no)	0.368	0.483	0	1	+
Driver gender = Male (1 = yes; 0 = no)	0.640	0.481	0	1	-
Driver age <25 years (1 = yes; 0 = no)	0.440	0.497	0	1	-
Behavior Variables					
Pedestrian standing in the street (1 = yes; 0 = no)[2]	0.819	0.386	0	1	+
Pedestrian acting assertively (1 = yes; 0 = no)[3]	0.431	0.496	0	1	+
Pedestrian group size = 1 (1 = yes; 0 = no)[4]	0.731	0.444	0	1	-
Site Variables					
Traffic volume (AADT)	10,800	3,260	4,900	16,400	-
Posted speed limit (miles per hour)	29.0	1.98	25	30	-
Average crossing distance (feet)[5]	52.3	4.53	40	59	-
Near-side bus stop present (1 = yes; 0 = no)	0.365	0.482	0	1	+
Distance from upstream signal (feet)[6]	720	421	253	2,000	-
Distance to downstream signal (feet)[6]	779	452	253	2,000	+
Distance from crosswalk to street parking (feet)[7]	148	157	18	500	+
Both crosswalks marked (1 = yes; 0 = no)	0.610	0.488	0	1	+
Presence of crosswalk sign (1 = yes; 0 = no)[8]	0.335	0.473	0	1	+
Right-turn area present (1 = yes; 0 = no)[9]	0.508	0.501	0	1	-
Adjacent commercial land use (1 = yes; 0 = no)[10]	0.703	0.457	0	1	+
Majority of pedestrians are White (1 = yes; 0 = no)	0.228	0.420	0	1	+
Majority of drivers are White (1 = yes; 0 = no)	0.302	0.460	0	1	+
Intersection had 2+ pedestrian crashes (1 = yes; 0 = no)[11]	0.585	0.493	0	1	-

Note: 10 miles per hour = 16.1 kilometers per hour; 1 foot = 0.305 meters.

1) The demographic characteristics of pedestrians and drivers were estimated by field data collectors.

2) "Standing in the street" indicates that pedestrians waited in the crosswalk with at least one foot in the street.

3) "Acting assertively" indicates that pedestrians exhibited any one of the following characteristics: 1) the pedestrian actively leaned toward the opposite side of the roadway when in the crosswalk, 2) the pedestrian directed his or her eyes toward approaching drivers for more than 3 seconds, or 3) the pedestrian pointed his or her arms or fingers toward the crosswalk.

4) Group size was the total number of pedestrians waiting to cross at one time. The group was defined by waiting together; they did not all need to end up crossing at the same time.

5) The crosswalk crossing distance was the shortest distance from the curb on one side of the street to the curb on the other side of the street within the crosswalk. Average crossing distance for each intersection was the average of the two crosswalks.

6) Distance from upstream signal is the distance from the upstream signal to the center of the intersection, and distance to downstream signal is the distance from the downstream signal to the center of the intersection. These variables were calculated for the direction of travel of each individual approaching vehicle.

7) Distance from the crosswalk to street parking was the distance from the crosswalk at the edge of the intersection to the closest car parked on the street in advance of the crossing (in the direction from where the study vehicles are coming from).

8) Intersection had a crosswalk sign (MUTCD W11-2 or W11-2A). No site had warning signs in advance of the crosswalks.

9) A right-turn area was noted if there was a separate area to the right of the travel lane that was commonly used by right-turning cars to move out of the traffic stream prior to turning right.

10) Adjacent commercial land use indicates that the intersection was in a downtown or neighborhood commercial district.

11) Intersection experienced at least two reported daytime pedestrian crashes during the five-year period, 2010-2014.

4.2.2. Binary Logistic Modeling Approach

We developed a series of binary logistic regression models to identify roadway features, pedestrian and driver demographic characteristics, and pedestrian and driver behaviors that may be associated with drivers choosing to yield (or not yield) to pedestrians. The binary logistic regression model is specified as:

$$g(X) = Ln\left[\frac{P(x_i)}{1-P(x_i)}\right] = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_k X_{ki} + \varepsilon_i$$

Where $P(x_i)$ is the probability of a driver yielding to a pedestrian at any of the *i* = 364 pedestrian crossing opportunities, X_{ki} is a vector representing the *k-th* explanatory variables (e.g., roadway features, pedestrian and driver demographic characteristics, pedestrian and driver behaviors) for the *i*-th observation, β_k is a vector of parameters that express the relationship between each explanatory variable in X_{ki} and the probability of a driver yielding to a pedestrian, and ε_i is the error term. We estimated the parameters β_k using maximum likelihood estimation. Using the equation specified above, the probability of driver yielding to pedestrian can be written as:

$$P(x_i) = \frac{1}{1+\exp[-(\beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_k X_{ki})]}$$

As discussed in Section 4.2, the naturalistic observations of driver yielding behavior were collected at twenty uncontrolled intersections in Milwaukee. It is possible that driver yielding behavior is correlated between drivers at a particular intersection due to some unmeasured factors. To evaluate the unobserved correlation in driver yielding at particular intersections (or any other unmeasured intersection-related characteristics contributing the driver yielding decision), a random-effect logistic regression model was also developed. The random-effect logistic regression equation was specified as:

$$g(X) = Ln\left[\frac{P(x_{ij})}{1-P(x_{ij})}\right] = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_k X_{ki} + U_j$$
$$U_j \sim Normal(0, \sigma^2)$$

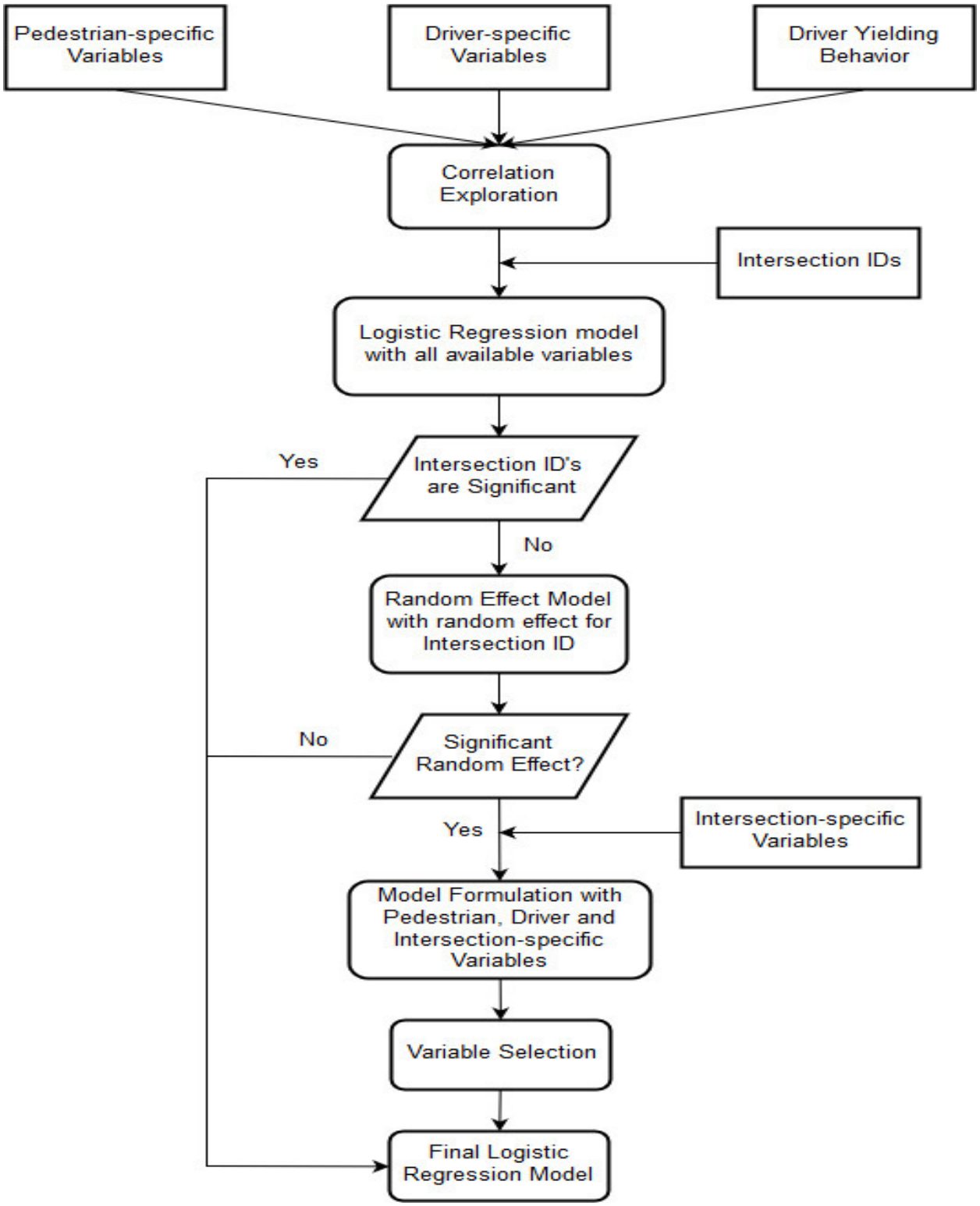
Where, $P(x_{ij})$ is the probability of a driver yielding to the *i*-th observed pedestrian at the *j*-th intersection and U_j is the random-effect representing unobserved correlation in driver yielding behavior within particular intersections or other unmeasured intersection-related characteristics at each study site. We estimated the parameters β_k and the standard deviation of U_j using maximum likelihood estimation.

To compare the performance of all logistic regression models, we considered the null deviance, residual deviance, and Akaike Information Criterion (AIC). Null deviance compares the fit of the estimated model to the fit of an intercept-only model (only one parameter for all observations). Better models have lower values. Residual deviance compares the fit of the estimated model with a saturated model (a separate parameter for each observation). Better models have lower values. AIC is similar to adjusted R^2 in ordinary least squares regression. It is a measure of fit that controls for the number of model coefficients. The model with the lowest AIC value is preferred. Classification rates and receiver operating characteristic (ROC) curves were also generated to evaluate model performance in predicting driver yielding behavior.

4.2.3. Overall Statistical Analysis Process

The binary logistic model described above was used for the final statistical analysis. Yet, other modeling approaches were considered in the overall data analysis process, including a random-effects model that would account for correlations between driver yielding and unobserved characteristics at each intersection (Figure 8). Since the random-effect in that model was not significant, we used a model that incorporated a variety of intersection characteristics as explanatory variables (in addition to the demographic and behavior variables).

Figure 8. Overall Statistical Analysis Process



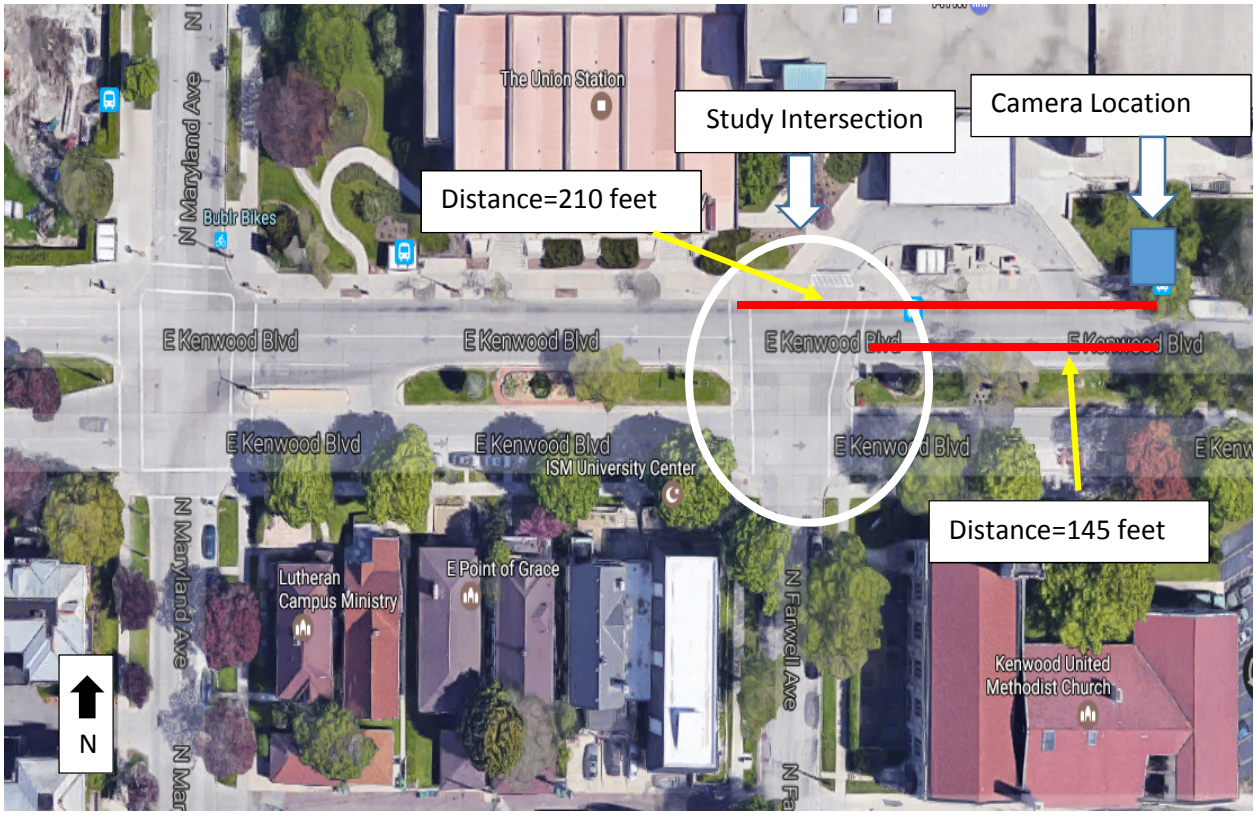
4.3. Detailed Video Observations of Pedestrian and Driver Characteristics and Behaviors

We collected detailed observations of pedestrian and driver characteristics and behaviors from video at one uncontrolled intersection in Milwaukee (Kenwood Boulevard and Farwell Avenue) and one uncontrolled intersection in Madison (Dayton Street and Charter Street). The Milwaukee intersection was near the University of Wisconsin-Milwaukee Campus and the Madison crosswalk was near the University of Wisconsin-Madison campus. The study sites in Milwaukee and Madison have traffic volumes of 5,000 and 6,000 vehicles per day and speed limits of 30 miles per hour and 25 per hour, respectively. Both parking and bike lanes are present upstream and downstream of the crossing location at the Milwaukee study site. In Madison, a bike lane is present, but there is no on-street parking near the study location. The crosswalk lengths at the Milwaukee and Madison sites are 71 feet and 40 feet, respectively. The Milwaukee crossing is longer because it includes a raised median. At each site, pedestrians cross one travel lane in each direction. Both intersections have high pedestrian volumes during the day because they are close to university campuses. We focused on just the west crosswalk across Kenwood Avenue in Milwaukee because trees blocked parts of the east crosswalk. We focused on both crosswalks across Dayton Street in Madison.

Video data were collected during weekday mid-day periods at both sites (approximately 9:30 am to 2:30 pm) before and after HVE efforts were conducted in Milwaukee and Madison. We installed video cameras on utility poles between 10 and 12 feet above the ground at each site. In Milwaukee, the camera was approximately 210 feet east of the study crosswalk (Figure 9). At this site, we only observed drivers traveling westbound toward the crosswalk and pedestrians who were crossing southbound due to trees blocking sight lines in the roadway median. The crosswalk was approximately 300 feet east of a signalized intersection (Kenwood Boulevard and Maryland Avenue), so the downstream traffic signal was also visible to drivers approaching the crosswalk. In Madison, the camera was approximately 140 feet west of the west study crosswalk and 200 feet west of the east study crosswalk (Figure 10). We observed drivers traveling in both directions (eastbound and westbound) and observed pedestrians crossing in both directions (northbound and southbound). The closest signalized intersections to this crossing were Dayton Street and Randall Avenue (approximately 900 feet west of the study intersection) and Dayton Street and Mills Street (approximately 400 feet east of the study intersection). The video camera was not positioned to observe the traffic signal phases at either of these intersections.

Two individuals viewed the video and recorded detailed pedestrian assertiveness and driver yielding information for both study sites. To reduce data processing error due to subjectivity, the two individuals each made observations separately and then cross-validated their data. Adjustments were made adjustments where disagreements were found. Overall, there were few disagreements, so the video observation protocol generally worked well.

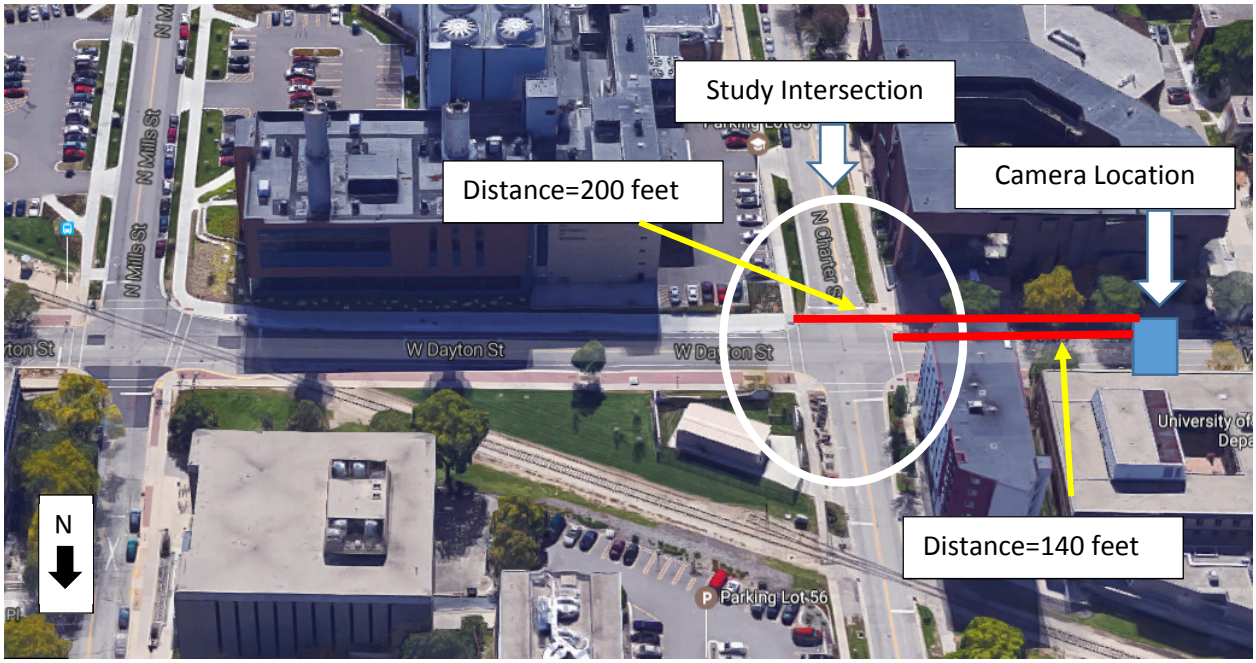
Figure 9. Milwaukee Video Observation Intersection (E. Kenwood Boulevard and N. Farwell Avenue)



Base image source: Google Earth, 2016.

E. Kenwood Boulevard looking west toward the study intersection. Image taken from video camera.

Figure 10. Madison Video Observation Intersection (W. Dayton Street and N. Charter Street)



Base image source: Google Earth, 2016.

W. Dayton Street looking east toward the study intersection. Image taken from video camera.

Similar to our naturalistic observations, we recorded pedestrian demographic characteristics, pedestrian waiting location (e.g., on the curb or in the street), pedestrian wait times, pedestrian crossing group size, and driver yielding behavior for each pedestrian. We also observed characteristics of the first automobile with an opportunity to yield to the pedestrian. These characteristics included the type of vehicle, whether or not the vehicle slowed, whether or not the driver yielded, and how close to the crosswalk the driver yielded (or if they just slowed to provide a gap for the pedestrian to cross). We anticipated that other traffic characteristics could impact drivers' decisions to yield, so we recorded whether or not there was another vehicle following the first vehicle and the phase of the downstream traffic signal facing the driver when the pedestrian arrived at the crosswalk (green, yellow, or red).

We were particularly interested in the assertiveness of pedestrians and drivers as they interacted near the crosswalk. In addition to the pedestrian assertiveness dummy variable used for field observations, we recorded eight specific pedestrian actions to categorize pedestrian assertiveness:

1) Pedestrian uses body gesture to cross.
2) Pedestrian uses hand gesture to cross.
3) Pedestrian does not stop before crossing.
4) Pedestrian stands on street and observes oncoming traffic for an opportunity to cross.
5) Pedestrian stands on curb (<50 cm from edge of pavement) and observes oncoming traffic for an opportunity to cross.
6) Pedestrian stands in street but is inattentive (does not observe oncoming traffic).
7) Pedestrian stands on curb (<50 cm from edge of pavement) but is inattentive (does not observe oncoming traffic).
8) Pedestrian stands behind curb (>50 cm from edge of pavement) waiting to cross.

We also recorded four specific driver actions to categorize driver assertiveness.

1) Yielding type. These included:
    - Hard yield. The driver started to decelerate < 30 feet in advance of the crosswalk but still stopped or slowed to let the pedestrian cross.
    - Soft yield. The driver started to decelerate > 30 feet in advance of the crosswalk and either stopped or slowed to let the pedestrian cross.
    - No yield. The driver did not slow down or stop to accommodate the pedestrian crossing.
2) Acceleration or deceleration. The driver was noted as either accelerating, decelerating, or not changing speed after the pedestrian arrived at the crosswalk. This was only recorded if the driver did not yield.
3) Estimated distance from the crosswalk when the pedestrian arrived at the crosswalk.
4) Estimated vehicle speed when the pedestrian arrived at the crosswalk.

See Appendix D for the video data reduction protocol.

5. Results

The results of each component of the study are presented below. These include public understanding of the law requiring drivers to yield the right-of-way to pedestrians in crosswalks, perceptions of local driver yielding and pedestrian crossing behavior, driver yielding rates at Milwaukee intersections, factors associated with driver yielding, and the relationship between pedestrian and driver assertiveness and driver yielding.

5.1. Public Understanding of the Law Requiring Drivers to Yield to Pedestrians

Question 11 on the survey presented a series of scenarios where respondents were asked to state whether the pedestrian or driver had the right-of-way. Table 3 shows how the responses relate to the correct answers. The results indicate confusion about whether pedestrians have the right-of-way in unmarked crosswalks. Regarding question S3, only 87% of respondents answered correctly that the pedestrian had the right-of-way in an unmarked crosswalk on a two-lane roadway. S6 and S7 were identical except that S6 referred to a marked crosswalk. While 96% of respondents answered correctly that the pedestrian had the right-of-way in a marked crosswalk on a four-lane roadway (S6), only 66% answered correctly when the crosswalk was unmarked (S7). Another area of confusion was raised by the two scenarios where the driver had the right-of-way, with nearly one quarter responding incorrectly (S1 and S4). This may indicate a misunderstanding that pedestrians always have the right-of-way, a common theme in open-ended responses.

Responses by community showed only minor differences in understanding the pedestrian right-of-way law between Milwaukee, Madison, and La Crosse. There were also only minor differences in understanding the law between respondents who drove more than 30 minutes per day, had more than 30 years of driving experience, and crossed 10 or more streets per day as a pedestrian. Interestingly, people who had more years of driving experience were more likely to answer correctly that pedestrians had the right-of-way at an unmarked crosswalk on a four-lane roadway (Figure 11).

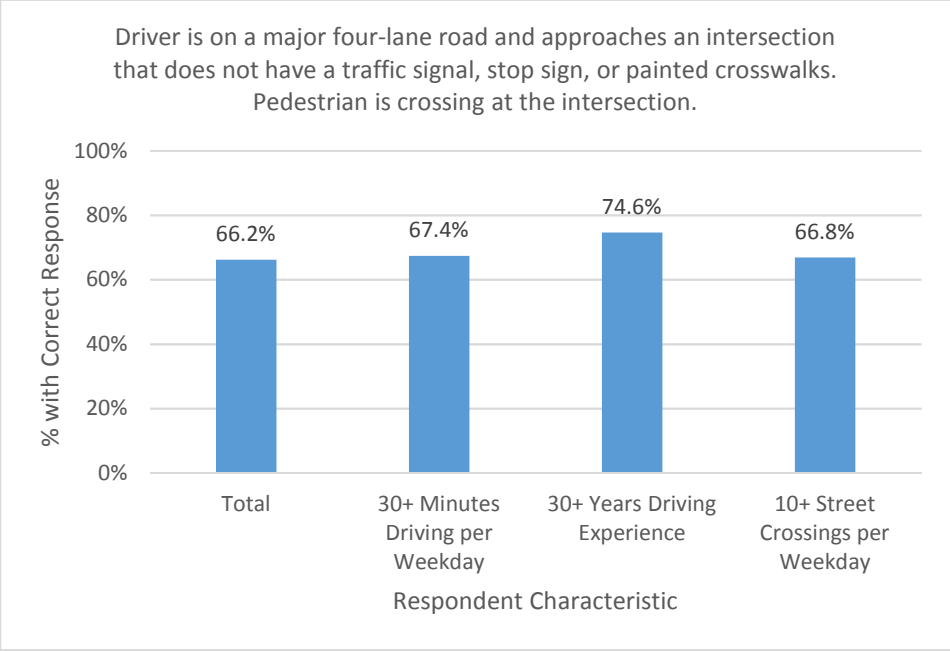
Qualitatively, some respondents reported confusion about the pedestrian right-of-way law in their open-ended responses:

- “I'm glad someone is researching this. Lots of angry drivers and pedestrians out there because of mismatched understandings of who should go when.” (Age 18-24, Madison)
- “The concept of 'right of way,' as it pertains to pedestrian-vehicle interactions, is unclear to me. Is 'right-of-way' the set of rules for how to behave when everyone else is following the rules, or is it the set of rules for how to behave based on how everyone else actually behaves?” (Age 25-34, Madison)
- “[Right-of-way is] different between where I live and where I work. Knowing regular behaviors of drivers/peds in each certain area is how I decide how and when to cross a street.” (Age 55-64, Madison)
- “The pedestrian always has the right of way, regardless of the situation.” (Age 25-34, Milwaukee)

Table 3. Understanding of Pedestrian Right-of-Way Law

Indicate whether the pedestrian or the driver has the right of way given each scenario.	**Correct Answer**	**Respondent Answers**		
		Driver	**Pedestrian**	**Total**
S1. Driver approaches an intersection with a green traffic signal and wants to continue straight. Pedestrian is crossing when there is a Don't Walk signal.	Driver	346 (76.4%)	107 (23.6%)	453 (100.0%)
S2. Driver approaches an intersection with a green traffic signal and wants to turn right. There is no pedestrian signal, but the pedestrian enters right-side crosswalk with the green light.	Pedestrian	24 (5.3%)	429 (94.7%)	453 (100.0%)
S3. Driver is on a residential two-lane road and approaches an intersection that does not have a traffic signal, stop sign, or painted crosswalks. Pedestrian is crossing at the intersection.	Pedestrian	59 (13.1%)	392 (86.9%)	451 (100.0%)
S4. Driver is on a major two-lane road, is not near an intersection, and there is no painted crosswalk. Pedestrian is crossing in the middle of the block.	Driver	341 (75.6%)	110 (24.4%)	451 (100.0%)
S5. Driver approaches an intersection with a red traffic signal. Pedestrian is crossing when there is a Don't Walk signal.	Pedestrian	3 (0.7%)	447 (99.3%)	450 (100.0%)
S6. Driver is on a major four-lane road and approaches an intersection that does not have a traffic signal or stop sign but has painted crosswalks. Pedestrian is crossing in the painted crosswalk.	Pedestrian	16 (3.5%)	436 (96.5%)	452 (100.0%)
S7. Driver is on a major four-lane road and approaches an intersection that does not have a traffic signal, stop sign, or painted crosswalks. Pedestrian is crossing at the intersection.	Pedestrian	152 (33.8%)	298 (66.2%)	450 (100.0%)

Figure 11. Understanding of Pedestrian Right-of-Way Law: Major 4-Lane Road with Unmarked Crosswalks



5.2. Public Perceptions of Driver Yielding and Pedestrian Crossing Behavior

Survey questions 13 and 14 gathered respondent perceptions of social norms related to driver yielding and pedestrian crossing behavior in their local community. These survey results related to drivers yielding and pedestrians crossing in different scenarios (questions 13 and 14) should be interpreted cautiously because the survey did not clarify that the driver had sufficient time to stop if the pedestrian entered the crosswalk[9]. This additional nuance would have added more complexity to the survey, which was designed to be simple for the public to understand.

Table 4 shows perceptions about driver yielding behavior in different scenarios. Overall, no more than 60% of respondents thought that drivers yielded when legally required in their local community (scenarios D1, D2, D3, D4, and D5). The highest percentages of respondents perceiving that local drivers yield were for pedestrians in marked crosswalks at uncontrolled intersections on residential two-lane roads (D4, 60%) and for pedestrians in marked crosswalks when turning right at signalized intersections (D1, 58%). The lowest percentages were for pedestrians in marked crosswalks at uncontrolled intersections on major four-lane roads (D2, 36%) and for pedestrians in unmarked crosswalks at uncontrolled intersections on major four-lane roads (D3, 22%). More respondents perceived drivers to yield on two-lane roadways (D4 and D5) than on four-lane roadways (D2 and D3). More respondents also perceived drivers to yield at uncontrolled crossings with marked crosswalks (D2 and D4) than at similar crossings with unmarked crosswalks (D3 and D5). There were also geographic differences in perceptions of driver yielding behavior. Compared with Madison and La Crosse, fewer Milwaukee respondents perceived that local drivers yielded to pedestrians under all scenarios, including pedestrians crossing residential, two-lane roadways within marked crosswalks (Figure 12).

Open-ended responses underscore these perceptions of driver yielding behavior:

- "Bottom line is cars will yield to not hit someone, but not yield in other cases, even when required by law at almost all kinds of intersections in my community." (Age 25-34, Milwaukee)
- "Most pedestrians attempt to cross in the painted crosswalk…but cars do not stop, so in the end most pedestrians are not able to cross until there are no cars around." (Age 35-44, Madison)
- "Drivers in Wisconsin are exception to 'Midwestern Nice'...they are rude, defiant of law, and pretend not to see pedestrians." (Age 35-44, Madison)
- "At a local high school, right turn drivers with the green daily honk at students who have the Walk signal. As though the drivers believe their green gives them priority over the walk signal." (Age 55-64, La Crosse)
- "When I yield to a family w/ a stroller and a toddler or two, they cross my lane with a thank-you wave, then tell their kids to sprint to the other side. I see this over and over; rude, dangerous drivers are so ubiquitous that families are conditioned to sprint like scared deer. It is embarrassing, not to mention dangerous, to live in this community as a pedestrian!" (Age 55-64, Madison)

Table 5 shows perceptions of local pedestrian crossing behavior in different scenarios. Pedestrians have the legal right of way in scenarios P2, P3, P4, P5, and P6. Across these scenarios, the percentage of respondents who perceived that local pedestrians would cross if a driver was approaching the crosswalk was highest for drivers turning right at a signalized intersection when the pedestrian was considering crossing on a green signal (P2, 70%) and lowest for drivers approaching an unmarked crosswalk at an

[9] According to State Statute 346.24(2), "No pedestrian, bicyclist, or rider of an electric personal assistive mobility device shall suddenly leave a curb or other place of safety and walk, run, or ride into the path of a vehicle which is so close that it is difficult for the operator of the vehicle to yield."

uncontrolled intersection on a major four-lane road (P4, 17%). In general, more respondents think that pedestrians exercise their legal right to cross uncontrolled intersections on two-lane roadways (P5 and P6) than four lane roadways (P3 and P4). In addition, more respondents think that pedestrians exercise their legal right to cross at uncontrolled intersections when there are marked crosswalks (P3 and P5) than at similar crossings with unmarked crosswalks (P4 and P6). Compared with Madison and La Crosse, fewer Milwaukee respondents perceived that local pedestrians cross under most scenarios. Figure 13 shows responses from each community for pedestrians crossing residential, two-lane roadways with marked crosswalks.

Table 4. Perceptions of Driver Yielding Behavior in Respondent's Local Community

Based on your personal perception of local behaviors, in what situations do most drivers in your local community yield the right-of-way to pedestrians?	**Drivers Yield**	**Drivers Do Not Yield**	**Total**
D1. Driver approaches an intersection with a green traffic signal and wants to turn right. There is no pedestrian signal, but the pedestrian enters right-side crosswalk with the green light.	246 (58.4%)	175 (41.6%)	421 (100.0%)
D2. Driver is on a major four-lane road and approaches an intersection that does not have a traffic signal or stop sign but has painted crosswalks. Pedestrian is crossing in the painted crosswalk.	153 (36.4%)	267 (63.6%)	420 (100.0%)
D3. Driver is on a major four-lane road and approaches an intersection that does not have a traffic signal, stop sign, or painted crosswalks. Pedestrian is crossing at the intersection.	92 (22.0%)	327 (78.0%)	419 (100.0%)
D4. Driver is on a residential two-lane road and approaches an intersection that does not have a traffic signal or stop sign but has painted crosswalks. Pedestrian is crossing in the painted crosswalk.	251 (59.9%)	168 (40.1%)	419 (100.0%)
D5. Driver is on a residential two-lane road and approaches an intersection that does not have a traffic signal, stop sign, or painted crosswalks. Pedestrian is crossing at the intersection.	180 (43.0%)	239 (57.0%)	419 (100.0%)
D6. Driver is on a major two-lane road, is not near an intersection, and there is no painted crosswalk. Pedestrian is crossing in the middle of the block.	81 (19.3%)	338 (80.7%)	419 (100.0%)

Figure 12. Local Perceptions of Driver Yielding Behavior: Residential 2-Lane Road with Marked Crosswalks

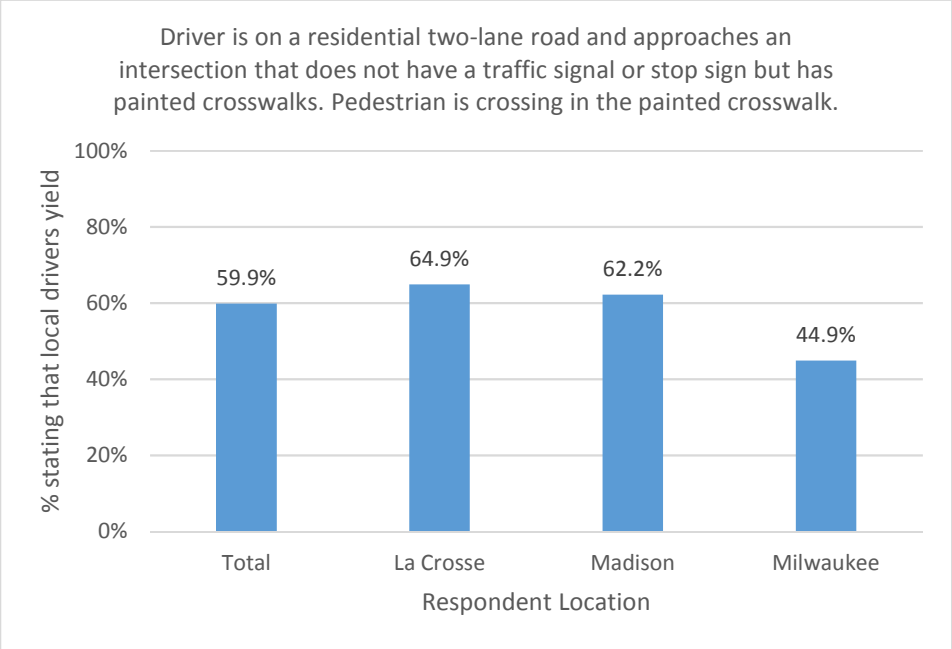
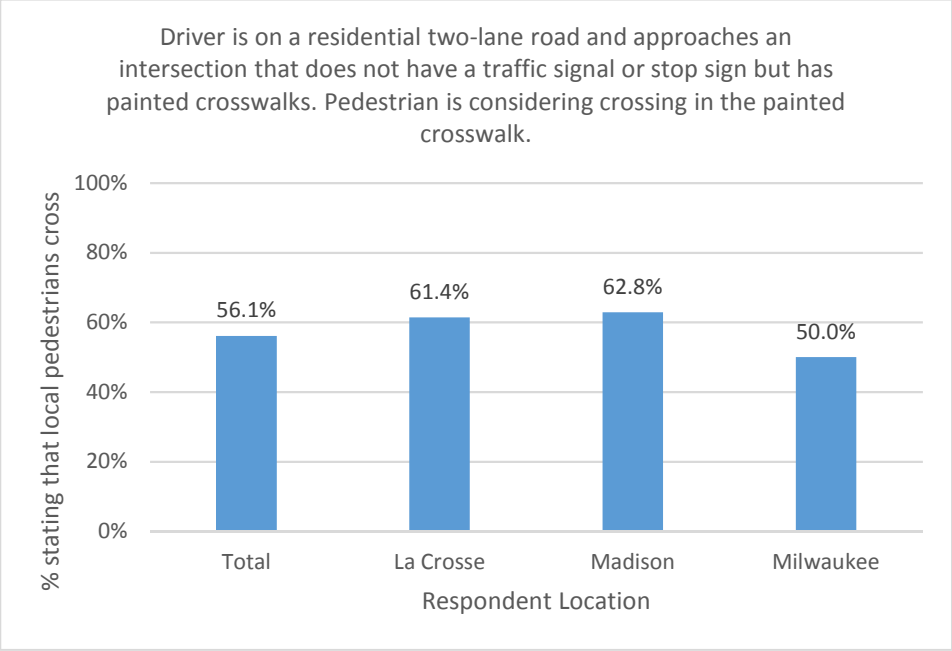


Table 5. Perceptions of Pedestrian Crossing Behavior in Respondent's Local Community

Based on the knowledge of behaviors in your community, in what situations do most pedestrians in your local community leave the curb to cross the street?	**Pedestrians Cross**	**Pedestrians Do Not Cross**	**Total**
P1. Driver approaches an intersection with a green traffic signal. Pedestrian is considering crossing when there is a Don't Walk signal.	51 (13.0%)	340 (87.0%)	391 (100.0%)
P2. Driver approaches an intersection with a green traffic signal and wants to turn right. There is no pedestrian signal, but the pedestrian is considering entering right-side crosswalk with the green light.	274 (70.3%)	116 (29.7%)	390 (100.0%)
P3. Driver is on a major four-lane road and approaches an intersection that does not have a traffic signal or stop sign but has painted crosswalks. Pedestrian is considering crossing in the painted crosswalk.	117 (30.2%)	271 (69.8%)	388 (100.0%)
P4. Driver is on a major four-lane road and approaches an intersection that does not have a traffic signal, stop sign, or painted crosswalks. Pedestrian is considering crossing at the intersection.	66 (17.0%)	322 (83.0%)	388 (100.0%)
P5. Driver is on a residential two-lane road and approaches an intersection that does not have a traffic signal or stop sign but has painted crosswalks. Pedestrian is considering crossing in the painted crosswalk.	235 (60.6%)	153 (39.4%)	388 (100.0%)
P6. Driver is on a residential two-lane road and approaches an intersection that does not have a traffic signal, stop sign, or painted crosswalks. Pedestrian is considering crossing at the intersection.	165 (42.4%)	224 (57.6%)	389 (100.0%)
P7. Driver is on a major two-lane road, is not near an intersection, and there is no painted crosswalk. Pedestrian is considering crossing in the middle of the block.	88 (22.6%)	301 (77.4%)	389 (100.0%)

Figure 13. Local Perceptions of Pedestrian Crossing Behavior: Residential 2-Lane Road with Marked Crosswalks



Most open-ended comments were consistent with the finding that pedestrians do not exercise their right to cross roadways at uncontrolled crosswalks:

- “Most pedestrians I observe seem to be conditioned to not aggressively cross (even if they have the right of way) because most drivers do not stop appropriately.” (Age 35-44, Madison)
- “In general pedestrians are cautious because they know that even when they should have a right to cross the street, it's very unlikely that the car is willing to give them the right away, or is even paying attention to pedestrians.” (Age 35-44, Milwaukee)
- “Most pedestrians are scared to cross, even though they have the right of way.” (Age 18-24, Milwaukee)
- “Only if you have a death wish will you cross the street with a car approaching.” (Age 35-44, Milwaukee)
- “I think most pedestrians would rather live than be right.” (Age 35-44, Milwaukee)
- “[Pedestrians] wait for traffic to clear instead of take their chances by stepping into the roadway.” (Age 45-54, Milwaukee)
- “A pedestrian's decision to cross almost always depends on whether there are cars approaching or not, unless there is an explicit "Walk" or "Don't walk" signal.” (Age 25-34, Madison)
- “In my experience in Madison pedestrians always yield the right of way. It drives me nuts that drivers do not stop for pedestrians waiting to cross on painted crosswalks.” (Age 25-34, Madison)

Yet, some responses emphasized that pedestrians do cross more assertively in certain situations, particularly in college campus areas:

- “Except near university campus where pedestrians cross at will wherever they like.” (Age 55-64, La Crosse)
- “Depends on number of cars and pedestrians, time of day, etc. If there are enough pedestrians to form a critical mass and stop traffic at intersections they will.” (Age 25-34, Madison)
- “Answers to these questions depend heavily on where I am observing these actions. In/around the downtown/campus area, pedestrians are more assertive than in a smaller community with less pedestrian activity. Pedestrians in the downtown/campus area seem to be more prone to crossing against traffic control devices and/or without checking for traffic.” (Age 25-34, Madison)
- “In the places I drive, there are two colleges. Many of the students will not even take a look before crossing into the path of drivers. It can be frustrating and dangerous. Downtown events also bring out very dangerous pedestrian behavior.” (Age 35-44, La Crosse)
- “A lot of these answers depend on how much traffic there is. If there is only one car coming down the road, most pedestrians will walk any time, but if there are many drivers on the road the answer may change.” (Age 25-34, Madison)

These results also suggest a relationship between driver behavior and pedestrian behavior. In more automobile-oriented environments (i.e., more travel lanes, unmarked crosswalks), drivers are less likely to yield and pedestrians are less likely to exercise their right to cross the roadway when an automobile is approaching from a distance (though still sufficient time to stop). In more pedestrian-oriented environments (i.e., fewer travel lanes, marked crosswalks), drivers are more likely to yield and pedestrians are more likely to exercise their right to cross the roadway. Several open-ended comments describe this relationship:

- "It all depends on eye contact and whether the pedestrian sees the driver slow down. I've never seen a driver fail to yield to a pedestrian and so hit them (fortunately!)." (Age 65+, Madison)
- "…a lot depends on location, time of day, and number of pedestrians. Near and on campus when there are a lot of students hurrying to class pedestrians are a lot more assertive about their rights. Away from campus and when there are fewer people waiting to cross pedestrians are generally less assertive. Also…if pedestrians are actually in the street, drivers will stop to avoid hitting them. But drivers generally do not slow or stop to allow them to cross even if they are at a crosswalk, unless the drivers have a red light and are not turning right." (Age 55-64, Madison)
- "Most pedestrians assume drivers won't yield and will wait to enter the road until the car is gone out the driver comes to a complete stop. Most drivers fail to field unless there's a red light, stop sign, flashing ped xing or 'state law yield to peds in crosswalk sandwich board'. They do not interpret a marked crosswalk (and certainly not an unmarked crosswalk) as cause to yield fit peds (or cyclists). Similar issues exist at sidewalk/driveway crossings." (Age 35-44, Madison)
- "Different in different communities, but most communities in Wisconsin, cars do not yield and pedestrians are not bold." (Age 18-24, Madison)
- "Knowing regular behaviors of drivers/peds in each certain area is how I decide how and when to cross a street. It also depends on if 1 person is crossing, a few, or a lot at the same time." (Age 55-64, Madison)

Interestingly, respondent driving frequency was related to perceptions of local driver and pedestrian behavior. Respondents who reported driving 30 or more minutes per day were more likely than other groups to perceive that local drivers yield to pedestrians and that local pedestrians exercise their legal right-of-way at all types of uncontrolled crosswalks (two-lane and four-lane; marked and unmarked).

Finally, several respondents suggested that inconsistent driver and pedestrian behaviors can lead to frustrating and dangerous situations near crosswalks:

- "It is difficult to stop for pedestrians when they have a right of way, but are hesitant to cross because a car might pass me on the right (illegally) when I stop for a pedestrian, or cars going the other way do not stop. I get honked at for stopping for pedestrians, especially on Regent Street near the UW campus. Also, even when pedestrians have the right of way, sometimes they are not paying attention and don't cross when I stop for them." (Age 65+ Madison)
- "There are sometimes marked intersections with flashing lights, and when the drivers often do not bother stopping for the flashing lights or cross the flashing lights when they think the pedestrian is out of danger, even if pedestrian is still in intersection. Often times the flashing lights flash for twice as long as it takes a person to cross intersection--so drivers blow them off even when there is a pedestrian who should have the right of way. It almost seems as if the flashing lights may make it even more dangerous to cross." (Age 45-54, La Crosse)

Overall, our survey responses suggest that social norms in the Milwaukee, Madison, and La Crosse communities are not consistent with pedestrian right-of-way laws, especially on multilane roadways. The majority of respondents perceived that drivers do not yield to pedestrians where legally required on major four-lane roadways (only 36% thought that drivers would yield if there was a marked crosswalk; 22% thought that drivers would yield if there was an unmarked crosswalk). Even on two-lane residential roadways, only 60% perceived that drivers yield to pedestrians in marked crosswalks at uncontrolled intersections. In addition, many respondents perceived that pedestrians do not exercise their legal right-of-way in crosswalks.

5.3. Driver Yielding Rates at Milwaukee Intersections

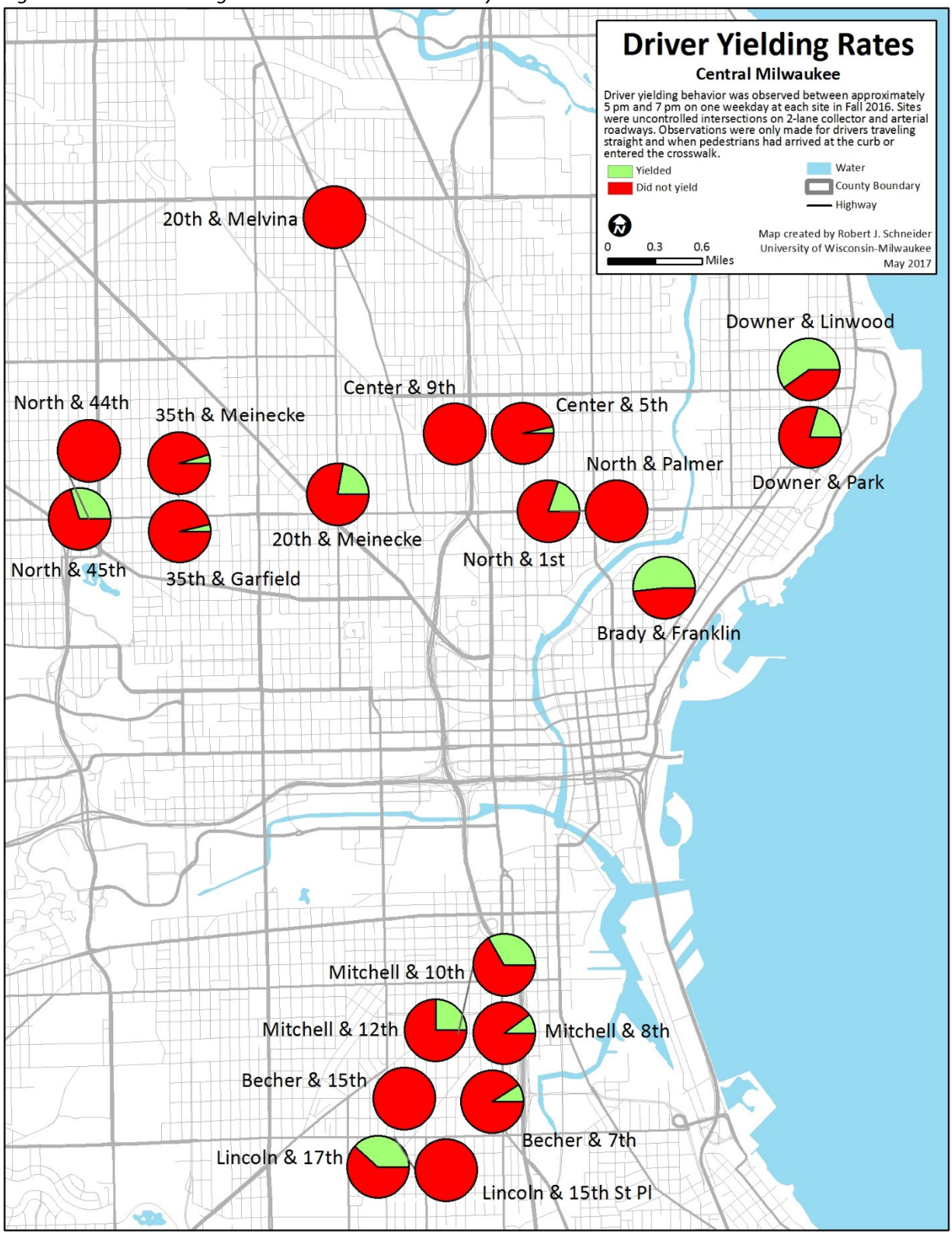
We observed 473 pedestrian crossings at 20 uncontrolled intersections in Milwaukee during weekday early evening peak travel periods in fall 2016 (Table 6). Of these crossings, 364 had opportunities for drivers to yield to a pedestrian. We observed 60 of these drivers yield, producing an overall yielding rate of 16%. Yielding rates differed between intersections, ranging from a high of 60% to a low of 0% (Figure 14). In fact, six of the 20 intersections had no drivers yield to pedestrians during the two-hour observation period. Note that two of these intersections had fewer than 10 yielding opportunities, so these small sample sizes should be interpreted with caution. Of the 15 intersections with more than 10 yielding opportunities during the two-hour observation period, four had 0% driver yielding rates.

Our definition of driver yielding opportunities was slightly broader than the state's legal definition. If we had specified that driver yielding opportunities only existed when pedestrians placed at least one foot in the crosswalk, as defined by state law, we would have found that 54 of 298 drivers yielded (18% of the total rather than 16%). Yet, narrowing the definition of driver yielding opportunity to the state law would have excluded 66 pedestrians (18% of all observed yielding opportunities) who were hesitant to step in the roadway but still intended to cross the street. Of these 66 people, there were even 17 (26%) who assertively indicated their intention to cross from the curb. The broader definition of driver yielding opportunity allowed us to account for all people who wanted to cross and all people exhibiting assertive and non-assertive behavior so that we could analyze pedestrian crossing behavior more completely.

Table 6. Driver Yielding Rates at 20 Milwaukee Uncontrolled Intersections

Study intersection	Field data collection date	Field data collection time period	Vehicle travel direction	Pedestrian travel direction	Major road Annualized Average Daily Traffic (AADT)	Pedestrian crossings	Driver yielding opportunities	Number of drivers who yielded	Percent of drivers who yielded
E North Ave & N Palmer St	8/15/2016	5:00-7:00 pm	EB-WB	NB-SB	16400	17	17	0	0%
W North Ave & N 1st St	11/1/2016	4:30-6:30 pm	EB-WB	NB-SB	16400	14	10	2	20%
N 35th St & W Garfield Ave	8/24/2016	5:15-7:15 pm	NB-SB	EB-WB	14500	31	28	1	4%
W Lincoln Ave & S 15th St Pl	8/25/2016	5:00-7:00 pm	EB-WB	NB-SB	14200	38	34	0	0%
N 35th St & W Meinecke Ave	9/13/2016	4:45-6:45 pm	NB-SB	EB-WB	13800	26	22	1	5%
W North Ave & N 44th St	8/18/2016	5:15-7:15 pm	EB-WB	NB-SB	13200	17	16	0	0%
W Lincoln Ave & S 17th St	10/18/2016	5:00-7:00 pm	EB-WB	NB-SB	13000	19	13	5	38%
W North Ave & N 45th St	9/6/2016	4:30-6:30 pm	EB-WB	NB-SB	11000	30	27	8	30%
E Brady St & N Franklin Pl	8/10/2016	5:00-7:00 pm	EB-WB	NB-SB	10100	38	27	14	52%
W Center St & N 5th St	8/16/2016	5:00-7:00 pm	EB-WB	NB-SB	10000	32	29	1	3%
W Becher St & S 7th St	8/29/2016	5:00-7:00 pm	EB-WB	NB-SB	9600	24	11	1	9%
W Center St & N 9th St	8/31/2016	4:30-6:30 pm	EB-WB	NB-SB	9100	16	16	0	0%
W Mitchell St & S 8th St	10/19/2016	4:30-6:30 pm	EB-WB	NB-SB	9000	16	10	1	10%
W Mitchell St & S 10th St	9/1/2016	5:00-7:00 pm	EB-WB	NB-SB	8400	20	18	6	33%
N Downer Ave & E Park Pl	8/11/2016	5:00-7:00 pm	NB-SB	EB-WB	7200	58	29	6	21%
N 20th St & W Meinecke Ave	10/25/2016	4:30-6:30 pm	NB-SB	EB-WB	6800	23	18	4	22%
W Becher St & S 15th St	10/11/2016	4:30-6:30 pm	EB-WB	NB-SB	6600	15	7	0	0%
W Mitchell St & S 12th St	8/24/2016	5:00-7:00 pm	EB-WB	NB-SB	6300	18	16	4	25%
N Downer Ave & E Linnwood Ave	8/30/2016	5:00-7:00 pm	NB-SB	EB-WB	5100	15	10	6	60%
N 20th St & W Melvina St	8/17/2016	5:00-7:00 pm	NB-SB	EB-WB	4900	6	6	0	0%
					Totals	**473**	**364**	**60**	**16%**

Figure 14. Driver Yielding Rates at 20 Milwaukee Study Intersections



5.4. Demographic, Behavior, and Site Factors Associated with Driver Yielding

We developed a series of binary logistic regression models to identify demographic, behavior, and site characteristics associated with driver yielding to pedestrians at our 20 Milwaukee study intersections. The models predict the probability of a driver yielding to a pedestrian who arrived at one of the study crosswalks, given the set of explanatory variables. These models were developed using data from the 364 driver yielding opportunities. Overall, drivers yielded to pedestrians 60 times (16% of opportunities).

During the modeling process, we tested all 23 explanatory variables to predict driver yielding behavior. As described in Figure 8, we started with only demographic and behavior variables, assuming that driver yielding behavior may depend on driver and pedestrian age, gender, and race, as well as where and how the pedestrian waited to cross. Then we added site specific variables to the modeling process. Variables were selected for more refined models using random forest and step-wise procedures. Explanatory variables were removed that did not have a significant relationship (90% confidence level) with driver yielding, starting with the least significant variables. We used theoretical relationships and practical expertise to prevent statistically correlated variables from being included in the same model. For example, the distance from an upstream signalized intersection and distance to a downstream signalized intersection were not used in the same model. We used the distance from an upstream signal more often in our modeling process because it had a clearer theoretical relationship with driver yielding behavior than the distance to a downstream signal[10].

The statistically-independent explanatory variables were then tested in a series of fixed-effect and random-effect models to explore variables associated with driver yielding behavior at different study sites. Random-effect logistic regression models allowed us to explore whether there was any random effect associated with each specific intersection. This was done by introducing 20 intersection-specific indicator variables to the model. These indicator variables were not significant, so we did not use the random-effect structure for the final model.

5.4.1. Overall Model Fit

The final model included eight explanatory variables (Table 7). It had the lowest AIC of all models tested (260), suggesting the best fit. All explanatory variables in the final model were significant at the 95% confidence level. Table 8 shows the relationships between each explanatory variable and driver yielding, holding other variable coefficients constant.

5.4.2. Demographic Variables Associated with Driver Yielding

The final model showed that drivers were more likely to yield to pedestrians who were White than pedestrians of other racial and ethnic backgrounds. This supports the findings of Goddard, Khan, and Adkins (2015). However, these results should be interpreted with caution. There were notable differences in the percentage of White pedestrians among the study intersections (12 intersections had 15% or fewer White pedestrians; 3 intersections had 85% or more White pedestrians). Therefore, it is

[10] We expected that as the distance from the upstream signal increases, drivers should be less likely to yield because drivers who had stopped at the upstream signal will have had more distance to increase their speed. In contrast, the expected influence of distance to the downstream signal on driver yielding is less clear. Drivers could be more likely to yield as the distance to the signal increases because they may be less focused on the signal and more focused on pedestrians. Yet, the signal phase is also likely to matter. If the signal is green, drivers may try to rush past pedestrians to get through the downstream signal. If the signal is red, drivers may be more willing to allow pedestrians to cross because they are in no hurry to reach a red light.

possible that the percentage of White pedestrians variable is capturing other unmeasured characteristics that were different among the intersections (e.g., neighborhood income levels, which may relate to pedestrian clothing type and appearance; neighborhood driver behavioral norms, including acceptance of speeding; neighborhood enforcement of traffic laws). Our data cannot determine whether specific drivers are less likely to yield because a pedestrian is a person of color or whether drivers in neighborhoods where there are more people of color crossing the street are less likely to yield in general. Nonetheless, this finding points to the importance of equity in pedestrian safety efforts.

Pedestrian age and gender were not significant. None of the driver demographic variables (age, gender, or race) were significant in the final model.

Table 7. Final Driver Yielding Model

Variables	Coefficient Estimate	Std. Error	Z-value	Pr(>|z|)
Intercept	15.580	3.751	4.155	0.000
Demographic Variables				
Pedestrian race/ethnicity = White	1.005	0.423	2.376	0.017
Behavior Variables				
Pedestrian standing in the street	1.284	0.548	2.341	0.019
Pedestrian acting assertively	0.946	0.405	2.330	0.019
Site Variables				
Traffic volume (AADT)	-0.000125	0.000062	-2.071	0.038
Posted speed limit (miles per hour)	-0.384	0.099	-3.869	0.000
Average crossing distance (feet)	-0.129	0.052	-2.482	0.013
Bus stop present	1.669	0.520	3.208	0.001
Intersection had 2+ pedestrian crashes	-1.928	0.462	-4.168	0.000

Sample size (n)	364
Null deviance	325.85 on 363 degrees of freedom
Residual deviance	242.52 on 355 degrees of freedom
AIC	260.52

Note: 10 miles per hour = 16.1 kilometers per hour; 1 foot = 0.305 meters.

Table 8. Model Sensitivity Example Using Hypothetical Site Values

Model variables	Hypothetical site variable initial value[1]	Hypothetical site variable changed value	Percent change in driver yielding associated with hypothetical variable change[2]
Pedestrian race/ethnicity = White (1 = yes; 0 = no)	0	1	+2.0%
Pedestrian standing in the street (1 = yes; 0 = no)	0	1	+3.0%
Pedestrian acting assertively (1 = yes; 0 = no)	0	1	+1.8%
Traffic volume (AADT)	6,000	5,000	+0.2%
Posted speed limit (miles per hour)	30	25	+6.4%
Average crossing distance (feet)	45	40	+1.1%
Bus stop present (1 = yes; 0 = no)	0	1	+4.8%
Intersection had 2+ pedestrian crashes (1 = yes; 0 = no)	1	0	+6.4%

1) Hypothetical site variable initial values were chosen to produce a low model-estimated probability of driver yielding. This made it easier to change each individual variable in the same direction (i.e., to increase the model-estimated probability).
2) The model-estimated probability of a driver yielding at a site with the hypothetical initial values for all variables is 1.2%. For example, changing the base value of White = no to White = yes is associated with a 2.4% increase in the model-estimated driver yielding percentage (from 1.2% to 3.2%).

5.4.3. Behavior Variables Associated with Driver Yielding

Two pedestrian behaviors were significant in the final model. Pedestrians who waited in the street rather than on the curb were more likely to have drivers yield to them. In addition, pedestrians who indicated their intent to cross the street assertively were more likely to have drivers yield[11]. Waiting in the street and taking an assertive stance in the crosswalk may make drivers more aware of pedestrians and may also more clearly indicate an intent to cross. Pedestrian group size was not significant in the model.

5.4.4. Site Variables Associated with Driver Yielding

Within our study context of two-lane roadways with speed limits of 25 to 30 miles per hour, all else equal, drivers were less likely to yield at intersections with higher traffic volumes and higher posted speed limits. Streets with these characteristics may be perceived by drivers and pedestrians as thoroughfares for automobiles, so drivers may be less aware of pedestrians and be less concerned about yielding to pedestrians at a crosswalk. In addition, it is more difficult to yield to a pedestrian when traveling at a higher speed, since it requires seeing the pedestrian sooner and decelerating more quickly than when traveling more slowly. Plus, on streets with more traffic and higher speeds, drivers may be more likely to worry about being rear-ended by other cars and worry about being passed recklessly on the right or left when the pedestrian is in the crosswalk.

Drivers were less likely to yield when the pedestrian crossing distance was longer. While our study focused on two-lane roadways, there was still some variation in road width. Wider roads generally make it easier for other drivers to pass on the right, especially when they think that a car stopped in front of them for a pedestrian is turning left. In addition, wider roads may be associated with higher travel speeds, regardless of speed limit, making it more difficult for drivers to yield.

While we found evidence of more yielding when near-side bus stops were present, this does not suggest that near-side bus stops are safer for pedestrians than far-side bus stops. To the contrary, the Federal Highway Administration recommends placing bus stops on the far side of intersections when possible to reduce the chances of multiple-threat pedestrian crashes (Zegeer, Nabors, and Lagerwey 2013). However, far-side bus stops are rare in Milwaukee, so all of our study sites had near-side bus stops. Therefore, this variable may simply indicate that intersections with bus stops tend to have higher driver yielding. This could be due to higher pedestrian volumes (pedestrians crossing to catch the bus), buses slowing traffic near the intersection as they exit and enter the traffic stream, or other factors.

Drivers were less likely to yield to pedestrians who were crossing at intersections that had experienced two or more daytime pedestrian crashes in the last five years. Given that factors such as traffic volume, traffic speed, and crossing distance are already captured in the model, this variable may be capturing some other unmeasured roadway or behavior characteristics that are associated with higher pedestrian risk at these particular crossings (i.e., driving while intoxicated or distracted; speeding; walking while intoxicated).

[11] In this section of the study, pedestrians were recorded as "acting assertively" if they exhibited any one of the following characteristics: 1) the pedestrian actively leaned toward the opposite side of the roadway when in the crosswalk, 2) the pedestrian directed his or her eyes toward approaching drivers for more than 3 seconds, or 3) the pedestrian pointed his or her arms or fingers toward the crosswalk. Later phases of the study used video observations to develop a more detailed definition of assertiveness, described in Section 4.3 and Section 5.5.

Several other site characteristics were tested but not significant in the final model, including marked crosswalks, right-turn areas, a majority of drivers and pedestrians at the intersection being White, and adjacent commercial land use. While these variables were not significant in this particular model of behavior at a limited set of crosswalks in Milwaukee, they may still have a relationship with driver yielding and pedestrian safety.

5.5. Pedestrian Assertiveness and Driver Yielding

Our statistical model identified pedestrian assertiveness as an important factor that increases the probability of drivers yielding to pedestrians in uncontrolled crosswalks. However, the public survey results suggested that many pedestrians are cautious or afraid to assert their right to cross because they do not trust drivers to yield. Given this complex and critical interaction between pedestrians and drivers, we decided to explore the concept of assertiveness in more depth. We reviewed the video data at one crosswalk in Madison and one crosswalk in Milwaukee to develop a better understanding of the relationship between pedestrian assertiveness and driver assertiveness at uncontrolled crosswalks.

The cleaned pedestrian assertiveness and driver yielding video observations are organized into matrices. Each matrix includes observations from both crosswalk sites (Madison and Milwaukee). Initially, pedestrian assertiveness was categorized into eight (8) groups (C1 to C8) (see Appendix E). However, some assertiveness categories had similar data and described similar concepts, so we simplified the pedestrian assertiveness categories into three levels of assertiveness. Assertiveness Level 1 is the most assertive, representing crossing without stopping. Assertiveness Level 2 represents stopping but includes making a body gesture or hand gesture to indicate a desire to cross the street, standing in the street and observing (looking at) the traffic, and standing on curb (<50 cm) and observing the traffic[12]. Assertiveness Level 3 is the least assertive, including standing in the street or curb but being inattentive (not looking at the traffic) and standing further than 50 cm from the curb.

Driver behaviors were also categorized into several groups depending on how close the vehicle was to the crosswalk when the pedestrian arrived (<10 m, 10-20 m, or >20 m) and how the driver yielded (no yield = NY, hard yield = HY, and soft yield = SY).

5.5.1. General Relationship between Pedestrian Assertiveness and Driver Yielding

Reviewing the data as a whole, we found several general patterns (Table 9):

- Regardless of their vehicle distance from the crosswalk when the pedestrian arrived, drivers tended to yield more often to more assertive pedestrians than less assertive pedestrians. 71% (48 of 68) of drivers yielded to pedestrians exhibiting Assertiveness Level 1, 30% (25 of 82) yielded to pedestrians exhibiting Assertiveness Level 2, and 3% (1 of 29) yielded to pedestrians exhibiting Assertiveness Level 3.
- Drivers only made a hard yield when the pedestrian arrived when they were close to the crosswalk (within 10 m). This suggests that some drivers were braking quickly, just in case the pedestrian continued across the street without stopping. Drivers likely did not make hard yields when the pedestrian arrived when they were farther away from the crosswalk because they had more time to make a choice about yielding or not.
- Driver yielding rates ((HY + SY)/yielding opportunities) were highest (60%) when the pedestrian arrived and the driver was close to the crosswalk (within 10 m). This may seem counterintuitive,

[12] Among the eight detailed assertiveness categories, body gesture (C1) or hand gesture (C2) are always associated with pedestrians standing on the curb (<50 cm) and observing traffic (C5). Therefore, the count of C1 or C2 is not included when summarizing the number of pedestrians in Level 2.

but the difference between yielding from a closer distance and further distances is almost entirely accounted for by hard yields (likely due to drivers reacting quickly and cautiously, as described in the previous bullet). The proportion of soft yields was similar for all distance categories (31% to 38%).

- Vehicles' average speeds were slightly slower when pedestrians arrived when they were closer to the crosswalk. While these speeds are only slightly different, it is possible that the faster speeds could lead to more focus toward the center of the roadway (a narrower "vision cone") and less recognition of pedestrians waiting at the end of a crosswalk.

Table 9. Relationship between Pedestrian Assertiveness and Driver Yielding Behavior

Driver Yielding Behavior \ **Pedestrian Assertiveness**			Assertiveness Level 1 (C3)	Assertiveness Level 2 (C1+C2+C4+C5)	Assertiveness Level 3 (C6+C7+C8)	Total	
Vehicle Location Group	Yielding Type	Average Speed (MPH)					
<10 m	HY	18.00	4	6	0	10	28.57%
	NY	18.57	4	7	3	14	40.00%
	SY	16.82	9	2	0	11	31.43%
10-20 m	HY	-	0	0	0	0	0.00%
	NY	20.36	11	35	10	56	61.54%
	SY	18.00	24	11	0	35	38.46%
>20 m	HY	-	0	0	0	0	0.00%
	NY	21.71	5	15	15	35	66.04%
	SY	20.88	11	6	1	18	33.96%
Total		19.72	68	82	29	179	100%

5.5.2. Driver Yielding Behavior Before and After High-Visibility Enforcement

To evaluate the possible effect of high-visibility enforcement on driver yielding behavior, we created an assertiveness matrix from data collected before HVE program implementation (Table 10) and after HVE program implementation (Table 11). The overall driver yielding rate (including both hard yield and soft yield) increased slightly from 40.2% (37 of 92) to 42.5% (37 of 87).

To conduct a more detailed statistical test of whether drivers were deciding to yield or not, we focused on soft yielding behavior. This is because hard yielding was likely a reaction to a potential hazardous situation rather than a more conscious choice to yield or not yield. Overall, the soft yielding rate increased from 31.5% (29 of 92) to 40.2% (35 of 87) after the HVE program activities. However, according to a one-tailed z-test of the difference between these two proportions, this increase was not statistically significant (p-value = 0.11). We also conducted t-tests on the soft yielding rates between before and after observations for all categories of driver distance from the crosswalk and pedestrian assertiveness levels. This comparison is shown in Table 12. Although the average mean soft yielding rate increased from 26.8% (average of all before-period cells in Table 12) before the HVE programs in Madison and Milwaukee to 30.7% (average of all after-period cells in Table 12) afterwards, the difference was not statistically significant (p-value = 0.39). This means that the HVE program activities may have improved the yielding rate, but this improvement could also be due to expected random fluctuations in driver yielding rates.

Table 10. Assertiveness Matrix Before High-visibility Enforcement

Driver Yielding Behavior / **Pedestrian Assertiveness**			Assertiveness Level 1 (C3)	Assertiveness Level 2 (C1+C2+C4+C5)	Assertiveness Level 3 (C6+C7+C8)	Total	
Vehicle Location Group	Yielding Type	Average Speed (MPH)					
<10 m	HY	18.13	3	5	0	8	27.59%
	NY	18.50	3	4	3	10	35.71%
	SY	17.50	9	1	0	10	35.71%
10-20 m	HY	-	0	0	0	0	0.00%
	NY	22.06	7	24	3	34	66.67%
	SY	18.82	12	5	0	17	33.33%
>20 m	HY	-	0	0	0	0	0.00%
	NY	21.82	1	6	4	11	84.62%
	SY	17.50	1	1	0	2	15.38%
Total		20.11	36	46	10	92	100%

Table 11. Assertiveness Matrix After High-visibility Enforcement

Driver Yielding Behavior / **Pedestrian Assertiveness**			Assertiveness Level 1 (C3)	Assertiveness Level 2 (C1+C2+C4+C5)	Assertiveness Level 3 (C6+C7+C8)	Total	
Vehicle Location Group	Yielding Type	Average Speed (MPH)					
<10 m	HY	17.50	1	1	0	2	28.57%
	NY	18.75	1	3	0	4	57.14%
	SY	10.00	0	1	0	1	14.29%
10-20 m	HY	-	0	0	0	0	0.00%
	NY	17.73	4	11	7	22	55.00%
	SY	17.22	12	6	0	18	45.00%
>20 m	HY	-	0	0	0	0	0.00%
	NY	21.67	4	9	11	24	60.00%
	SY	21.33	10	5	1	16	40.00%
Total		19.30	32	36	19	87	100%

Table 12. Comparison on Yielding ("SY") Rate between Before & After Observations

Vehicle Location Group \ **Pedestrian Assertiveness**		Assertiveness Level 1 (C3)	Assertiveness Level 2 (C1+C2+C4+C5)	Assertiveness Level 3 (C6+C7+C8)
Before	<10 m	60.00%	10.00%	0.00%
	10-20 m	63.16%	17.24%	0.00%
	>20 m	50.00%	14.29%	0.00%
After	<10 m	0.00%	20.00%	-
	10-20 m	75.00%	35.29%	0.00%
	>20 m	71.43%	35.71%	8.33%

6. Recommendations

Results from the survey, field observations, and detailed video analysis support two main categories of strategies to improve pedestrian safety. One set of recommendations focuses on education and enforcement programs, and the other focuses on roadway design and engineering treatments. Both strategies are intended to change the culture of driver yielding in Wisconsin communities and improve driver yielding behavior at specific pedestrian crossing locations. These strategies should be part of a comprehensive, multimodal safety program in Wisconsin.

6.1. Education and Enforcement Strategies to Increase Driver Yielding

The first set of recommendations includes education and enforcement strategies to change the culture of driver yielding in Wisconsin communities. These strategies are intended to increase driver awareness of the responsibility to yield to pedestrians in crosswalks, increase pedestrian awareness of the rights to cross the roadway in a crosswalk, and make it normal and expected for drivers to yield to pedestrians. The strategies in this category generally focus on education and enforcement programs.

6.1.1. Increase the Reach of Pedestrian Safety Education Programs

Pedestrian safety programs, such as the statewide Share and Be Aware campaign, help educate drivers, pedestrians, and bicyclists about laws and behaviors that promote safety for all roadway users, especially pedestrians and bicyclists. Ensure that effective pedestrian safety programs and messages continue to educate drivers on their responsibility to yield to pedestrians in marked and unmarked crosswalks, educate pedestrians about legal rights and responsibilities when crossing the street, and encourage pedestrians to indicate their intent to cross the street.

In addition, programs like Share and Be Aware should continue to emphasize the following messages:

- Drivers must yield the right-of-way to pedestrians when they set one foot into a crosswalk. This includes drivers who are traveling straight on a major roadway where the only traffic control is a crosswalk (i.e., there is no stop sign or traffic signal).
- Drivers should actively look for pedestrians whenever they drive and expect pedestrians to be crossing the roadway. This is particularly important for people driving in cities and villages with regular pedestrian activity.
- Pedestrians are allowed to cross within a crosswalk, even when there is no other traffic control besides the crosswalk, and even if it requires a driver to slow or stop for the pedestrian. Pedestrians should not enter a crosswalk in front of a car that is already too close to the crosswalk to stop (i.e., do not dart into traffic).
- While not required by law, pedestrians should indicate their intent to cross the roadway by pointing across the street where they would like to cross and make eye contact with approaching drivers. Pointing has been shown to be an effective way to indicate intent (Crowley-Koch, Van Houten, and Lim 2011). Dane County provides orange pedestrian crossing flags at some locations to help pedestrians indicate their intent and increase their visibility.

6.1.2. Ensure that Laws to Yield the Right-of-Way to Pedestrians in Crosswalks are Emphasized in Driver Education Courses

Driver education classes are required prior to taking driving tests and obtaining a driver license. Therefore, driver education curricula should emphasize that it is a driver's responsibility to yield the right-of-way to pedestrians (as well as bicyclists and users of personal assistive mobility devices) in crosswalks. Understanding pedestrian right-of-way at marked and unmarked crosswalks, driving with the consciousness that a motor vehicle can cause serious injuries if it strikes a pedestrian, and anticipating the possibility that pedestrians may try to cross the street are fundamental responsibilities

of driving a motor vehicle on public roadways. Pedestrian right-of-way laws should be included as a part of comprehensive driver education that not only focuses self-preservation of the driver, but also focuses on personal behaviors that help ensure the safety of other people—friends, family, neighbors, and all others who use public roadways.

6.1.3. Foster a Safety Culture of Yielding the Right-of-Way Among Professional Drivers

Professional drivers include bus and shuttle drivers, truck drivers, law enforcement officers, first responders, delivery workers, taxi and transportation network company (TNC) operators, and other company drivers. These professionals can help demonstrate exemplary driving behavior, potentially leading to a tipping point where yielding to pedestrians is seen as the normal behavior in Wisconsin. The need to create a safety culture of yielding is not unique to professional drivers. Staying alert and reducing speed improves conditions for all roadway users, especially for people who are walking and crossing the roadway. However, professional drivers are a logical initial audience for crosswalk right-of-way education and enforcement because they may be reached more quickly through job training and their jobs depend on good driving behavior.

6.1.4. Conduct Sustained High-Visibility Enforcement Programs in Multiple Communities

Previous studies have shown that HVE programs can change driver yielding behavior and increase pedestrian safety over time. Evaluation of the HVE program in Gainesville, FL (Van Houten et al. 2013) shows the importance of sustained enforcement and media outreach efforts. In contrast, the before and after evaluation of the 2016 HVE efforts in Madison and Milwaukee found an increase in driver yielding, but this was not statistically significant. This is likely because they only lasted for a relatively short period. Therefore, we suggest conducting HVE programs that will be sustained for a full year or more.

6.2. Engineering Strategies to Increase Driver Yielding

The second set of recommendations focus on roadway design and engineering changes to improve driver yielding behavior. Education and enforcement efforts (discussed above) also complement these engineering strategies. Note that our model identifies associations between driver yielding and specific roadway and behavior characteristics. While these results do not imply direct causation, they provide support for several strategies to increase driver yielding to pedestrians in uncontrolled crosswalks.

6.2.1. Reduce Roadway Design Speeds and Reduce Posted Speed Limits

Lower speed limits are associated with a greater likelihood of drivers yielding to pedestrians. This finding complements other research that finds actual approach speeds are inversely related to driver yielding rates (Bertulis and Dulaski 2014). Since higher speeds are also associated with higher pedestrian injury severity (Tefft 2013), we recommend reducing motor vehicle speeds, especially in areas where pedestrian activity is common.

- Design new roadways and retrofit existing roadways to discourage speeding. These strategies may include: minimize the total number of automobile lanes, minimize automobile lane widths, and introduce on-street parking or other features that provide visual cues to travel slowly. Reducing the number of motor vehicle lanes has been shown to benefit pedestrian, bicyclist, and motorist safety (Knapp et al. 2014).
- Since reducing vehicle speeds provides more time for drivers to react to pedestrians and to come to a stop, reduce posted speed limits to 25 miles per hour on all two-lane roadways in urban and other areas where pedestrian crossings are frequent. Consider speed limits lower than 25 miles per hour in areas with very high pedestrian activity.

6.2.2. Reduce Pedestrian Crossing Distances

Shorter pedestrian crossing distances were associated with a higher likelihood of drivers yielding to pedestrians in our final model. Shorter crossings also reduce the amount of time that pedestrians are in the roadway and exposed to traffic. Several design treatments can be used to shorten pedestrian crossing distances.

- Install curb extensions. Curb extensions can be used at crossing locations on roadways with on-street parking. In addition to reducing the crossing distance, this treatment helps keep sight lines between pedestrians and drivers from being blocked by parked cars. Curb extensions can also reduce vehicle turning speeds.
- Install raised median islands. Median islands divide the crosswalk into two distinct crossings, each shorter than the original crossing. This provides a refuge for pedestrians, allowing them to cross one direction of traffic at a time.
- Reduce the number of motor vehicle lanes and reduce lane widths. Reducing the roadway width allocated to travel lanes will reduce the distance that pedestrians will be exposed to potential conflicts with motor vehicles. Reducing the number of motor vehicle lanes has been shown to benefit pedestrian, bicyclist, and motorist safety (Knapp et al. 2014). This also provides additional space for bicycle lanes, shoulders, landscaped buffers, sidewalks, or other street features.

6.2.3. Install Pedestrian Crossing Signs and Beacons

Install pedestrian crossing signs and beacons at carefully-chosen locations to remind drivers and pedestrians of the state law to yield the right-of-way to pedestrians in crosswalks. These devices include:

- MUTCD R1-6 "State Law: Yield to Pedestrian" signs[13]
- MUTCD W11-2 pedestrian crossing signs with rapid flashing beacons

Place these devices strategically at the beginning of a series of crosswalks or at specific locations with yielding problems. Also continue to observe driver yielding at crosswalks without these devices. If drivers are yielding more at locations with the devices than without them, use other engineering, education, and enforcement treatments to ensure that the message translates to all pedestrian crossings in a community.

6.2.4. Test the Gateway Treatment at Pilot Locations in Several Communities

Experiment with the Gateway Treatment at important uncontrolled pedestrian crossings, including multi-lane roadway crossings where a single MUTCD R1-6 is not sufficient. The Gateway Treatment uses a set of three to four MUTCD R1-6 "State Law: Yield to Pedestrian" signs placed on the centerline or median island and at both curbs to emphasize a crosswalk. On multilane roadways, high-visibility bollards can be placed on lane lines. Michigan DOT has experimented with this treatment and has shown positive results (Bennett and Van Houten 2016; Van Houten and Hochmuth 2016).

6.2.5. Adjust Bus Stop Locations

Bus stop placement and proximity to a crosswalk are important. This design decisions determine how visible a pedestrian is to drivers. Look for practical opportunities to move bus stops to the far side of intersections so that the bus will stop after the crosswalk and reduce the risk of multiple-threat crashes

[13] The Michigan DOT study on the Gateway Treatment (Van Houten and Hochmuth 2016) provided useful guidance on R1-6 sign maintenance: 1) use a curb-type base with flexible rubber connector rather than a pivoting base (this can even survive plowing), and 2) place the sign in advance of the crosswalk (avoid turning vehicles).

(pedestrians crossing in front of the bus, creating limited visibility for drivers approaching the crosswalk in the lane adjacent to the bus).

Further, bus stops that are located near the end of crosswalks may cause confusion about the intent of pedestrians to cross the street. If pedestrians are just waiting for the bus, drivers may become conditioned not to expect pedestrians who are at the end of a crosswalk to want to cross. Over time, drivers may be less aware of pedestrians who actually do want to cross in the crosswalk. Therefore, placing bus stops in locations where pedestrians do not wait directly at the end of a crosswalk might help reduce confusion and increase driver attention to when pedestrians truly want to cross. This study did not test this hypothesis, so further research is needed to explore how bus stop locations affect driver expectations of pedestrian crossing behavior.

6.2.6. Follow FHWA Guidelines for Marked Crosswalks and Utilize Safe Transportation for Every Pedestrian (STEP) Proven Safety Countermeasures

Currently, most drivers and pedestrians perceive that drivers do not yield to pedestrians in crosswalks on higher-speed, multilane roadways. This may be related to the roadway being designed to facilitate high-speed traffic with little consideration for other roadway users. Further, when simple painted markings are used to designate the crosswalk on major roadways, drivers and pedestrians may learn that these markings have little practical meaning. Therefore, there is a need to revisit how crosswalks are provided on these major roadways. Following FHWA guidance (Zegeer et al. 2005), this does not mean that marked crosswalks should be eliminated; it means that marked crosswalks should be supplemented with specific treatments or roadway redesigns that produce safer crossings where drivers will be more likely to yield. Local, county, and state agencies should review crosswalk locations against the FHWA crosswalk guidelines to see if additional treatments are needed to supplement crosswalk markings to improve pedestrian crossing safety.

Pedestrian crossings on roadways with multiple lanes, higher speeds, and higher traffic volumes should be addressed with additional crossing treatments besides simple crosswalk markings (e.g., median islands, pedestrian hybrid beacons). In some cases, these crossing treatments can be added as a part of a comprehensive roadway redesign. Many of the possible safety treatments are identified by FHWA as STEP proven safety countermeasures for uncontrolled crossing locations.

6.3. Comprehensive and Equitable Approaches to Increase Driver Yielding

The final recommendation is to take a comprehensive approach to increase driver yielding. This type of approach incorporates the recommendations above and includes:

- Education (e.g., emphasize that drivers should anticipate pedestrians and must yield the right-of-way to pedestrians who enter uncontrolled crosswalks; emphasize that pedestrians should make eye contact with drivers and confidently assert their right-of-way in crosswalks).
- Enforcement (e.g., implement HVE programs that combine enforcement of pedestrian right-of-way laws with public messaging and media outreach).
- Engineering (e.g., use roadway design principles supported by this study and other promising treatments described in the literature review).

Comprehensive pedestrian safety programs have increased driver yielding (Malenfant and Van Houten 1990; Sandt et al. 2016). Further, given that our findings suggest that drivers may be more likely to yield to White pedestrians, local leaders and agency staff should ensure that comprehensive education, enforcement, and engineering strategies are applied throughout a jurisdiction, including neighborhoods

with many people of color. Additional focus may be needed to ensure that pedestrians of color experience crossing the street as comfortably and safely as all other community members.

6.4. Considerations and Future research

Future studies should build on the survey, statistical modeling, and in-depth video analysis presented in this report. They should also help provide clearer connections between driver and pedestrian behavior and pedestrian safety.

6.4.1. Driver and Pedestrian Interaction Surveys

Follow-up studies should conduct a more extensive survey to gather responses from a wider range of Wisconsin residents. The online distribution method for the pilot survey likely reached individuals who are connected professionally or socially with members of the research team. With more resources, a survey could be distributed randomly to a wider range of individuals. In addition, the survey could be distributed statewide rather than in the three focus communities of Milwaukee, Madison, and La Crosse.

6.4.2. Driver Yielding Field Observations and Driver Yielding Models

Our study focused on driver yielding behavior at uncontrolled crossings of two-lane arterial and collector roadways. While we identified several significant demographic, behavior, and site variables, there are other variables that should be included in future studies, such as actual vehicle speeds, pedestrian clothing type and brightness, and a wider range of roadway design characteristics (e.g., number of travel lanes, designated turn lanes, median islands, curb extensions, and different combinations of signs, markings, and beacons). In addition, there are other contexts where driver yielding behavior at uncontrolled crossings should be documented, such as on urban residential streets and on suburban and rural roadways. A related line of research should also be undertaken to study driver yielding behavior when turning at controlled and uncontrolled intersections.

We collected data at 20 study sites in Milwaukee. While our multiple data collection sites allowed us to analyze several different roadway features, the sample of sites is small. Therefore, data should be collected at more locations in Milwaukee as well as sites in other communities to examine the consistency of our results and to explore additional variables that may be related to driver yielding behavior. In particular, more study sites would help provide a more diverse set of data to explore the association between pedestrian and driver race/ethnicity and driver yielding and better understand the underlying reasons for any inequities.

Like most other driver yielding studies, we collected data during daylight hours. However, 31% of the pedestrian crashes in Wisconsin between 2011 and 2015 where driver failure to yield was a contributing circumstance occurred during darkness (Wisconsin TOPS Lab 2017). Lighting and visibility are likely to influence pedestrian and driver behaviors at uncontrolled crosswalks at night, so more study is needed to identify the potentially different factors associated with driver yielding at night.

We collected demographic and behavior data directly in the field, so we accepted observation, judgement, and recording errors made by field data collectors. Other researchers have addressed this challenge by conducting trainings to improve inter-observer agreement among data collectors (10) or using video in driver yielding studies (Stapleton et al. 2017; Schroeder and Rouphail 2011; Schroeder 2008; Sun et al. 2003). However, given the resources for this study, field observations were the only method available to our team that allowed us to observe pedestrian and driver demographic characteristics as well as behaviors at 20 different sites. By comparison, a previous study of unstaged pedestrian crossings in Raleigh used video to observe driver and pedestrian demographic characteristics

and behaviors, but data were collected at only two sites (Schroeder and Rouphail 2011; Schroeder 2008). Collecting data at multiple sites allowed us to test the relationship between several roadway design variables and driver yielding.

Our definition of driver yielding opportunities did not match state law precisely. If we had specified that driver yielding opportunities only existed when pedestrians placed at least one foot in the crosswalk, as defined by state law, we would have found that 54 of 298 drivers yielded (18% of the total rather than 16%). Yet, narrowing the definition of driver yielding opportunity to the state law would have excluded 66 pedestrians (18% of all observed yielding opportunities) who were hesitant to step in the roadway but still intended to cross the street. Of these 66 people, there were even 17 (26%) who assertively indicated their intention to cross from the curb. The broader definition of driver yielding opportunity allowed us to account for all people who wanted to cross and all people exhibiting assertive and non-assertive behavior so that we could analyze pedestrian crossing behavior more completely.

This study points to several lines of additional research. In particular, future studies should:

- Develop a consistent definition of pedestrian assertiveness. Previous studies have used different definitions, but the important relationship between this behavior and driver yielding underscores the need to measure it similarly across multiple studies.
- Collect additional data on driver yielding to pedestrians with disabilities. There were only four driver yielding opportunities to people who used wheelchairs or walkers or had other visible physical disabilities, so we did not conduct a separate analysis for this group. However, people with disabilities are particularly important because they may cross at slower speeds (they may only find a sufficient gap in traffic to cross at an uncontrolled location if drivers yield) and may be less able to take evasive maneuvers if drivers do not yield.
- Count the total pedestrian volume at an intersection. While we noted whether or not pedestrians crossed in groups, the overall intersection pedestrian volume could also be associated with the general level of driver awareness of pedestrians crossing at that specific location. Higher pedestrian volumes may help drivers anticipate yielding opportunities, even for a single pedestrian.
- Explore the association between bus stops and driver yielding behavior. Pedestrians may be more assertive when hurrying to board approaching buses, and drivers may be more cautious when approaching buses that are dropping passengers off at the intersection, but we did not observe these behaviors.
- Record vehicles traveling in platoons. Cars traveling in groups may have a significant influence on driver yielding (Schroeder and Rouphail 2011). We attempted to observe the total number of cars that did not yield after the pedestrian arrived as proxy for the effect of cars following each other in a close group. Yet, our data collectors did not have sufficient capacity to observe this characteristic while documenting other important behaviors.
- Use staged pedestrian crossings to complement naturalistic observations. Staged pedestrian crossings could help address the issues in the bullets above and control for characteristics such as pedestrian attire and pedestrian skin color.
- Incorporate video-based observations at more sites. This would help produce more reliable measurements of driver yielding and pedestrian assertiveness while still capturing data at multiple sites with a variety of roadway characteristics.
- Collect complementary survey data on local social norms related to driver yielding behavior. Some drivers may follow how the majority of other drivers behave in their local community, despite pedestrian behavior, roadway design, or other site characteristics. Therefore, as future

studies begin to collect and analyze driver yielding data from multiple communities, it will be important to control for social norms as a model variable.

6.4.3. In-Depth Video Analysis of Pedestrian and Driver Assertiveness

We reviewed video data in close detail to measure pedestrian assertiveness and driver assertiveness at one crosswalk in Milwaukee and one crosswalk in Madison. However, the field data collection equipment locations should be adjusted in the future to capture images of vehicles and vehicle speeds and images of pedestrians and pedestrian speeds at greater distances from the crosswalk. This would help to more accurately quantify vehicle and pedestrian trajectories as users approached the crosswalk. Overall, more specific measures of acceleration and deceleration could be developed to create more representative classifications of pedestrian and driver assertiveness.

6.4.4. Future Research Questions

This study raises several issues for future research. First, are higher driver yielding rates related to fewer pedestrian crashes? While we only analyzed 10 sites with reported crashes and 10 sites without, we found that intersections with higher yielding rates were associated with fewer pedestrian crashes. This contributes to a growing body of research showing similar results: a pedestrian enforcement campaign led to higher yielding and fewer pedestrian crashes in St. Johns, Newfoundland and Fredericton, New Brunswick (Malenfant and Van Houten 1990), and the Gainesville HVE study found that higher driver yielding rates were associated with significant decreases in pedestrian crashes across the city (Van Houten et al. 2017). However, there is a need for additional robust studies to explore the relationship between driver yielding rates and pedestrian crash rates at specific locations in a variety of communities and roadway environments.

Second, how do changes in driver yielding behavior affect the dynamic relationship between pedestrians and drivers? Our analysis of assertiveness suggests that drivers and pedestrians react to each other, so pedestrians may adjust to increased driver yielding by crossing the street more assertively. If this occurs, would this lead to more driver yielding or could it lead to drivers becoming more aggressive to try to re-assert preferences to travel with little impedance?

Third, how would higher driver yielding rates affect the attractiveness of walking and overall enjoyment of public roadway space? It is likely that communities would benefit from slower, more aware, and more courteous drivers through greater social interaction, opportunities for physical activity and recreation, and support for local business. However, surveys and interviews are needed to quantify these benefits so that they could be weighed against some small increases in automobile travel times.

7. Conclusion

Pedestrian fatalities are increasing in Wisconsin and in the United States. The failure of drivers to yield to pedestrians in crosswalks is the most common contributing circumstance cited in Wisconsin pedestrian crash reports. In response to this problem, we conducted this exploratory study to document public knowledge of laws requiring drivers to yield the right-of-way to pedestrians, public perceptions of driver yielding, and pedestrian crossing behavior. We also collected field observations to document driver yielding behavior at a small sample of pedestrian crossings and analyzed detailed videos to describe the relationship between driver assertiveness and pedestrian assertiveness. Overall, we found that drivers do not often yield to pedestrians in uncontrolled crosswalks, as required by law. Further, pedestrians tend not to assert their right to cross roadways.

Our binary logistic model suggested that drivers were more likely to yield when the major roadway had a lower speed limit or less traffic; when the intersection had a shorter crossing distance or a bus stop; and when the pedestrian was White, standing in the street, or acting assertively. These results support roadway design strategies such as reducing roadway design speeds and narrowing roadway crossing distances to increase the probability of drivers yielding to pedestrians. They also suggest the importance of educating pedestrians and drivers so that pedestrians can carefully and confidently cross at uncontrolled crosswalks. We recommend additional driver yielding research at a wider range of sites, in more communities, and at different times of day, especially at night.

We did not find evidence that the limited HVE efforts in Milwaukee and Madison in 2016 had a significant effect on driver yielding behavior. However, we draw on evidence from other studies to recommend a long-term, sustained HVE program to change social norms to become more supportive of driver yielding. HVE should be complemented by other enforcement, education, and engineering strategies to increase driver yielding and ultimately improve pedestrian safety in Wisconsin.

8. References

Bennett, M.K. and R. Van Houten. "Variables Influencing Efficacy of Gateway In-Street Sign Configuration on Yielding at Crosswalks," Transportation Research Record: Journal of the Transportation Research Board, Volume 2586, pp. 100-105, 2016.

Bertulis, T. and D.M. Dulaski. "Driver Approach Speed and Its Impact on Driver Yielding to Pedestrian Behavior at Un-signalized Crosswalks," Transportation Research Record: Journal of the Transportation Research Board, Volume 2464, pp. 46-51, 2014.

Coughenour, C., S. Clark, A. Singh, E. Claw, J. Abelar, and J. Huebner. "Examining Racial Bias as a Potential Factor in Pedestrian Crashes," Accident Analysis & Prevention, Volume 98, pp. 96-100, 2017.

Crowley-Koch, B.J., R. Van Houten, and E. Lim. "Effects of Pedestrian Prompts on Motorist Yielding at Crosswalks," Journal of Applied Behavior Analysis, Volume 44, pp. 121-126, 2011.

Elder, R.W., R.A. Shults, D.A. Sleet, J.L. Nichols, R.S. Thompson, W. Rajab and the Task Force on Community Preventive Services. "Effectiveness of Mass Media Campaigns for Reducing Drinking and Driving and Alcohol-involved Crashes," American Journal of Preventive Medicine, Volume 27, pp. 57-65, 2004.

Findley, D., M. Palmer, S. Searcy, K. Jackson, and T. Nye. Crosswalk Yielding Enforcement, North Carolina Governor's Highway Safety Program, Project Number 2000004234, North Carolina State University, Institute for Transportation Research and Education, September 2016.

Fitzpatrick, K., S. Turner, M. Brewer, P. Carlson, B. Ullman, N. Trout, E.S. Park, J. Whitacre, N. Lalani, and D. Lord. Improving Pedestrian Safety at Unsignalized Crossings, Transit Cooperative Research Program Report 112, National Cooperative Highway Research Program Report 562, Transportation Research Board, Available online, http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_562.pdf, 2006.

Fitzpatrick, K., S.T. Chrysler, R. Van Houten, W.W. Hunter, and S. Turner. Evaluation of Pedestrian and Bicycle Engineering Countermeasures: Rectangular Rapid-Flashing Beacons, HAWKs, Sharrows, Crosswalk Markings, and the Development of an Evaluation Methods Report, Federal Highway Administration, FHWA-HRT-11-039, April 2011.

Fitzpatrick, K., M.A. Brewer, R. Avelar, and T. Lindheimer. Will You Stop for Me? Roadway Design and Traffic Control Device Influences on Drivers Yielding to Pedestrians in a Crosswalk with a Rectangular Rapid-Flashing Beacon, Center for Transportation Safety, Texas A&M Transportation Institute, June 2016.

Goddard, T., K.B. Khan, and A. Adkins. "Racial Bias in Driver Yielding Behavior at Crosswalks," Transportation Research Part F, Volume 33, pp. 1-6, 2015.

Harrell, W.A. "Driver Response to a Disabled Pedestrian Using a Dangerous Crosswalk," Journal of Environmental Psychology, Volume 12, Issue 4, p. 345-354, 1992.

Harrell, W.A. "The Impact of Pedestrian Visibility and Assertiveness on Motorist Yielding," Journal of Social Psychology, Volume 133, Number 3, pp. 353-360, 1993.

Huang, H., C. Zegeer, R. Nassi, and B. Fairfax. "The Effects of Innovative Pedestrian Signs at Unsignalized Locations: A Tale of Three Treatments," Federal Highway Administration, FHWA-RD-00-098, August 2000.

Knapp, K., B. Chandler, J. Atkinson, T. Welch, H. Rigdon, R. Retting, S. Meekins, E. Widstrand, and R.J. Porter. Road Diet Informational Guide, Federal Highway Administration, FHWA-SA-14-028, Available online, https://safety.fhwa.dot.gov/road_diets/info_guide/rdig.pdf, November 2014.

Malenfant, L. and R. Van Houten. "Increasing the Percentage of Drivers Yielding to Pedestrians in Three Canadian Cities with a Multifaceted Safety Program," Health Education Research, Volume 5, pp. 275-279, 1990.

Mitman, M.F. and D.R. Ragland. "Crosswalk Confusion: More Evidence Why Pedestrian and Driver Knowledge of the Vehicle Code Should Not Be Assumed," Transportation Research Record, Volume 2002, pp. 55-63, 2007.

National Highway Traffic Safety Administration (NHTSA). Fatality Analysis Reporting System (FARS) Encyclopedia, FARS Data Tables, Available online, https://www-fars.nhtsa.dot.gov/Main/index.aspx, 2017.

Piff, P.K., D.M. Stancato, R. Mendoza-Denton, D. Keltner, and S. Coteb. "Higher Social Class Predicts Increased Unethical Behavior," Proceedings of the National Academy of Sciences of the United States of America, Volume 109, Number 11, pp. 4086-4091, 2012.

Retting, R. Pedestrian Traffic Fatalities by State: 2016 Preliminary Data, Governors Highway Safety Association, Available online, http://www.ghsa.org/sites/default/files/2017-03/2017ped_FINAL_4.pdf, 2017.

Ross, J., D. Serpico, and R. Lewis. Assessment of Driver Yielding Rates Pre- and Post-RRFB Installation, Bend, Oregon, Oregon Department of Transportation, FHWA-OR-RD 12-05, Available online, http://www.oregon.gov/ODOT/TD/TP_RES/docs/reports/2011/spr721_bend_rrfb.pdf, December 2011.

Salamati, K., B.J. Schroeder, D.R. Geruschat, and N.M. Rouphail. "Event-Based Modeling of Driver Yielding Behavior to Pedestrians at Two-Lane Roundabout Approaches," *Transportation Research Record: Journal of the Transportation Research Board*, Number 2389, pp. 1-11, 2013.

Sandt, L.S., S.W. Marshall, D.A. Rodriguez, K.R. Evenson, S.T. Ennett, and W.R. Robinson. "Effect of a Community-Based Pedestrian Injury Prevention Program on Driver Yielding Behavior at Marked Crosswalks," Accident Analysis & Prevention, Volume 93, pp. 169-178, 2016.

Schneider, R.J. and J. Stefanich. Wisconsin Pedestrian and Bicycle Crash Analysis: 2011-2013, Wisconsin Department of Transportation, Bureau of Transportation Safety, Available online, http://wisconsindot.gov/Documents/safety/education/crash-data/bikeped-crash-2011-2013.pdf, 2015.

Schneider, R.J. and R.L. Sanders. "Pedestrian Safety Practitioners' Perspectives of Driver Yielding Behavior across North America," Transportation Research Record: Journal of the Transportation Research Board, Volume 2519, pp. 39-50, 2015.

Schroeder, B. A Behavior-Based Methodology for Evaluating Pedestrian-Vehicle Interaction at Crosswalks, PhD Thesis, North Carolina State University, 2008.

Schroeder, B.J. and N.M. Rouphail. "Event-Based Modeling of Driver Yielding Behavior at Unsignalized Crosswalks," Journal of Transportation Engineering, Volume 137, Number 7, pp. 455-465, 2011.

Shurbutt, J. and R. Van Houten. Effects of Yellow Rectangular Rapid-Flashing Beacons on Yielding at Multilane Uncontrolled Crosswalks, Federal Highway Administration, FHWA-HRT-10-043, September 2010.

Stapleton, S., T. Kirsch, T.J. Gates, and P.T. Savolainen. "Factors Affecting Driver Yielding Compliance on College Campuses: An Evaluation of 31 Uncontrolled Midblock Crosswalks on Low Speed Roadways in Michigan," Presented at the Transportation Research Board Annual Meeting, Washington, DC, 2017.

Sun, D., S.V.S.K Ukkusuri, R.F. Benekohal, and S.T. Waller. "Modeling of Motorist-Pedestrian Interaction at Uncontrolled Mid-Block Crosswalks," Presented at the Transportation Research Board Annual Meeting, Washington, DC, 2003.

Tefft, B. "Impact Speed and a Pedestrian's Risk of Severe Injury or Death," Accident Analysis and Prevention, Volume 50, pp. 871-878, 2013.

Van Houten, R., R.A. Retting, C.M. Farmer, and J. Van Houten. "Field Evaluation of a Leading Pedestrian Interval Signal Phase at Three Urban Intersections," Transportation Research Record 1734, pp. 86-92, 2000.

Van Houten, R., J.E.L. Malenfant, and D. McCusker. "Advance Yield Markings: Reducing Motor Vehicle-Pedestrian Conflicts at Multilane Crosswalks with Uncontrolled Approach," Transportation Research Record 1773, pp. 69-74, 2001.

Van Houten, R. and J.E.L. Malenfant. "Effects of a Driver Enforcement Program on Yielding to Pedestrians," Journal of Applied Behavior Analysis, Volume 37, pp. 351-363, 2004.

Van Houten, R., R. Ellis, and E. Marmolejo. "Stutter-Flash Light-Emitting-Diode Beacons to Increase Yielding to Pedestrians at Crosswalks," Transportation Research Record, 2073, pp. 69-78, 2008.

Van Houten, R., L. Malenfant, R.D. Blomberg, B.E. Huitema, and S. Casella. High-Visibility Enforcement on Driver Compliance with Pedestrian Right-of-Way Laws, National Highway Traffic Safety Administration, DOT HS 811 786, Available online, http://www.nhtsa.gov/staticfiles/nti/pdf/811786.pdf, August 2013.

Van Houten, R. and J. Hochmuth. Evaluation of R1-6 Gateway Treatment Alternatives for Pedestrian Crossings, Michigan Department of Transportation, RC-1638, Available online, http://www.michigan.gov/documents/mdot/SPR-1638_552736_7.pdf, February 2016.

Van Houten, R., L. Malenfant, R.D. Blomberg, and B.E. Huitema. The Effect of High-Visibility Enforcement on Driver Compliance with Pedestrian Right-of-Way Laws: 4-year Follow-Up, National Highway Traffic Safety Administration, DOT HS 812 364, Available online, https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812364_highvisibilityenfdrivercomppeds4yearfollowup.pdf, January 2017.

Waller, P.F., L.K. Li, J.R. Stewart, and J.M. Ma. Evaluation of the Effect of Perception of Risk Messages on Observed Safety Belt Usage, National Highway Traffic Safety Administration, DOT-HS-806-595, Available online, https://archive.org/details/evaluationofeffe00wall, 1984.

Wisconsin Bicycle Federation. "Join Us in Making Wisconsin's Roads Safer," Overview of Share and Be Aware Program, Available online, http://wisconsinbikefed.org/for-your-community/share-be-aware/, 2017.

Wisconsin Department of Transportation (WisDOT). "Weekly Fatality Report," Available online, http://wisconsindot.gov/Pages/about-wisdot/newsroom/statistics/fatality.aspx, 2017a.

Wisconsin Department of Transportation (WisDOT). "Six Year Highway Improvement Program: 2017-2022," Available online, http://wisconsindot.gov/Pages/projects/6yr-hwy-impr/overview/default.aspx, 2017b.

Wisconsin Department of Transportation (WisDOT). Facilities Development Manual, Chapter 11: Design, Section 46: Complete Streets, Available online, http://wisconsindot.gov/rdwy/fdm/fd-11-46.pdf, 2016.

Wisconsin Traffic Operations and Safety (TOPS) Laboratory. WisTransPortal Database, Available online, https://transportal.cee.wisc.edu/services/crash-data/, 2017.

Zegeer, C.V., J.R. Stewart, H. Huang, P. Lagerwey, J. Feaganes, and B.J. Campbell. Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations, US Department of Transportation, Federal Highway Administration. FHWA-RD-04-100, Available online: http://www.fhwa.dot.gov/publications/research/safety/04100/04100.pdf, 2005.

Zegeer, C.V., D. Nabors, and P. Lagerwey. *PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System*, Federal Highway Administration (FHWA), Available online: http://www.pedbikesafe.org/PEDSAFE/index.cfm, August 2013.

Zhang, Y., M. Gawade, P. Lin, and T. McPherson. "Educational Campaign for Improving Pedestrian Safety: A University Campus Study," Procedia-Social and Behavioral Sciences, Volume 96, pp. 2756-2766, 2013.

Appendix A. Wisconsin Driver and Pedestrian Interaction Survey Questions

We administered a Wisconsin Pedestrian-Vehicle Interaction Survey during fall 2016. The survey questions are provided on the next two pages. Since the survey was distributed online, the actual questions were presented in a different format. The electronic response database fields are presented in a table following the first two pages.

Note that one question was transferred to the online survey incorrectly. The first scenario under Question 10 in the original survey and Question 13 in the online survey was intended to say, "Driver approaches an intersection with a red traffic signal. Pedestrian is considering crossing when there is a 'Walk' signal." However, the online survey Question 13_1 scenario said, "Driver approaches an intersection with a red traffic signal. Pedestrian is crossing when there is a Don't Walk signal." Therefore, we removed responses to that question from the analysis.

Wisconsin Pedestrian-Vehicle Interaction Survey (Original Design)

1. How many years have you been driving? _____ Years
(if you have never driven a car, enter 0 years)

2. On a typical weekday (including during work and outside of work), how many different times do you cross streets while walking? (check one)

__ 0 __ 1-4 __ 5-9 __ 10-19 __ 20-49 __ 50+

3. On a typical weekday, how many minutes do you spend driving? (check one)

__ 0 __ 1-9 __ 10-29 __ 30-49 __ 50-69 __ 70+

4. What is your age? (check one)

____ 18-24 ____ 25-34 ____ 35-44
____ 45-54 ____ 55-64 ____ 65 or older

5. What is the zip code of where you live?

_____

6. What is the zip code of where you work?

_____
(if you do not currently have a job, enter 0)

Right of Way Scenarios

7. Indicate by marking with an X if a pedestrian, or driver has the right of way given each scenario.

Scenario Description	**Who has the right of way?**	
	Pedestrian	*Driver*
Driver approaches an intersection with a green traffic signal and wants to continue straight. Pedestrian is crossing when there is a "Don't Walk" signal.		
Driver approaches an intersection with a green traffic signal and wants to turn right. There is no pedestrian signal, but the pedestrian enters right-side crosswalk with the green light.		
Driver is on a residential two-lane road and approaches an intersection that does not have a traffic signal, stop sign, or painted crosswalks. Pedestrian is crossing at the intersection.		
Driver is on a major two-lane road, is not near an intersection, and there is no painted crosswalk. Pedestrian is crossing in the middle of the block.		
Driver approaches an intersection with a red traffic signal. Pedestrian is crossing when there is a "Walk" signal.		
Driver is on a major four-lane road and approaches an intersection that does not have a traffic signal or stop sign but has painted crosswalks. Pedestrian is crossing in the painted crosswalk.		
Driver is on a major four-lane road and approaches an intersection that does not have a traffic signal, stop sign, or painted crosswalks. Pedestrian is crossing at the intersection.		

8. Please add any comments you have about these scenarios:

_____

_____

_____

Driver Yielding Behavior

9. Based on your personal perception of local behaviors, in what situations do most drivers in your local community yield to the right-of-way to pedestrians?

Scenario Description	**Most drivers ___ to pedestrians**	
	yield	*do not yield*
Driver approaches an intersection with a red traffic signal. Pedestrian is crossing when there is a "Walk" signal.		
Driver approaches an intersection with a green traffic signal. Pedestrian is crossing when there is a "Don't Walk" signal.		
Driver approaches an intersection with a green traffic signal and wants to turn right. There is no pedestrian signal, but the pedestrian enters right-side crosswalk with the green light.		
Driver is on a major four-lane road and approaches an intersection that does not have a traffic signal or stop sign but has painted crosswalks. Pedestrian is crossing in the painted crosswalk.		
Driver is on a major four-lane road and approaches an intersection that does not have a traffic signal, stop sign, or painted crosswalks. Pedestrian is crossing at the intersection.		
Driver is on a residential two-lane road and approaches an intersection that does not have a traffic signal or stop sign but has painted crosswalks. Pedestrian is crossing in the painted crosswalk.		
Driver is on a residential two-lane road and approaches an intersection that does not have a traffic signal, stop sign, or painted crosswalks. Pedestrian is crossing at the intersection.		
Driver is on a major two-lane road, is not near an intersection, and there is no painted crosswalk. Pedestrian is crossing in the middle of the block.		

Pedestrian Behavior When Leaving Curb

10. Based on the knowledge of behaviors at your community, in what situations do most pedestrians in your local community leave the curb to cross the street?

Scenario Description	**Most pedestrians _____**	
	cross	*do not cross*
Driver approaches an intersection with a red traffic signal. Pedestrian is considering crossing when there is a "Walk" signal.		
Driver approaches an intersection with a green traffic signal. Pedestrian is considering crossing when there is a "Don't Walk" signal.		
Driver approaches an intersection with a green traffic signal and wants to turn right. There is no pedestrian signal, but the pedestrian is considering entering right-side crosswalk with the green light.		
Driver is on a major four-lane road and approaches an intersection that does not have a traffic signal or stop sign but has painted crosswalks. Pedestrian is considering crossing in the painted crosswalk.		
Driver is on a major four-lane road and approaches an intersection that does not have a traffic signal, stop sign, or painted crosswalks. Pedestrian is considering crossing at the intersection.		
Driver is on a residential two-lane road and approaches an intersection that does not have a traffic signal or stop sign but has painted crosswalks. Pedestrian is considering crossing in the painted crosswalk.		
Driver is on a residential two-lane road and approaches an intersection that does not have a traffic signal, stop sign, or painted crosswalks. Pedestrian is considering crossing at the intersection.		
Driver is on a major two-lane road, is not near an intersection, and there is no painted crosswalk. Pedestrian is considering crossing in the middle of the block.		

11. Please add any comments you have about these scenarios:

_____

_____

_____

Wisconsin Pedestrian-Vehicle Interaction Survey (Final Online Questions)

StartDate	Start Date
EndDate	End Date
Progress	Progress
Duration (in seconds)	Duration (in seconds)
Finished	Finished
RecordedDate	Recorded Date
ResponseId	Response ID
	The following survey is part of a research project conducted by the University of Wisconsin-Madison and the University of Wisconsin-Milwaukee. The purpose of this survey is to understand the interactions of vehicles and pedestrians on the road. You may ask any questions about the research at any time. If you have questions about the research you should contact the Principal Investigator David A. Noyce at (608) 265-1882. If you are not satisfied with response of the research team, have more questions, or want to talk with someone about your rights as a research participant, you should contact the Education and Social/Behavioral Science IRB Office at 608-263-2320. Your participation is completely voluntary. If you decide not to participate or to withdraw from the study it will have no effect on any services or treatment you are currently receiving. If you decide to participate in this research you will be asked to Fill out a 5-10 minute survey that asks about pedestrian and vehicle interactions you have observed. Due to the nature of the online survey we don't anticipate any risks to you from participation in this study. We also don't expect any direct benefits to you from participation in this study. This study is anonymous. Neither your name or any other identifiable information will be recorded. Next Steps: If you agree to proceed by selecting "I Agree to Proceed" you can proceed to the next page by clicking/tapping the ">>" button.
Q3	How many years have you been driving? _____ Years (if you have never driven a car, enter 0 years)
Q5	On a typical weekday (including during work and outside of work), how many different times do you cross streets as a pedestrian?
Q7	On a typical weekday, how many minutes do you spend driving?
Q8	What is your age?
Q9	What is the zip code of where you live?
Q10	What is the zip code of where you work or go to school? (if you do not currently have a job or go to school, enter 0)
Q11	Indicate whether the pedestrian or the driver has the right of way given each scenario.
Q11_1	Driver approaches an intersection with a green traffic signal and wants to continue straight. Pedestrian is crossing when there is a Don't Walk signal.
Q11_2	Driver approaches an intersection with a green traffic signal and wants to turn right. There is no pedestrian signal, but the pedestrian enters right-side crosswalk with the green light.

Q11_3	Driver is on a residential two-lane road and approaches an intersection that does not have a traffic signal, stop sign, or painted crosswalks. Pedestrian is crossing at the intersection.
Q11_4	Driver is on a major two-lane road, is not near an intersection, and there is no painted crosswalk. Pedestrian is crossing in the middle of the block.
Q11_5	Driver approaches an intersection with a red traffic signal. Pedestrian is crossing when there is a Don't Walk signal.
Q11_6	Driver is on a major four-lane road and approaches an intersection that does not have a traffic signal or stop sign but has painted crosswalks. Pedestrian is crossing in the painted crosswalk.
Q11_7	Driver is on a major four-lane road and approaches an intersection that does not have a traffic signal, stop sign, or painted crosswalks. Pedestrian is crossing at the intersection.
Q12	Please add any comments you have about these scenarios:
Q13	Based on your personal perception of local behaviors, in what situations do most drivers in your local community yield the right-of-way to pedestrians?
Q13_1	Driver approaches an intersection with a red traffic signal. Pedestrian is crossing when there is a Don't Walk signal.
Q13_2	Driver approaches an intersection with a green traffic signal. Pedestrian is crossing when there is a Don't Walk signal.
Q13_3	Driver approaches an intersection with a green traffic signal and wants to turn right. There is no pedestrian signal, but the pedestrian enters right-side crosswalk with the green light.
Q13_4	Driver is on a major four-lane road and approaches an intersection that does not have a traffic signal or stop sign but has painted crosswalks. Pedestrian is crossing in the painted crosswalk.
Q13_5	Driver is on a major four-lane road and approaches an intersection that does not have a traffic signal, stop sign, or painted crosswalks. Pedestrian is crossing at the intersection.
Q13_6	Driver is on a residential two-lane road and approaches an intersection that does not have a traffic signal or stop sign but has painted crosswalks. Pedestrian is crossing in the painted crosswalk.
Q13_7	Driver is on a residential two-lane road and approaches an intersection that does not have a traffic signal, stop sign, or painted crosswalks. Pedestrian is crossing at the intersection.
Q13_8	Driver is on a major two-lane road, is not near an intersection, and there is no painted crosswalk. Pedestrian is crossing in the middle of the block.
Q14	Based on the knowledge of behaviors in your community, in what situations do most pedestrians in your local community leave the curb to cross the street?
Q14_1	Driver approaches an intersection with a red traffic signal. Pedestrian is considering crossing when there is a Don't Walk signal.
Q14_2	Driver approaches an intersection with a green traffic signal. Pedestrian is considering crossing when there is a Don't Walk signal.
Q14_3	Driver approaches an intersection with a green traffic signal and wants to turn right. There is no pedestrian signal, but the pedestrian is considering entering right-side crosswalk with the green light.
Q14_4	Driver is on a major four-lane road and approaches an intersection that does not have a traffic signal or stop sign but has painted crosswalks. Pedestrian is considering crossing in the painted crosswalk.

Q14_5	Driver is on a major four-lane road and approaches an intersection that does not have a traffic signal, stop sign, or painted crosswalks. Pedestrian is considering crossing at the intersection.
Q14_6	Driver is on a residential two-lane road and approaches an intersection that does not have a traffic signal or stop sign but has painted crosswalks. Pedestrian is considering crossing in the painted crosswalk.
Q14_7	Driver is on a residential two-lane road and approaches an intersection that does not have a traffic signal, stop sign, or painted crosswalks. Pedestrian is considering crossing at the intersection.
Q14_8	Driver is on a major two-lane road, is not near an intersection, and there is no painted crosswalk. Pedestrian is considering crossing in the middle of the block.
Q15	Please add any comments you have about these scenarios:

Appendix B. Wisconsin Driver and Pedestrian Interaction Survey Open-Ended Responses

Question 11 stated, “Indicate whether the pedestrian or the driver has the right of way given each scenario.” This was followed by seven scenarios. Question 12 stated, “Please add any comments you have about these scenarios.” All responses to Question 12 are listed below.

Comment	Age	Home region
The trickiest one is with the Ped crossing mid-block. I'm pretty sure the driver has the ROW, but the driver must exercise due care not to hit the Ped.	35-44	Milwaukee
Not sure of the true legality of each, but this is what I do as a driver. As a pedestrian, I assume I never have the right of way without making sure a driver has seen me and is stopping.	35-44	Madison
Visual displays with the above explanations of these scenarios would help depict them better.	18-24	Other WI
Of course, even when the pedestrian is crossing out of turn, not hitting a pedestrian with one's car is essential so I'd still stop!	35-44	Out of State
In all situations, it seems that the pedestrian would always have the right of way to account for safety. So, I'm wondering if the question is actually "who legally has the right of way" or who needs to yield to whom.	25-34	Madison
If a vehicle "has the right of way," this does not mean that the driver can run over, be rude to, or scare a pedestrian. It means that the pedestrian can be cited for not following the law by a law enforcement officer.	25-34	Madison
Certainly the pedestrian shouldn't be crossing in some of these scenarios, but my understanding you must stop for a pedestrian and let them cross if they are already in process of doing so!	25-34	Madison
The pedestrian shouldn't be crossing in the middle of a block, which is why I said that the driver has a right of way. But...a car should always yield to a pedestrian in the middle of the road.	35-44	Madison
The pedestrian always has the right of way, even if I don't agree with why they are crossing the road when it isn't their turn or isn't safe. You're not allowed to hit pedestrians therefore they always have the right of way.	25-34	Milwaukee
All of my answers work from the basic assumption that "Pedestrian is crossing" means that the pedestrian has stepped off of the curb and is in the right-of-way.	45-54	Milwaukee
I'm glad someone is researching this. Lots of angry drivers and pedestrians out there because of mismatched understandings of who should go when.	18-24	Madison
I hope at some point you tell us what the correct answer is under Wisconsin law.	45-54	Madison
I have faced the final scenario at Cherry and Water multiple times. One time, I was already well into the crosswalk crossing the North East bound lane when a car came around the corner at Knapp. They showed no intention of slowing down, and only slammed on the breaks when it became clear I was not going to be past their trajectory by the time they got there. The driver laid on the horn and them floored it the moment I was out of the way, well before I'd left the roadway, approximate 6 inches from my heal. This was particularly aggressive, but by no means unique to this intersection. Similarly, when I used to live at Oakland and Newton I would watch for literally minutes as elderly and disabled residents waited to cross Oakland, having to dash out when the road was clear. Very rarely did drivers yield and wait for these individuals to cross.	25-34	Milwaukee
when the pedestrian is crossing not in a painted crosswalk, is it still between 2 sidewalks? if so, then the pedestrian has the right of way as long as they give the car enough time to see them and stop		Madison

As a driver I treat every situation as pedestrian has right of way	18-24	Milwaukee
In some cases when there is no painted crosswalks, pedestrian right of way depends on whether there is a curb cut and how close the nearest crosswalk is.	25-34	Madison
In cases where the pedestrian is crossing when they should not (not in a crosswalk, during a DON'T WALK signal), the driver has the right of way but must stop to avoid hitting the pedestrian. So, this is how I answered the questions above - even if the driver technically has the right of way, it just won't do to run over a pedestrian.	25-34	Madison
Pedestrians always come first in the absence of a clear sign or signal favoring the motorist. We need to change our culture so that all drivers and pedestrians understand and respect this basic principle. Thank you.	55-64	Milwaukee
Question #2 poorly worded.	55-64	Madison
The last one is the only one I'm not sure of.	45-54	Madison
The first scenario seems like it should be driver has right of way, but it also sounds like the pedestrian is already in the crosswalk. In that case, the driver should yield to the more vulnerable user, so as not to cause harm. In most cases, I think it's less about the rules of "right of way" and more about the driver yielding to the more vulnerable user in the roadway.	25-34	Madison
In the last two scenarios, I assume the pedestrian is actually in the road. The driver must stop or slow greatly to permit the pedestrian safe passage. If however in these two scenarios the pedestrian is waiting for pulsed traffic to clear, very few drivers will stop.	65 or older	Madison
Cars are not as dangerous to me as bicyclists are.	65 or older	Madison
Drivers rarely respect the rights of pedestrians, and rarely drive to even acknowledge they exist.	55-64	Madison
I have doubts on the first question. I would want to say that driver has right of way..... but there seems to be a different NORM in Madison or close to campus.....	55-64	Madison
pedestrian always has the right of way except when explicitly disobeying signs don't walk	55-64	Madison
Drivers in Madison are rude, hazardous, disrespectful and utterly indifferent of the laws on r-o-w. Police are generally ill-informed as to the law and virtually never enforce r-o-w violations. One walks at one's own risk here. It is "Lord if the Flies" mode on Madison streets...	55-64	Madison
I do not understand the second scenario.	55-64	Madison
Peds always have the right of way, but are foolish to assert it.	65 or older	Madison
In the last example, it's unclear to me if there is an "unmarked" crosswalk. I'm unsure if there is an unmarked crosswalk at every intersection by default (though I suspect there is, and drive as if this is the case). My understanding of right-of-way law in Wisconsin, pedestrians have the right-of-way in marked and unmarked crosswalks with the stipulation that they may not enter the crosswalk so suddenly as to leave no reaction time to the driver of a car. Pedestrians do not have right of way when not crossing in a marked or unmarked crosswalk.	25-34	Madison
generally, the driver needs to take responsibility for the safety of the pedestrian regardless of right of way.	35-44	Madison

As an aside, I feel it unfortunate that so many of our roads inside of cities are roads and not streets. Streets are built for people, roads are built for cars. I hope that Wisconsin can work towards designing a transportation that benefits PEOPLE, not just cars/drivers. I'm tired of seeing broad roads in residential areas that are designed for cars to speed through. I'd prefer seeing solutions to this that don't just include signage or education of pedestrians/drivers, but include how streets are constructed, public transportation options, large and separate bikelanes, etc. We need a holistic and innovative vision for how people could get around. What we are doing is wasteful and unsafe, and it isn't "forward" looking at all.	25-34	Other WI
Drivers often ignore pedestrian right of way.	18-24	Madison
A pedestrian who is crossing (already in the roadway) always has the right of way.	25-34	Madison
You could say the pedestrian always has the right if way because obviously it would never be ok to hit the pedestrian	25-34	Madison
The concept of 'right of way,' as it pertains to pedestrian-vehicle interactions, is unclear to me. Is 'right-of-way' the set of rules for how to behave when everyone else is following the rules, or is it the set of rules for how to behave based on how everyone else actually behaves? I understand that there are situations where pedestrians are, legally, not supposed to cross the road. However, I also understand that when I am driving a vehicle, I am not supposed to hit pedestrians, even if they are crossing illegally. I don't know which of those concepts I should use to define 'right of way,' but I do know that I should not hit pedestrians, and I know that I should not step out in front of moving vehicles and expect them to stop for me.	25-34	Madison
Of course having right of way doesn't mean you get it!	65 or older	Madison
As I understood it, nobody ever "has" the right of way: the law is about who must yield the right of way. But it amounts to the same thing, I guess. Also in some of these scenarios I think it depends on when the pedestrian enters the crosswalk.	45-54	Madison
I rarely see drivers stop for red lights if they are within half a block of the intersection. Nor do many stop fully at stop signs.	55-64	Madison
When driving, I assume a pedestrian who has started crossing the street has the right of way regardless of crosswalks, etc. They might be eligible for a ticket, but I am certainly NOT going to hit them!! When I am a pedestrian, I assume cars will not stop for me unless I am in a crosswalk and/or have a 'walk' signal.	65 or older	Madison
You need to I'd whether sidewalk is present, a street with sidewalk without MARKED crosswalks still has a legal crosswalk...albeit unmarked	45-54	Madison
but I think that even when the driver has right of way technically they should always yield to a person, right? because nobody wants to kill anyone. I guess maybe it determines if you get charged with manslaughter or not whether you had right of way? I just try not to hit people, which isn't easy if you're on campus. (Usually I'm one of the people though, just trying to not get hit. I rarely drive)	25-34	Madison
If someone is walking in the street they have right of way	55-64	Madison

It's a good idea for drivers to yield to pedestrians. In addition to the brilliant plan of avoiding striking people with one's car, more often than not, pedestrians do actually have the right of way. That does not mean people can walk around willy-nilly in the street and expect cars to work around them, but it really should be emphasized to people who drive that pedestrians are given preference in terms of who gets to go first. I use public transit (Milwaukee County Transit System buses), so between walking to and from the bus stop near my house, transfers from one bus to the next, and walking to and from the stop near my destination, I cross a lot of streets. One-way to the UWM campus is 6 streets to cross. To get to the gym, I cross 7. I cross 9 on the way to work, and there are 10 streets to cross to get to my partner's house. Most intersections are controlled by traffic lights, but a few have stop signs, and some are even uncontrolled. I do have my driver's license, so I'm familiar with rules of right-of-way and so on, so it really makes me angry to see people not cooperating.	18-24	Milwaukee
language about pedestrian is crossing is unclear. If the pedestrian is already in the road by the time the driver comes along, they have right of way. 4th and last scenario pedestrian only has right of way if already in the street when the driver comes along.	25-34	Madison
Regardless of who has the right of way, the vehicle should yield to the pedestrian in every case to avoid causing injury or death.	55-64	La Crosse
Pedestrians are gods.	45-54	Madison
A little uncertainty about the precise meaning of the wording. So when you say "pedestrian is crossing the intersection" in the 3rd and 4th scenarios I took that to mean the pedestrian has not already started the crossing by the time the car comes into sight. I am also assuming the car is traveling at about the speed limit. Also, my understanding is that pedestrians can cross any time they are not obstructing legal traffic, so if the pedestrian sees a car coming but correctly judges that she/he can cross safely before the car reaches that point, that is fine. A note about responses on previous page - my response is for spring through fall when I commute by bike. In winter, when I often take the bus, I cross the street at least 12 x per day and often much more. And some days I have to drive fairly long distances for work.	55-64	Madison
there is a difference between what is the actual 'right of way' vs. getting your ass run over	25-34	Madison
as a frequent ped and cyclist, most of the time when theres a crosswalk at a 4 lane street I prefer if the traffic keeps going. I find it easier to cross between traffic gaps. Otherwise people waive you across when the other lane isn't stopped, or someone slams on the brakes, surprising the driver behind them, etc.	35-44	Madison
Aside from state laws, I give pedestrians the right of way when crossing the street because they are the most vulnerable infrastructure users.		Madison
The painted cross walks made a difference in my responses.	65 or older	Madison
having the right of way does not mean it is safe	55-64	Madison
While I have indicated scenarios where I believe the driver has the right of way, I also believe "pedestrians always have the right of way" and if a pedestrian is already crossing, it is the drivers responsibility to stop.	35-44	Madison
Ultimately since drivers don't want to hit pedestrians they have to stop. The bigger problem is the drivers don't ever yield unless there is a red light for them and a green one for pedestrians.	45-54	Madison

Pedestrian always has the right of way because the driver would always be considered at fault if an accident were to occur.	25-34	Madison
I would call myself a city driver but also have experience directing traffic. I would say my driving behavior is different for a lone pedestrian versus a crowd. With crowds one has the 'tyranny of the pedestrian' whereby pedestrians if there is no signal (and sometimes when there is one!) generally keep walking without regard to the line of vehicles piling up. So if there's a gap where I can fit my car through without hitting a ped, I accelerate quickly to get through and avoid an excessive wait. When it's a lone pedestrian or one group I'm more inclined to yield and be more generous with how I yield, the exception would be if I'm in a big hurry.	25-34	Milwaukee
May be there should be a study also involving bicyclists.	18-24	Madison
Paint colors green and red throughout the City of Madison are confusing. There needs to be a public service campaign to info the public about the role of the pedestrian, driver, and cyclist in various scenarios AND clearly communicate the purpose of the paint colors at various intersections.	45-54	Madison
Doesn't the driver always have an obligation to defer to the pedestrian?	35-44	Madison
Just because driver has right of way does not mean driver should keep going at risk of hitting pedestrian.	65 or older	Madison
This is what I'd do with some variations for context (e.g. I may hesitate to yield to a ped in heavy traffic on a four lane road if I don't feel that I can stop safely.) Also, I'm going to have more respect for painted crosswalks than implied cross walks. Everyone (car/bike/ped) should have adequate infrastructure but each of those should respect the other's infrastructure (i.e. I'm never going to think it's okay for a ped or bike to cross on a red.)	25-34	Madison
The pedestrian always has the right of way, regardless of the situation.	25-34	Milwaukee
My assumptions are that pedestrians always have the right of way unless it could cause a dangerous scenario...but legally, we have to stop at all crosswalks when a pedestrian is crossing...and I don't think this applies in the very first scenario because it is a controlled intersection with an orchestration that chooses who has the right of way. Now I'm intrigued...I'm not so sure.	25-34	Madison

While the pedestrian has the right of way in most of these scenarios, if I usually defer to the driver because I'd rather be alive than correct in my assumed knowledge of the rules of the road. And as a driver, I appreciate when a pedestrian yields to a car traveling at speed through an unmarked intersection. Sometimes, while the car doesn't have the right of way, it's safer for that car to continue its flow of traffic and not have to slam on its brakes for a pedestrian who decides to leap into the path of oncoming traffic. That can be dangerous, and let's be honest â€" can't the pedestrian break stride for a millisecond to allow an automobile to clear the intersection before entering the intersection? This is particularly annoying at school intersections. This happened to me this weekend. Multiple crossing guards were crossing children across a busy 4-way intersection that had several streets merging onto the intersection and turn islands. It would be safer for this unique configuration to have a traffic lights, but it is in a historic area, so it doesn't. The crossing guards weren't working together to keep the flow of traffic moving. They would simply leap into the crosswalk, despite cars already in the intersections. They also crossed groups of 2 and 3 children instead of waiting for a group to gather (School had just let out) or would stand in the crosswalk for minutes at a time so new groups of pedestrians could approach the crosswalk and cross the street. The resulting traffic backlog led to cars straddling train tracks and being forced to stop-short in the middle of intersections. It was a total clusterf@#$.	35-44	Milwaukee
In a lot of these situations, where the pedestrian does not have the technical right of way (crossing on a do not walk, or a middle of the block scenario) even though I believe the driver has the right of way, I also believe the driver should (obviously) yield to keep the pedestrian safe.	18-24	Madison
While in some of the scenarios, the traffic controls are clearly set for the driver when the pedestrian is crossing, every attempt should be made by the driver to safely stop. I nearly selected that the pedestrian has the right of way in all instances, since vehicles should give the right of way whenever the pedestrian in crossing, regardless if the pedestrian is crossing correctly or not.	35-44	Madison
Even for the ones where I chose "driver has right of way", the driver will still need to stop/slow down if there is a pedestrian in the road (!).	45-54	Madison
The format of the survey questions and answers is difficult to understand.	35-44	Milwaukee
In the situations above at the times when I said the driver should have the right of way, I would still expect if a pedestrian has begun crossing that the driver would yield to them and think of the pedestrians safety, despite the fact that the pedestrian should not have crossed without yielding to traffic.	18-24	Madison
Legally the pedestrian may not have the right-of-way, however, regardless of whether they are right or wrong, you have to yield to the pedestrian.	65 or older	Out of State
I am a lot more clueless than I expected - I think I know what the answers OUGHT to be but I realize I don't know what they really are. I just assume cars are supposed to yield to pedestrians, but that doesn't mean the pedestrian always has the right of way (right?)	45-54	Madison
Even if the driver has right of way they still have to stop for the pedestrian	25-34	Madison
Which one of these results in a crash??? Had to include it.. Tina G.	45-54	La Crosse
It the pedestrian is in the road I am going to let them cross.	45-54	Madison
You should still give the pedestrian the right of way?	55-64	Out of State

All of your scenarios involve a pedestrian in the road. Once the ped is in the roadway vehicles must stop.	25-34	Out of State
Some of these are a little confusing (a picture might be helpful). I think the pedestrian always has the right of way, but shouldn't be doing some of these things (e.g., crossing in the middle of a block of a major two-lane road), and if they are, they need to use extreme caution. I've seen people dart out. I've also given the right of way to a pedestrian crossing in a marked intersection on a block, and almost got slammed into by other drivers, and I've been honked at when I stop for pedestrians. I'd like to know the answers to these!		Not Provided
Have filled out these scenarios as to who I think technically has the right of way. In any real scenario, the driver must always yield to pedestrians to avoid injuring them.	25-34	Madison
A pedestrian in the road way always has the right of way (i.e., the driver of a car doesn't have a right to hit the pedestrian). I would have selected "Pedestrian has right of way" for all these scenarios, but I decided to envision the scenarios as the person standing on the sidewalk contemplating crossing, not actually crossing.	25-34	Out of State
Not actually sure of law, but in any case I always give the pedestrian the right of way.	65 or older	Out of State
In all cases a driver should yield to the pedestrian, if for nothing else to be on the safe side.	25-34	Madison
even in scenarios where the car has the right of way, I think that has more to do with fault in an accident, not whether or not a motorist should not harm a pedestrian or other vulnerable road user	25-34	Madison
Pedestrian always has right of way except when the pedestrian sign shows otherwise. Even so it's up to the car to stop if the pedestrian insists on crossing.		Madison
If pedestrian is already in the road, as stated above, then driver should yield.	35-44	Madison
Do any of these laws vary by state?	35-44	Out of State
I wasn't sure what the "right side crosswalk" meant. I assumed it meant that the pedestrian was crossing the street in which the driver wanted to turn right.	35-44	Milwaukee
I added what I think is correct, but I'm not entirely sure, and I don't always observe these rules (both as a pedestrian or with other drivers)	25-34	Madison
In practice, whether a pedestrian has the right of way becomes irrelevant if they are in the traffic lane.	35-44	Madison
While in some situations "legally" the driver has the right of way, in reality, the pedestrian ALWAYS has the right of way. Always, always, always. Unfortunately many drivers do not follow this. I have walked across crosswalks clearly marked with stop signs and signs saying "state law - yield to pedestrians within crosswalk" and they will STILL almost hit me!	18-24	Milwaukee
It's my impression that the pedestrian always has the right-of-way, even when they're in the wrong.	45-54	Milwaukee
-	18-24	Madison

While I feel that the pedestrian has the right of way. It doesn't mean I think they should. Milwaukee needs more protected left hand turns. Additionally, we need more left and right turn lights where the pedestrian has a don't walk. I am very nervous about hitting a pedestrian every timebI make a turn here.	35-44	Milwaukee
the scenarios all say the pedestrian "is crossing." To me that wording means they are already in the road. If the wording had indicated that the pedestrian had not started crossing yet, my answers would have been different in a couple of scenarios.	45-54	Milwaukee
They do not address pedestrians *waiting* to cross in any of these situations. I am consistently ignored by drivers in Madison when I stand on the curb.	18-24	Madison
In some cases I am not clear on the definition of 'right of way'. I know that for example the pedestrian should not cross a street in the middle of the block. But at the same time the driver has to yield to them anyhow.	25-34	Madison
Even if pedestrian is not crossing traffic in a safe and appropriate manor, he or she will have the right of way rather than being hit by a car!	45-54	Madison
I'm interested to learn the law about RESIDENTIAL two-lane roads without crosswalks. And any other ones I may have gotten wrong. Also, in the first set of questions, I was unsure how to answer the question about number of times crossing streets. If I am out walking from one place to another and cross four streets, is that one time "crossing streets" or four times crossing one street?	25-34	Milwaukee
Drivers should always yield to pedestrians, even if they do not have right of way.	45-54	Milwaukee
I wasn't sure if the "right-side crosswalk with the green light" meant the pedestrian was crossing parallel to traffic or not. Might be helpful to clarify that the pedestrian is crossing parallel to the traffic, only impeding the right turning car, not starting to cross in front of traffic from the right side of the road.	18-24	Madison
Most motorists ignore the law and assert right of way. It is exacerbated by pedestrians often behaving ignorantly.	55-64	Milwaukee
Technically, neither user "has" the right of way, but State Statutes dictate who must "yield" the right of way.	25-34	Milwaukee
Right or wrong CAUTION should always side with the pedestrian crossing the road.	65 or older	Milwaukee
Ultimately, doesn't the pedestrian always have the right of way because even if they don't it's not as if a driver can continue you going and be justified in running a pedestrian down because they had the right of way?	25-34	Milwaukee
regardless of who has the right-of-way, I would defer to the car if I were the pedestrian (unless the vehicle slowed to a stop and waved me across)	25-34	Milwaukee
Drivers (including me) understand cyclists' right-of-way even less. I still don't understand it. A birds-eye view of all of these scenarios with directional arrows would be very helpful.	25-34	Milwaukee
For safety reasons I assume driver has the right of way unless there is a stop sign, painted crosswalk, or traffic signal. Though even then it doesn't seem to matter for drivers.	35-44	La Crosse

Question 2 where the driver was turning right, it is confusing which crosswalk the pedestrian was in, and depending on which crosswalk is who has the right of way.	25-34	La Crosse
Despite the driver sometimes having the "right-of-way", it is the driver's responsibility to avoid hitting the pedestrian at all times and in all situations.	35-44	La Crosse
Regardless of right of way, I think pedestrians should be wary because them having the right of way will not stop a car from harming them.	18-24	La Crosse
The questions are misleading due to the fact that they state pedestrians are in the intersection. They need to be more specific as waiting to cross or are crossing. That makes a huge difference. This also need to be given from the pedestrians perspective.	35-44	La Crosse
Once the pedestrian is in the road, they have the right of way as far as I'm concerned. The car can afford to lose 20 seconds. The pedestrian can't afford to jump out of the car's path.	55-64	La Crosse
I was always taught that a pedestrian ALWAYS has the right of way, even if they're doing something stupid or illegal.	35-44	La Crosse
I am reminded of the important need for more protections for pedestrians, better education for drivers, and enforcement of rules that protect pedestrians. I walk or bicycle a lot, and prefer not to drive if I don't have to. It is my impression most drivers have very, very little awareness of bicyclists or pedestrians. Most drivers are not on the lookout in order to actively try to see bikes or pedestrians. I think there is a similar lack of awareness for the harm a vehicle can cause to a person on a bike or one who is walking.	55-64	La Crosse
I assume that the pedestrian has already stepped onto the street	25-34	La Crosse
From my understanding of Wisconsin Statutes, pedestrians have right of way when crossing at any marked or unmarked "crosswalk" (intersection). As an actual pedestrian, I would not attempt to cross in most of the scenarios that I have marked as "pedestrian has right of way"; my experience is that frequent users of human-powered transportation (pedestrians and cyclists) tend to have a better understanding of Wisconsin Statutes regarding rules of the road than frequent drivers and infrequent pedestrians/cyclists.	35-44	La Crosse
The lack of enforcement of pedestrian right of way leads to more driver error in hitting pedestrians. In my locale, drivers ignore pedestrians crossing streets at alarming rates.	55-64	La Crosse
legally does the pedestrian always have the right of way?	35-44	La Crosse

Question 13 stated, “Based on your personal perception of local behaviors, in what situations do most drivers in your local community yield the right-of-way to pedestrians?” This was followed by eight situations. Question 14 stated, “Based on the knowledge of behaviors in your community, in what situations do most pedestrians in your local community leave the curb to cross the street?” This was followed by eight situations. Question 15 stated, “Please add any comments you have about these scenarios.” All responses to Question 15 are listed below.

Comment	Age	Home region
The survey form works well on my phone.	35-44	Milwaukee
One scenario I've noticed a lot is that near a major bike lane (e.g. Wilson St.) near my residence, drivers do not have a stop sign, but pedestrians, cars, and bikes alike on the perpendicular street think it is a 4-way stop even though they only have a stop sign. Most cars without the stop sign have to yield to pedestrians, cars, and bikes as they do rolling stops through their stop sign and continue straight.	25-34	Madison
I don't think the pedestrians DO NOT CROSS the street ever, but rather they wait for traffic to clear instead of take their chances by stepping into the roadway.	45-54	Milwaukee
Pedestrians act as if they own the road and everything revolves around them.	18-24	Milwaukee
A pedestrian's decision to cross almost always depends on whether there are cars approaching or not, unless there is an explicit "Walk" or "Don't walk" signal.	25-34	Madison
There are many other variables here as a pedestrian - I may consider crossing, but I will only cross in any scenario if I see the drivers of on-coming cars see me and are slowing down and stopping to let me walk. I think in general in my community, very few people will walk out into an intersection that does not have a traffic signal if there are oncoming cars, without first checking to see if they can cross safely. Many people will simply wait until the cars pass to cross the road, whether the crosswalk is painted or not.	25-34	Madison
Pedestrians are generally very cautious of drivers--with good reason.	55-64	Milwaukee
I've seen exceptions to all of these.	45-54	Madison
Your focus on "most" totally misses the outliers who are many, severely rude, and dangerous. When I yield to a family w/ a stroller and a toddler or two, they cross my lane with a thank-you wave, then tell their kids to sprint to the other side. I see this over and over; rude, dangerous drivers are so ubiquitous that families are conditioned to sprint like scared deer. It is embarassing, not to mention dangerous, to live in this community as a pedestrian!	55-64	Madison
I feel like most pedestrians do not consider walking out in front of cars. For the previous list of scenarios, I treated "yield" as kindly stopping rather than almost hitting, yelling, and flipping off. I've never seen anyone actually get hit. Most drivers are at least attentive enough to avoid hitting someone. I think these questions are strange.	25-34	Other WI
Different in different communities, but most communities in Wisconsin, cars do not yield and pedestrians are not bold.	18-24	Madison
If you wait for traffic to clear, you never get across the street. A lot of people just go for it.	25-34	Madison

For the section about 'when do most drivers yield,' I think the questions were worded badly. Regardless of the setting, a driver approaching a pedestrian who is already in the street can yield, swerve, or hit them. Pretty much everyone yields. At least, that's how I interpreted the questions.	25-34	Madison
It all depends on eye contact and whether the pedestrian sees the driver slow down. I've never seen a driver fail to yield to a pedestrian and so hit them (fortunately!) Maybe i've misunderstood what you were trying to ask. On campus, of course, it's an entirely different story. It's rarely only one pedestrian crossing at a time, for example.	65 or older	Madison
In my experience young people, college students, are likely to cross mid-block, run across to 'beat the light' or seem to assume the cars see them and will stop or slow down. Foreign students are likely to cross in crosswalks that are painted on multilane roads where there are no traffic signals. Each time I see this, I pray they make it across because the cars are not even slowing down. The students seem to assume the cars will stop for them. This is a disaster waiting to happen So it depends on the demographics of the pedestrians to some extent. The drivers in nearly all cases except red lights seem to either not see, or to assume, pedestrians will stop and wait for them to go past before continuing to cross.	65 or older	Madison
a lot of times one drive will stop on a 2-lane road at a crosswalk, but if you try to walk you'll be killed by the next car over because they can't see you and they never stop too. If you do try to go when the first driver stops for you, you just end up standing in the middle of the street in front of their car while the other lane continues to whiz by indefinitely.	25-34	Madison
questions are general; each street, road, etc., is so different between where I live and where I work. Knowing regular behaviors of drivers/peds in each certain area is how I decide how and when to cross a street. It also depends on if 1 person is crossing, a few, or a lot at the same time.	55-64	Madison
Except near university campus where pedestrians cross at will wherever they like.	55-64	La Crosse
People are too afraid of many of these scenarios to even attempt walking. The most dangerous situation is prople crossing multiple lanes of traffic that are going in the same direction, at a unlighted corner. The first lane's driver may stop, but not the second. For an example of a terrible dangerous heart in throat crossing, see Whitewater, WI situation on their main drag, on their college campus. The wide street indicates to drivers that they can go as fast as they want. Meanwhile students are attempting to cross from where all the free parking is, to campus. A near miss everyday.	45-54	Madison
With scenarios 3 and 6 (and the others) a lot depends on location, time of day, and number of pedestrians. Near and on campus when there are a lot of students hurrying to class pedestrians are a lot more assertive about their rights. Away from campus and when there are fewer people waiting to cross pedestrians are generally less assertive. Also a comment about the previous page -- if pedestrians are actually in the street, drivers will stop to avoid hitting them. But drivers generally do not slow or stop to allow them to cross even if they are at a crosswalk, unless the drivers have a red light and are not turning right.	55-64	Madison

most of the time most people stop for peds in madison. students on university don't care tho they walk in the street whenever they please it is very unsafe and drivers around madison have to be vigilant because people walk around like they have a spare ass at home	25-34	Madison
if theres a car coming, usually peds don't cross. for the previous set of ?s, if there is a ped IN the crosswalk... drivers stop...	35-44	Madison
Unless there is a device (stop sign, traffic light) halting traffic, pedestrians are unlikely to initiate the stop of traffic by stepping into a crosswalk or into the road.		Madison
depends on neighborhood (ie downtown vs residential area)	55-64	Madison
In these scenarios I believe peds are more inclined to wait	25-34	Milwaukee
Whether or not the pedestrian will attempt to cross the street will depend on how close that driver is to the intersection and if they begin to slow down when they enter the crosswalk.	18-24	Madison
Monroe Street is a clear example of pedestrians crossing the road at their convenience not at delineated crosswalks. In Cross Plains on Hwy 14 pedestrians make clear use of the pedestrian crossing tools available to them and the majority cross at delineated crosswalks since it is a Major highway. Pedestrians on residential streets cross at their convenience-not at the intersection.	45-54	Madison
Drivers in Wisconsin are exception to "Midwestern Nice" ... they are rude, defiant of law, and pretend not to see pedestrians.	35-44	Madison
It is difficult to stop for pedestrians when they have a right of way, but are hesitant to cross because a car might pass me on the right (illegally) when I stop for a pedestrian, or cars going the other way do not stop. I get honked at for stopping for pedestrians, especially on Regent Street near the UW campus. Also, even when pedestrians have the right of way, sometimes they are not paying attention and don't cross when I stop for them.	65 or older	Madison
Location is important, even in the same city. Drivers are more apt to yield on some roads rather than others, peds are more apt to push the point and cross in some locations rather than others.	25-34	Madison
I think most pedestrians would rather live than be right.	35-44	Milwaukee
If you are trying to catch a bus, I feel that most pedestrians try to follow an order of A) cross at light B) cross at painted lines C) cross at intersection and D) cross in middle of block. Pedestrians care for their safety but it takes a long time to walk places without bridges or paths.	18-24	Madison
Most pedestrians will wait to see if the car is going to stop for them before proceeding	65 or older	Out of State
"it depends" -- I spend about half my time downtown in madison near campus, and students cross whenever they feel like it, and drivers seem pretty paranoid about students popping out in front of them. The other half of my time is spent in rural areas, where there's little traffic but it moves fast and there aren't any cross walks, and there aren't many pedestrians (just runners). In rural areas pedestrians/runners seem more aware of cars but also take chances and will run across without checking to see if a car is coming.	45-54	Madison

There are so many nuances here, it's hard to say. Is the driver paying attention to the road or looking at their phone (sadly, I see this WAY too often). I guess you could say the same about the pedestrian- are they paying attention, or engrossed in their phone? For those individuals without those distractions, the pedestrian will generally look for indications from the driver. Does the driver slow down, or give any indication that it is okay for the pedestrian to go? What is the speed of the driver? Is there enough time to get across? I've seen a driver who slowed down to allow me to cross almost get slammed into (It was on a major 4-way road, with a painted crosswalk). I generally just wave people to go, and I'll wait for a break in traffic, because that experience was pretty scary. Also, if the pedestrian is on a bike, the answers are generally different, and depends on the locale. [For the previous page of questions (asking about what I've noticed about driver behavior in certain situations)- there was no option for comments on those... My answers hold, but with the caveat, I'm assuming you were referring to both if a person was crossing and preparing to cross. If a person is already in the middle of the intersection crossing, the driver will generally yield (or go around). If the pedestrian is on the sidewalk preparing to cross, the driver will generally not yield.]		Not Provided
Depends on number of cars and pedestrians, time of day, etc. If there are enough pedestrians to form a critical mass and stop traffic at intersections they will.	25-34	Madison
Most pedestrians wait for there to be no cars before crossing the street.	25-34	Out of State
Drivers should yield to pedestrians in cross walks, even on "major" roads.	35-44	Madison
Even with flashing lights and signs that say "state law to stop for pedestrians" many drivers don't stop and it is dangerous to cross in Colorado.	35-44	Out of State
I wasn't sure if you meant that the pedestrian is crossing despite oncoming traffic or if they are crossing knowing that the oncoming traffic would stop (such as when I lived in Seattle and people crossed when they knew they had the right of way and trusted that all oncoming traffic would stop). The former happens in Milwaukee when people cross anyway but simply dodge oncoming cars.	35-44	Milwaukee
In some of these scenarios, pedestrians will cross when drivers are not approaching (or are approaching at a far distance)	25-34	Madison
These questions are hard to answer without knowing how close the pedestrian and driver are. I don't see drivers mowing down pedestrians, nor pedestrians daring them too. But generally I don't see drivers yield to pedestrians even if they should (such as when turning right on red and the pedestrian has a walk signal). Likewise I don't see pedestrians stepping into a road way in a way that would make approaching cars have to slow or stop, even if the cars would have plenty of time to do so. On a side note, I also don't see pedestrians pressing the button for a walk signal even when a button is right there.	35-44	Madison
Most pedestrians are scared to cross, even though they have the right of way.	18-24	Milwaukee
-	18-24	Madison
Find it hard to decide without seeing the speed of approaching car, size of road, etc. Might be easier to guage with pictures.	25-34	Madison

Most people in WI know that cars will take them out, its the out-of-towners that think they will yield when you are in a crosswalk. Its not right, but its true.	45-54	Milwaukee
When children are involved, almost anything can happen. Children going to and from school have a particular problem at uncontrolled crossings. And then then run!	65 or older	Milwaukee
The only time i see drivers yielding to most of these scenarios is when there is a sign posted in the street reminding drivers to yield to pedestrians.	25-34	Milwaukee
At a local high school, right turn drivers with the green daily honk at students who have the Walk signal. As though the drivers believe their green gives them priority over the walk signal.	55-64	La Crosse
Personally, I am a very cautious pedestrian (and walking is on of my preferred modes of transportation). I don't think most pedestrians are as cautious as I am. If I need to cross a busy road I use a route that includes intersection/s that have pedestrian crossing signals. Drivers are inattentive toward pedestrians and bicyclists most of the time, and are oblivious to them at night. I don't trust most drivers to behave safely most of the time, and night time is especially dangerous for a person bicycling or walking.	55-64	La Crosse
Comment on the first scenario. When the driver approaches an intersection with a red traffic signal: most drivers will yield when going straight (i.e. they do not run the red light to go straight). Drivers wishing to turn right tend to yield, but a percentage do not yield to pedestrians crossing with a walk sign while the driver has the red light. (This is generally at major intersections.) Comment on different scenario: The most problematic scenario I have observed is when the driver has a green light, the pedestrian has a walk signal, and the driver wishes to turn right or left. Based upon "feedback" (getting cussed out) by drivers and many close encounters with vehicles, it appears that a good percentage (maybe 1 in 4 or 1 in 5) drivers believe that they have right of way so long as the light is green, regardless of whether they are turning and regardless of pedestrian signals. In other words, the green light trumps pedestrian signals. I will also note that for the purpose of these questions, I am interpreting the word "yield" broadly to mean: (1) the driver stops in a safe manner that does not potentially or actually endanger the health and safety of the pedestrian or other road users; and (2) the driver does so without entering into a verbal or physical altercation with the pedestrian or other road users.	35-44	La Crosse
most pedestrians attempt to cross in the painted cross walk scenarios but cars do not stop, so in the end most pedestrians are not able to cross until there are no cars around.	35-44	Madison
In my experience in Madison pedestrians always yield the right of way. It drives me nuts that drivers do not stop for pedestrians waiting to cross on painted crosswalks.	25-34	Madison
Don't walk signal could be interpreted as flashing do not cross signal	35-44	Milwaukee
On this and the previous screen I'm assuming "most" means at least half. In many cases significant minorities of drivers or pedestrians would do the opposite.	55-64	Madison
Diagrams would be nice for each one. It gets tedious re-imagining each of these scenarios every time.	25-34	Madison
A little confused with these scenarios. I answered them with the understanding that the ped sees a vehicle coming and is making a decision to cross based on whether or not they feel the motorist will stop for them.	45-54	Milwaukee
only if you have a death wish will you cross the street with a car approaching	35-44	Milwaukee

Hopefully the driver always yields to the pedestrian or someone is going to the hospital	25-34	Madison
Most pedestrians I observe seem to be conditioned to not aggressively cross (even if they have the right of way) because most drivers do not stop appropriately.	35-44	Madison
Most peds cross when it's safe	55-64	Madison
Anseers depend so much on specific situation, and really hard to say what "most" do. More important what "many" do?	55-64	Madison
For all "do not cross" answers, it really depends on perceived safety. If vehicle is far enough away to cross safely, most answers would change to cross.	35-44	Madison
a lot of these answers depend on how much traffic there is. If there is only one car coming down the road, most pedestrians will walk any time, but if there are many drivers on the road the answer may change.	25-34	Madison
Most pedestrians assume drivers won't yield and will wait to enter the road until the car is gone out the driver comes to a complete stop. Most drivers fail to field unless there's a red light, stop sign, flashing ped xing or "state law yield to peds in crosswalk sandwich board". They do not interpret a marked crosswalk (and certainly not an unmarked crosswalk) as cause to yield fit peds (or cyclists). Similar issues exist at sidewalk/driveway crossings.	35-44	Madison
I do think pedestrians would cross in any of these scenarios if there were no cars approaching. Pedestrians mainly yield to cars unless there is a signal requiring the car to stop (because cars won't stop if they "don't have to").	25-34	Madison
Pedestrian "is crossing" is a confusing term in all of the above questions. If the pedestrian "is crossing" the driver will generally yield if it is the only way to not hit the person, but won't yield if the pedestrian can still stop (whether that behavior follows the rules of the road or not). In this survey, it is difficult to know how to answer the questions given that observation. Bottom line is cars will yield to not hit someone, but not yield in other cases, even when required by law at almost all kinds of intersections in my community.	25-34	Milwaukee
At an intersection with no lights, I think most pedestrians will cross if traffic is clear.	25-34	Madison
In my observations, pedestrians do not assert their rights and yield to cars.	45-54	Madison
There isn't a lot of pedestrian traffic in the area where I currently live.	25-34	Out of State
Answers to these questions depend heavily on where I am observing these actions. In/around the downtown/campus area, pedestrians are more assertive than in a smaller community with less pedestrian activity. Pedestrians in the downtown/campus area seem to be more prone to crossing against traffic control devices and/or without checking for traffic.	25-34	Madison
These are really difficult to understand. I think your results are going to be tricky to say anything about. Are we imagining this happening all at the same time? Is that what you're going for? If there's a crosswalk and no lights, a pedestrian can cross -- it's going to depend on how close the car is for them to do so. So, what are we to imagine? That's going to determine our answers to these questions.	35-44	Madison
In Milwaukee even with a walk signal and a green light often drivers turning right will aggressively and impatiently make the turn acting like the pedestrian is in the way even though they have the right of way.	18-24	Milwaukee
no one knows pedestrians have ROW at all intersections....	55-64	Milwaukee
Some parts of Milwaukee have dog-eat-dog driving. Others have a herd mentality.	65 or older	Milwaukee

Your terms considering crossing, I believe most people will cross if they perceive they can do it successfully. So I was ambivalent on my answer. I live near Brady St., Milwaukee, where cars travel somewhat slowly....hence, pedestrians are likely to "jaywalk". I believe in smaller communities, that same logic applies.	65 or older	Milwaukee
In general pedestrians are cautious because they know that even when they should have a right to cross the street, it's very unlikely that the car is willing to give them the right away, or is even paying attention to pedestrians.	35-44	Milwaukee
I guess my answers are based on risk averse pedestrians, as I think this characterizes the majority of us. But there are definitely folks who will try to cross any street, anytime.	35-44	Madison
In the places I drive, there are two colleges. Many of the students will not even take a look before crossing into the path of drivers. It can be frustrating and dangerous. Downtown events also bring out very dangerous pedestrian behavior.	35-44	La Crosse
too many scenarios	45-54	La Crosse
There are sometimes marked intersections with flashing lights, and when the drivers often do not bother stopping for the flashing lights or cross the flashing lights when they think the pedestrian is out of danger, even if pedestrian is still in intersection. Often times the flashing lights flash for twice as long as it takes a person to cross intersection-- so drivers blow them off even when there is a pedestrian who should have the right of way. It almost seems as if the flashing lights may make it even more dangerous to cross	45-54	La Crosse

Appendix C. Driver Yielding Field Observation Protocol

Field Study of Drivers Yielding to Pedestrians at Uncontrolled Crosswalks: Data Collection Instructions

Robert Schneider and Aida Sanatizadeh
University of Wisconsin-Milwaukee
August 2016

Study Purpose

The purpose of this study is to quantify the proportion of drivers who yield to pedestrians at uncontrolled crosswalks in the City of Milwaukee. It will quantify driver yielding rates at different locations, and, where possible, record the group context, assertiveness, and demographic characteristics of pedestrians and group context and demographic characteristics of drivers at these locations. Specific design features of the roadway and crosswalk locations will also be recorded. Ultimately, the results can help inform education, enforcement, and engineering pedestrian safety treatments for uncontrolled crosswalks. Note that this study builds from methods used in Gainesville, FL (Van Houten, et al. 2013), Portland, OR (Goddard, Kahn, and Adkins 2015) and other driver yielding field observations.

Field Data Collection

The following sections provide instructions for collecting field data at uncontrolled crossings in Milwaukee. Data collection should be done at either crosswalk and for drivers approaching from either direction as the pedestrian enters the crosswalk. Data collection should typically be done for at least two hours. Three sheets should be filled out at each study location. Sheet 1 is for recording characteristics of the intersection. Sheet 2 is for recording pedestrian behaviors and demographic characteristics. Sheet 3 is for recording driver yielding behavior and demographic characteristics, and Sheet 4 is for collecting demographic data about the overall population of drivers using the roadway. In general, three data collectors are needed. If only two data collectors are available, Sheet 3 and Sheet 4 can be filled out on two different days, but they should be days and times with similar characteristics.

Sheet 1: Intersection Characteristics

- Time: List the time of day when data collection starts and ends. All observations should be made during daylight hours.
- Traffic volume: Record the annualized average daily traffic volume (AADT) for the main roadway. See https://trust.dot.state.wi.us/roadrunner/ for data.
- Two-way street: Record whether or not the street is one-way or two-way. This particular study considers only two way roads.
- Marked crosswalk (crosswalks 1 and 2): Record whether the crosswalks across the main roadway are marked or unmarked. A marked crosswalk is designated by visible lines (either paint or thermoplastic).
- Crosswalk crossing distance (feet): Record the crossing distance for each crosswalk. This is defined as the shortest distance from the curb on one side of the street to the curb on the other side of the street within the crosswalk. Depending on the number and width of travel lanes, crosswalk width might be longer or shorter.
- Crosswalk sign at the intersection (Type): Record all types of crosswalk signs at the intersection. These signs may include the standard crosswalk sign (yellow diamond warning sign at crosswalk), in-street “State Law: yield to pedestrians” signs on the roadway centerline, or pedestrian crosswalk overhead signs.

- Crosswalk sign in advance of the intersection (Y/N): Record whether or not there is an advance warning sign for the crosswalk. This type of sign may simply be a yellow warning sign with a pedestrian figure or may say "Pedestrian Crosswalk Ahead."
- Number of travel lanes being crossed: Record the number of travel lanes being crossed at the study crosswalk. Travel lanes include all general purpose travel lanes as well as left- and right-turn lanes. Bicycle lanes should not be treated as travel lanes. Parking lanes should not be treated as travel lanes (unless there is a peak hour parking restriction and there is moving traffic in the parking lane at the time of study).
- On-street parking (Y/N): Record whether or not there is an on street parking in vehicles direction where they are approaching to the crosswalk. Notice that there might be either on or off street parking at certain time of a day.
- Average distance from the crosswalks to on-street parking: Estimate the distance from the outside line of the crosswalk to the first car that has parked on-street nearby the intersection. This should be an average of four distances.
- Nearside bus stop near the intersection (Y/N): Record any nearside bus stop near the intersection. The sign might be on the curb where pedestrian waiting to cross..
- Farside bus stop near the intersection (Y/N): Record any farside bus stop near the intersection.
- Right-turn lane at the intersection (Y/N): Record whether or not main roadway has a designated right-turn lane at the intersection.
- Right-turn area in the direction of the traffic at the intersection (Y/N): Record whether or not there is a separate area to the right of the travel lane that is commonly used by right-turning cars to move out of the traffic stream prior to turning right.
- Left-turn lane in the intersection of traffic at the intersection (Y/N): Record whether or not main roadway has a left-turn lane at the intersection.
- Curb extension (Y/N): Record whether or not there are any curb extensions (bump outs) where pedestrians will be entering the crosswalks.
- Median at the crosswalk (Y/N): Record whether or not there is a median refuge that can be used by pedestrians at either crosswalk.
- Speed limit (miles per hour): All case studies should have similar speed limit. This measurement item is important, since based on the drivers' speed, they can find out the suitable distance for yielding to pedestrian crossing the street. Use the speed gun for recording vehicles speed or record the speed limit signs of the streets where cars approaching the intersection. Higher-speed vehicles may be less likely to yield.
- School zone or specific land use: Record the presence of any school, business or specific land use near (within one block of) the intersection.

Note: Data collectors should always take a picture of the crosswalk to help illustrate these characteristics when they first arrive at the intersection.

Sheet 2: Pedestrian Behavior and Demographic Characteristics

Each row in this form represents a pedestrian crossing in a single direction in a single crosswalk. The first pedestrian to arrive at the crosswalk in any group should be observed. No additional pedestrians should be recorded until all members of that group complete crossing. The information that should be recorded includes:

- Pedestrian direction: Record the direction that the pedestrian is crossing the street (e.g., northbound/southbound). This direction should be perpendicular to the driver's direction of travel (e.g., eastbound/westbound).

- Crosswalk location: Record the location of the crosswalk in which the pedestrian is crossing (e.g., east or west; north or south). Do not record pedestrians who start crossing outside of the crosswalk, but you may record pedestrians if they go outside of the crosswalk lines near the end of their crossing.
- Time: Record the time that the pedestrian enters the crosswalk to the closest ten seconds (e.g., 4:32:10 pm). Note that the time stamp allows the pedestrian characteristics to be matched with the driver characteristics.
- Yielding opportunity (Y/N): Record whether or not there is a car approaching with an opportunity to yield to the pedestrian. If there is, record Yes. If there is not, record No. In both cases, record all other relevant data fields. An approaching driver is defined as having an opportunity to yield to the pedestrian at the crosswalk if he or she is at least a minimum distance away from the crosswalk when the pedestrian arrives at the curb. This definition is slightly different than state law, which requires drivers to yield the right of way to a pedestrian once he or she has put at least one foot in the crosswalk. The method described by Van Houten et al. (2013) is used to calculate safe stopping distance. Based on a driver reaction time of 2.5 seconds, the posted speed limit in feet per second, and a conservative deceleration rate of 11.2 feet per second, the safe stopping distance for vehicles traveling at 30 mph on a flat grade is 196 feet.
- Gender (Female/Male): Estimate the gender of the pedestrian. People of different genders might be yielded to at different rates.
- Race (Black/White/Latino/Asian/Other): Estimate the race of the pedestrian. People with different racial appearances might be yielded to at different rates.
- Age: Estimate the general age category of the driver to the closest five years or decade (<20, 20s, 30s, 40s, 50s, 60s, 70s, 80s, 90s).
- Physical disability (weelchair/walker/other): Record the type of assistive device being used if the pedestrian has a visible physical disability.
- Waiting location (On the Curb/In the Street/None): Record whether the pedestrian waits to cross on the curb or in the street (has at least one foot in the crosswalk). By waiting in the street, pedestrians may make themselves more visible and may help oblige drivers to yield. If the pedestrian crosses without stopping, mark “none.”
- Assertive stance (Y/N): Pedestrian assertiveness should be recorded as “Yes” when one or more of three characteristics is observed: 1) the pedestrian actively leans toward the opposite side of the roadway when in the crosswalk, 2) the pedestrian directs his or her eyes toward approaching drivers for more than 3 seconds, or 3) the pedestrian points his or her arms or fingers toward the crosswalk.
- Group size (number of pedestrians waiting to cross at the same time): Record the group size. This is defined as the total number of pedestrians waiting to cross at one time. Babies being carried by their parents count as separate individuals. Even if members of the group cross at different times, the group size is based on the number of people waiting together initially. If additional pedestrians arrive after the initial pedestrian or group sets foot into the crosswalk, make a note of this on the data collection sheet. Drivers may be more likely to yield for a group of people waiting to cross rather than for a single pedestrian.
- Waiting time to cross (less than 10 sec/more than 10 sec): Record whether the pedestrian needed to wait less than 10 seconds or more than 10 seconds before they were able to cross the street. This may depend on whether or not drivers yield as well as traffic volumes.
- Number of cars that drove through crosswalk without yielding (Total): Record the total number of vehicles that passed through the crosswalk without yielding before the pedestrian crossed.

- Driver yielded (Y/N): Record whether or not the first driver with an opportunity to yield actually yielded to the pedestrian when he or she crossed. It is possible that the pedestrian simply crossed when there was a gap in traffic. In that case, mark N/A.

Sheet 3: Driver Yielding Behavior and Demographic Characteristics

The purpose of this sheet is to document the characteristics of drivers who either yield or do not yield when a pedestrian is at the crosswalk. Each row represents one driver with an opportunity to yield. A driver observation should be made for the first car that approaches the crosswalk after a pedestrian arrives at the crosswalk. Then, if the first car does not yield, the data collector should observe the next car that they can feasibly observe that has a yielding opportunity. Each driver should be recorded on a single row of the spreadsheet. The information that should be recorded by an observer includes:

- Driver direction: Record the driver's direction of travel (e.g., eastbound/westbound). This direction should be perpendicular to the direction that the pedestrian is crossing the street (e.g., northbound/southbound).
- Time: Record the time that the driver passes the point on the roadway where he or she has sufficient distance to stop for a pedestrian in the crosswalk (whether a pedestrian is present or not) to the closest ten seconds (e.g., 4:32:10 pm). Note that the time stamp allows the driver characteristics to be matched with the pedestrian characteristics.
- Yielded to the pedestrian (Y/N): If a driver has the opportunity to yield but the driver does not yield, then the observer should record this item as No. If a driver stops to yield or slows visibly to allow the pedestrian sufficient time to cross the street, this item should be recorded as Yes. See yielding definition in the Sheet 2 description for more details about safe stopping distance.
- Number of pedestrians at curb or crosswalk waiting to cross: Record the number of pedestrians waiting together (regardless of whether they appear to know each other or not). Babies being carried by their parents count as separate individuals. Drivers might not yield for one pedestrian waiting to cross, but they compel to yield for a group of people willing to cross.
- Gender (Female/ Male): Estimate the gender of the driver. There may be differences in driver yielding between male and female drivers.
- Race (Black/White/Latino/Asian/other): Estimate the race of the driver. There may be differences in driver yielding by race, ethnicity, or culture.
- Age: Estimate the general age category of the driver to the closest five years or decade (<20, 20s, 30s, 40s, 50s, 60s, 70s, 80s, 90s).
- Where the driver yielded: Record the appropriate yielding distance category (in crosswalk/within 1.5m/1.5-6m/>6m/did not stop (slowed/rolled)). If the driver did not yield, do not record a measurement in this field.

Sheet 4: Overall Driver Demographic Characteristics (Optional)

The purpose of this sheet is to capture the characteristics of the total population of drivers, including gender, race, age, and speed (optional). The demographic characteristics are the same as described in Sheet 3. Speed requires using a radar gun and recording the speed in the right-hand column. The driver of every fifth car should be observed, and the data collector should alternate approach directions.

Number of Data Collectors Needed

A minimum of three data collectors are needed to collect all of the information on the four forms. Any of the three data collectors can record the intersection characteristics prior to actual data collection (Sheet 1). The first observer should focus on pedestrian behavior and demographic characteristics

(Sheet 2). The second should focus on driver yielding behavior and demographic characteristics (Sheet 3). The third (optional) observer should focus on overall driver demographic characteristics (Sheet 4).

Appendix D. Video Data Reduction Protocol

Video and Radar Data Processing of Drivers Yielding to Pedestrians at Milwaukee and Madison Uncontrolled Crosswalks: Data Collection Instructions

Mohammad Razaur Rahman Shaon, Robert James Schneider, and Aida Sanatizadeh
University of Wisconsin-Milwaukee
November 2016

Study Purpose

The University of Wisconsin-Milwaukee (UWM) and City of Madison both conducted high visibility enforcement (HVE) at several locations to change pedestrian and driver behavior and improve pedestrian safety in September 2016. The purpose this data collection is to evaluate the effect of HVE in both communities by quantifying the proportion of drivers who yielded to pedestrians at study sites before and after HVE efforts. Driver and pedestrian data were collected at one uncontrolled crosswalk near the UWM and one uncontrolled crosswalk near the University of Wisconsin-Madison (UW-Madison).

Data Collection

The selected uncontrolled crosswalk location near UWM was on E Kenwood Blvd at N Farwell Ave. The location near UW-Madison was on Dayton Street at Charter Street. Video camera and radar sensors were instrumented at both intersections to collect data. The video camera continuously captured the crosswalk and oncoming traffic. The radar was instrumented at higher location to capture the trajectory of oncoming traffic. Data were collected at each crosswalk before and after the HVE effort. All field data was collected on weekdays during daylight periods, mainly between 11 am and 3 pm.

Field Data Collection

The following sections provide instructions for reducing video and radar sensor data collected at the UWM and UW-Madison study sites. Three spreadsheets are designed to collect data about interaction characteristics, pedestrian behavior and demographic characteristics, and driver behavior. All three sheets should be filled out at each study location. Sheet 1 is for recording characteristics of the intersection. Sheet 2 is for recording pedestrian behaviors and demographic characteristics. Sheet 3 is for recording driver yielding behavior.

Sheet 1: Intersection Characteristics

- **Time (Hr:Min:Sec):** List the time of day when data collection starts and ends. Each recorded video file starts with a watch view from computer for synchronizing video data with radar sensor data. Record the starting time from the recorded watch time at the beginning of video file.
- **Time delay (Min:Sec):** Record the difference between start time and the time when the target roadway is in the video frame for pedestrian data collection. This time difference is needed to calculate traffic flow rate on main roadway.
- **Two-way street (Y/N):** Record whether or not the street is one-way or two-way.
- **Crosswalk crossing distance (feet):** Record the crosswalk crossing distance. This distance is defined as the shortest distance from the curb on one side of the street to the curb on the other side of the street within the crosswalk. Depending on the number and width of travel lanes, crosswalk width might be longer or shorter. Record the crosswalk crossing distance in feet unit from "**Google Map**".
- **Number of travel lanes being crossed (Count):** Record the number of travel lanes being crossed at the study crosswalk. Travel lanes include all general purpose travel lanes as well as left- and right-turn lanes. Bicycle lanes should not be treated as travel lanes. Parking lanes should not be treated as travel lanes.

- **Crosswalk sign at the intersection (Y/N):** Record whether there are crosswalk signs at the intersection or not. Put the details in notes if there is another crosswalk sign such as a "State Law: yield to pedestrians" sign on the roadway centerline, or pedestrian crosswalk overhead signs at intersection. For UWM, record the crosswalk sign based on physical investigation. At Marquette University, record crosswalk signs from video.
- **On-street parking (Y/N):** Record whether or not there is on-street parking on the side of the street in the direction of vehicle approaching the crosswalk from recorded video data.
- **Median in the direction of the pedestrian crossing (Y/N):** Record whether or not there is a median in the specific crosswalk being studied from recorded video data.
- **Traffic volume (Count):** Record the total traffic count from the recorded video data for the period of video recording time. Traffic volume needs to be recorded for the full time period (from start time to end time). The total traffic volume will be converted to average traffic flow in the study period for analysis purposes. Record traffic volume separately for each direction for directional traffic flow estimation.
- **End Time (Hr:Min:Sec):** Record the end time of data collection. This time need to be calculated as Start Time + Duration of video file.

Sheet 2: Pedestrian Behavior and Demographic Characteristics

Each row in this form represents a single or group of pedestrian(s) crossing in a single direction in a single crosswalk. The first pedestrian to arrive at the crosswalk in any group size should be observed. No additional pedestrians should be recorded until all members of that group complete crossing. ***A buffer distance of 12 feet (1 lane width) will be used on both sides of the crosswalk as some may not cross the roadway within painted crosswalk***. **Pedestrians crossing the road outside this buffer distance will not be considered for this data reduction process**. The information that should be recorded includes:

- **Timestamp (Hr:Min:Sec):** Record the time that the pedestrian enters the crosswalk to the closest ten seconds (e.g., 4:32:10 pm). The timestamp should be synchronized with data collection start time in Intersection characteristics. Note that the time stamp allows the pedestrian characteristics to be matched with the driver characteristics.
- **Pedestrian direction (EB/WB/NB/SB):** Record the direction that the pedestrian is crossing the street (e.g., northbound/southbound). This direction should be perpendicular to the driver's direction of travel (e.g., eastbound/westbound). At UWM, the right side of the video screen is north, left is south, front is west and back side is east direction. At Marquette, the right side of the screen is east, lest is west, front is north and back side is south direction.
- **Crosswalk location (E/W/N/S):** Record the location of the crosswalk in which the pedestrian is crossing (e.g., east or west; north or south). Do not record pedestrians who start crossing outside of the crosswalk, but you may record pedestrians if they go outside of the crosswalk lines near the end of their crossing.
- **Gender (Female/Male/Both):** Estimate the gender of the pedestrian. People of different genders might be yielded to at different rates. If both male and female are in a group of pedestrian, record the observation as "Both".
- **Race (Black/White/Latino/Asian/Other):** Estimate the race of the pedestrian. People with different racial appearances might be yielded to at different rates. In case of a group of pedestrians, record each of the race(s) in the observed pedestrian group. More than one race may be entered.
- **Physical disability (weelchair/walker/other):** Record if any of the pedestrians in the group has a physical disability.

- **Group size (number of pedestrians waiting to cross at the same time):** Record the group size. This is defined as the total number of pedestrians waiting to cross at one time, as long as at least one person in the group is intending to enter the crosswalk. If additional pedestrians arrive after the initial pedestrian or pedestrian group passes the roadway centerline, record this additional pedestrian (or group) as a separate observation. Drivers may be more likely to yield for a group of people waiting to cross rather than for a single pedestrian.
- **Standing location (On the Curb/In the Street/On Median or Centerline):** Record whether the pedestrian or leading pedestrian in a group is standing on the curb, in the street (has at least one foot in the crosswalk), or on the median or centerline of the street. By standing on the street, pedestrians may make themselves more visible and may help oblige drivers to yield.
- **Assertive stance (Y/N):** Pedestrian assertiveness should be recorded as Yes when one or more of three characteristics is observed: 1) the pedestrian actively leans toward the opposite side of the roadway when in the crosswalk or 2) the pedestrian directs his or her eyes toward approaching drivers for more than 3 seconds, or 3) the pedestrian points his or her arms or fingers toward the crosswalk. Record the assertiveness of the pedestrian or leading pedestrian in a group as "Yes" if that person exhibits any of the above-mentioned characteristics.
- **Yielding opportunity (Y/N):** Record whether or not there is a car approaching with an opportunity to yield to the pedestrian. If there is, record Yes. If there is not, record No. In both cases, record all other relevant data fields.
- **First driver yielded (Y/N):** Record whether or not the driver of the first automobile with a yielding opportunity yielded to the pedestrian (or group of pedestrians) when the pedestrian wanted to cross. It is possible that the pedestrian simply crossed when there was a gap in traffic. In that case, mark No.
- **Waiting time to cross (less than 10 sec/ more than 10 sec):** Record whether the pedestrian or leading pedestrian in a group needed to wait less than 10 seconds or more than 10 seconds before they were able to cross the street. This may depend on whether or not drivers yield as well as traffic volumes.
- **Number of cars that did not yield (Count):** Record the total number of vehicles that passed through the crosswalk without yielding before the pedestrian (or group of pedestrians) crossed.
- **Last driver yielded (Y/N):** Record whether or not the driver of the last automobile with a yielding opportunity yielded to the pedestrian (or group of pedestrians) when the pedestrian wanted to cross. It is possible that the pedestrian simply crossed when there was a gap in traffic. In that case, mark No. It is also possible that a driver farther toward the front in a platoon of cars already yielded. In this case, mark N/A.
- **Pedestrian Assertiveness:** Categorize pedestrian activity at intersection after arriving at crosswalk based on eight (8) criteria described below:
    - **Criteria 1 (C1):** Pedestrian uses body gesture to cross; pedestrian actively leans toward the opposite side of the roadway to cross the intersection.
    - **Criteria 2 (C2):** Pedestrian uses Hand gesture to cross; pedestrian points his/ her arm or fingers towards the crosswalk to cross the intersection.
    - **Criteria 3 (C3):** Pedestrian does not stop before crossing; pedestrian do not stop at curb or street (waiting time ≤ 1sec) to cross the intersection.
    - **Criteria 4 (C4):** Pedestrian stands on street and observes traffic; pedestrian is standing on street and observing oncoming traffic for an opportunity to cross the intersection.
    - **Criteria 5 (C5):** Pedestrian standing on curb (<50 cm from curb face) and observes traffic; pedestrian is standing on curb with distance from roadway less than 50 cm and observing oncoming traffic for safe gap to cross the intersection.

- **Criteria 6 (C6):** Pedestrian stands in street but is inattentive; pedestrian is standing on street but do not observing oncoming traffic (using cell phone etc.) for safe gap to cross the street.
- **Criteria 7 (C7):** Pedestrian stands on curb (<50 cm from curb face) but is inattentive; pedestrian is standing on curb with distance from roadway less than 50 cm but do not observing oncoming traffic (using cell phone etc.) for safe gap to cross the street.
- **Criteria 8 (C8):** Pedestrian stands behind curb (>=50 cm from curb face); pedestrian is waiting to cross the intersection at a location 50 cm or more from the edge of pavement.

Sheet 3: Driver Yielding Behavior

The purpose of this sheet is to document the characteristics of drivers who either yield or do not yield when a pedestrian is at the crosswalk. Each row represents the first driver with an opportunity to yield. A driver observation should be made for the first car that approaches the crosswalk after a pedestrian arrives at the crosswalk. The information that should be recorded by an observer includes:

- **Timestamp (Hr:Min:Sec):** Record the time that the driver passes the point on the roadway where he or she has sufficient distance to stop for a pedestrian in the to the closest ten seconds (e.g., 4:32:10 pm). Note that the time stamp allows the driver characteristics to be matched with the pedestrian characteristics.
- **Driver direction (EB/WB/NB/SB)**: Record the driver's direction of travel (e.g., eastbound/westbound). This direction should be perpendicular to the direction that the pedestrian is crossing the street (e.g., northbound/southbound). As described before, At UWM, the right side of the video screen is north, left is south, front is west and back side is east direction. At Marquette, the right side of the screen is east, lest is west, front is north and back side is south direction.
- **1st vehicle type (Car, Truck, Bus):** Record the type of 1st vehicle. The 1st vehicle can be a car, truck or bus. Vehicle length and mass may have an effect on yielding.
- **Braking Activity (Yes/No):** Record the braking activity of 1st vehicle as Yes or No. If the tail-light of 1st vehicle is on when the vehicle is entering the video frame, record it as Yes, otherwise No.
- **Yielded to the pedestrian (Y/N):** If a driver has the opportunity to yield but the driver does not yield, then the observer should record this item as No. If a driver stops to yield or slows visibly to allow the pedestrian sufficient time to cross the street, this item should be recorded as Yes.
- **Car following (Yes/ No):** Record whether vehicle traversing the roadway section in a platoon or not. A platoon exists when at least one vehicle is following within four car lengths of the first vehicle with an opportunity to yield. If multiple vehicles are traveling in a platoon, record the observation as Yes. If vehicles are traveling in a platoon, it might put pressure on the first driver not to yield (due to fear of being rear-ended) and if the first driver doesn't yield, other drivers in the platoon may follow that lead and be less likely to yield.
- **Downstream Traffic Light (Red, Greed, Yellow):** Record the traffic signal light status downstream from the study crosswalk. The downstream traffic signal status should be recorded at the same time when pedestrian or group of pedestrians arrive at the crosswalk and intend to cross. At UWM, the video data is not clear enough to record the traffic light status at downstream intersection. In this case, if crossing traffic movement is active or vehicle stopped at intersection in the travel direction, it will be noted as "Red", otherwise "Green". At Marquette, the traffic light status should be recorded from video data.
- **Parallel Traffic (Yes/ No):** On Kenwood Boulevard at UWM, there is one lane in each travel direction. But, there is a shared bus and parking lane available. So it is possible that some vehicles are travelling parallel to each other on this section of the roadway. At Marquette, N. 16th Street has two northbound travel lanes. Record this observation as "Yes" if two vehicles are

travelling parallel to each other as they approach the crosswalk (the two vehicles must be within two car lengths ahead or behind each other).

- **Where the driver yielded:** Record the appropriate yielding distance category (in crosswalk/within 1.5m/1.5-6m/>6m/did not stop (slowed/rolled)) based on visual approximation. If the driver did not yield, do not record a measurement in this field.
- **Yielding Type (HY/ SY/ NY):** Record the driver yielding type for each pedestrian activity.
  - The driver activity should be recorded as **Hard Yield** (HY) if the driver started to decelerate *less than 10 m* in advance of the crosswalk but still stopped or slowed before the crosswalk to let the pedestrian cross.
  - The driver activity should be recorded as **Soft Yield** (SY) if the driver started to decelerate *more than 10 m* in advance of the crosswalk to accommodate the pedestrian crossing and either 1) stopped before the crosswalk or 2) did not come to a full stop (slowed).
  - The driver activity should be recorded as **No Yield** (NY) if the driver did not slow down or stop to accommodate the pedestrian crossing.
- **Acceleration/ Deceleration (ONLY under "No Yield"):** Record driver activity as "+1" if the driver accelerated after pedestrian arrival. Record this value as "-1" if the driver decelerated. Record this value as "0" if there was no visible change in speed.
- **Vehicle Location:** Categorize the estimated distance of the vehicle from the crosswalk when the pedestrian arrived at the crosswalk. It is not possible to measure distance exactly from the video image, so vehicle location should be categorized into the following distance groups (<10m, 10-20m, >20m).
- **Vehicle Speed:** Estimate the vehicle speed when the pedestrian arrived at the crosswalk. This estimate should be made to the nearest 5 miles per hour.

Appendix E. Detailed Assertiveness Matrix Tables

This appendix includes assertiveness matrix tables based on the original, detailed definitions of pedestrian assertiveness and driver yielding behavior used for data collection. The tables provided in the main report collapse several similar definitions into the same category. All tables combine the Milwaukee and Madison data collection sites.

Complete Assertiveness Matrix from Video Data

Pedestrian Assertiveness / Driver Yielding Behavior			Gesture (C1-C2)		Standing Location & Attentiveness (C3-C8)						Total
Vehicle Location Group	Yielding type	Average speed (MPH)	C1: Body Gesture	C2: Hand Gesture	C3: No stopping	C4: Standing on street and observing traffic	C5: Standing on curb (<50cm) and observing traffic	C6: Standing on street but inattentive	C7: Standing on curb (<50cm) but inattentive	C8: standing on curb (>50cm)	
<30ft	HY	18.00	0	0	4	1	5	0	0	0	10
	NY	18.57	0	0	4	1	6	0	0	3	14
	SY	16.82	0	2	9	0	2	0	0	0	13
30ft-70ft	HY	-	0	0	0	0	0	0	0	0	0
	NY	20.36	4	0	11	1	34	2	3	5	60
	SY	18.00	2	0	24	2	9	0	0	0	37
>70ft	HY	-	0	0	0	0	0	0	0	0	0
	NY	21.71	0	0	5	6	9	3	5	7	35
	SY	20.88	1	1	11	4	2	0	0	1	20
Total		19.72	7	3	68	15	67	5	8	16	189

Pedestrian Assertiveness / Driver Yielding Behavior			Gesture (C1-C2)		Standing Location & Attentiveness (C3-C8)						Total
Vehicle Location Group	Yielding type	Average speed (MPH)	C1: Body Gesture	C2: Hand Gesture	C3: No stopping	C4: Standing on street and observing traffic	C5: Standing on curb (<50cm) and observing traffic	C6: Standing on street but inattentive	C7: Standing on curb (<50cm) but inattentive	C8: standing on curb (>50cm)	
<10m	HY	18.00	0	0	4	1	5	0	0	0	10
	NY	18.57	0	0	4	1	6	0	0	3	14
	SY	16.82	0	1	9	0	2	0	0	0	11
10-20m	HY	-	0	0	0	0	0	0	0	0	0
	NY	20.36	4	0	11	1	34	2	3	5	56
	SY	18.00	2	0	24	2	9	0	0	0	35
>20m	HY	-	0	0	0	0	0	0	0	0	0
	NY	21.71	0	0	5	6	9	3	5	7	35
	SY	20.88	1	1	11	4	2	0	0	1	18
Total		19.72	7	2	68	15	67	5	8	16	179

Assertiveness Matrix before High-visibility Enforcement

Pedestrian Assertiveness / Driver Yielding Behavior			Gesture (C1-C2)		Standing Location & Attentiveness (C3-C8)						Total
Vehicle Location Group	Yielding type	Average speed (MPH)	C1: Body Gesture	C2: Hand Gesture	C3: No stopping	C4: Standing on street and observing traffic	C5: Standing on curb (<50cm) and observing traffic	C6: Standing on street but inattentive	C7: Standing on curb (<50cm) but inattentive	C8: standing on curb (>50cm)	
<30ft	HY	18.13	0	0	3	1	4	0	0	0	8
	NY	18.50	0	0	3	0	4	0	0	3	10
	SY	17.50	0	1	9	0	1	0	0	0	11
30ft-70ft	HY	-	0	0	0	0	0	0	0	0	0
	NY	22.06	0	0	7	0	24	1	0	2	34
	SY	18.82	1	0	12	0	5	0	0	0	18
>70ft	HY	-	0	0	0	0	0	0	0	0	0
	NY	21.82	0	0	1	1	5	1	3	0	11
	SY	17.50	0	0	1	1	0	0	0	0	2
Total		20.11	1	1	36	3	43	2	3	5	94

Pedestrian Assertiveness / Driver Yielding Behavior			Gesture (C1-C2)		Standing Location & Attentiveness (C3-C8)						Total
Vehicle Location Group	Yielding type	Average speed (MPH)	C1: Body Gesture	C2: Hand Gesture	C3: No stopping	C4: Standing on street and observing traffic	C5: Standing on curb (<50cm) and observing traffic	C6: Standing on street but inattentive	C7: Standing on curb (<50cm) but inattentive	C8: standing on curb (>50cm)	
<10m	HY	18.13	0	0	3	1	4	0	0	0	8
	NY	18.50	0	0	3	0	4	0	0	3	10
	SY	17.50	0	0	9	0	1	0	0	0	10
10-20m	HY	-	0	0	0	0	0	0	0	0	0
	NY	22.06	0	0	7	0	24	1	0	2	34
	SY	18.82	1	0	12	0	5	0	0	0	17
>20m	HY	-	0	0	0	0	0	0	0	0	0
	NY	21.82	0	0	1	1	5	1	3	0	11
	SY	17.50	0	0	1	1	0	0	0	0	2
Total		20.11	1	0	36	3	43	2	3	5	92

Assertiveness Matrix after High-visibility Enforcement

Pedestrian Assertiveness / Driver Yielding Behavior			Gesture (C1-C2)		Standing Location & Attentiveness (C3-C8)						Total
Vehicle Location Group	Yielding type	Average speed (MPH)	C1: Body Gesture	C2: Hand Gesture	C3: No stopping	C4: Standing on street and observing traffic	C5: Standing on curb (<50cm) and observing traffic	C6: Standing on street but inattentive	C7: Standing on curb (<50cm) but inattentive	C8: standing on curb (>50cm)	
<30ft	HY	17.50	0	0	1	0	1	0	0	0	2
	NY	18.75	0	0	1	1	2	0	0	0	4
	SY	10.00	0	1	0	0	1	0	0	0	2
30ft-70ft	HY	-	0	0	0	0	0	0	0	0	0
	NY	17.73	4	0	4	1	10	1	3	3	26
	SY	17.22	1	0	12	2	4	0	0	0	19
>70ft	HY	-	0	0	0	0	0	0	0	0	0
	NY	21.67	0	0	4	5	4	2	2	7	24
	SY	21.33	1	1	10	3	2	0	0	1	18
Total		19.30	6	2	32	12	24	3	5	11	95

Pedestrian Assertiveness / Driver Yielding Behavior			Gesture (C1-C2)		Standing Location & Attentiveness (C3-C8)						Total
Vehicle Location Group	Yielding type	Average speed (MPH)	C1: Body Gesture	C2: Hand Gesture	C3: No stopping	C4: Standing on street and observing traffic	C5: Standing on curb (<50cm) and observing traffic	C6: Standing on street but inattentive	C7: Standing on curb (<50cm) but inattentive	C8: standing on curb (>50cm)	
<10m	HY	17.50	0	0	1	0	1	0	0	0	2
	NY	18.75	0	0	1	1	2	0	0	0	4
	SY	10.00	0	1	0	0	1	0	0	0	1
10-20m	HY	-	0	0	0	0	0	0	0	0	0
	NY	17.73	4	0	4	1	10	1	3	3	22
	SY	17.22	1	0	12	2	4	0	0	0	18
>20m	HY	-	0	0	0	0	0	0	0	0	0
	NY	21.67	0	0	4	5	4	2	2	7	24
	SY	21.33	1	1	10	3	2	0	0	1	16
Total		19.30	6	2	32	12	24	3	5	11	87