Center for Advanced Multimodal Mobility Solutions and Education

Project ID: 2021 Project 02

DRIVER COMPLIANCE WITH PEDESTRIAN CROSSINGS AT NON-SIGNALIZED INTERSECTIONS

Interim Report

by

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September 2022

ACKNOWLEDGEMENTS

This project was funded by the Center for Advanced Multimodal Mobility Solutions and Education (CAMMSE @ UNC Charlotte), one of the Tier I University Transportation Centers that were selected in this nationwide competition, by the Office of the Assistant Secretary for Research and Technology (OST-R), U.S. Department of Transportation (US DOT), under the FAST Act. The authors are also very grateful for all of the time and effort spent by DOT and industry professionals to provide project information that was critical for the successful completion of this study. The authors would like to express appreciation to Joel Meyer, Jen Duthie, and their respective staffs. We certainly appreciate this opportunity to assist the CoA.

DISCLAIMER

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EXECUTIVE SUMMARY

By design, the built environment aims to make who has the right-of-way very clear by presenting expected, easy-to-interpret indications, such as yielding. Some environments are much clearer than others, for example a marked crosswalk versus an unmarked crosswalk. If there is a location where crashes between pedestrians and motorists occur often and for the same reason, then the local entity in charge will consider interventions to improve the design of the pedestrian crash hot-spot location. If engineers and planners can anticipate or know the response that the built environment activates in both motorists and pedestrians, then there is a reasonable chance at maximizing these safety improvements.

Previous research on pedestrian control devices and their effect on pedestrian safety has shown that driver yielding compliance can improve by installing pedestrian signals at crossings, improving the visibility of pedestrians, providing education about pedestrian crossings, and reducing speed limits. Installing in-street signs in a gateway formation, which considered experimental use of the sign and requires MUTCD approval, has also shown to be as effective as expensive PHB and RRFB signs.

The objective of this project is to determine how driver yielding compliance is affected by various combinations of low-cost crossing treatments and signage configurations. MUTCD provides guidance on pedestrian signs, beacons, pavement markings, for example, but guidance provided by the MUTCD regarding types of signs and particularly mounting locations for pedestrian crossing signs at non-signalized intersections is sparse. Specifications for mounting locations of warning signs and regulators signs leave lots of opportunity for engineering judgement. This study was as first step in defining the understanding the types of baseline yielding rates at four pedestrian crossing types and to understanding the impact of combination of signage type and crossing type have on driver yielding. When assuming no interaction between the R1-6 sign and crossing type, the effect of the sign is an +8% improvement on yielding compliance. When assuming interaction, the effect of the R1-6 sign depends on the crossing type. For concrete refuge islands, probability of yielding goes up by +50% ,which is 4x with the R1-6 sign. For flexpost islands, the sign improves yielding probability by an additional +4%, which doubles the probability. And at marked crosswalks, again compliance doubles by adding 3% to compliance probability with the sign. This study also found that high levels of pedestrian activity positively impact rates, and that high vehicle activity negatively impacted driver yielding rates at unmarked crosswalks.

Chapter 1. Introduction

1.1 Problem Statement

Leveraging quantitative knowledge on pedestrian control devices can maximize the potential to reach various goals, such as creating more walkable communities and improving safety. Many fast-growing areas across the country have expressed a rising interest in reducing motor vehicle dependency by creating denser, more walkable, more bikeable communities. Understanding the effects of the built environment on motorist-pedestrian interactions can inform future implementation of such control devices to maximize the potential to reach safety goals, such as decreasing pedestrian injuries and fatalities.

The National Highway Traffic Safety Administration (NHTSA) has shown record traffic fatalities with pedestrian deaths up 13% compared to 2020's already record-breaking numbers (*1*). While numerous reasons could explain this trend in pedestrian versus motorist crashes, at the end of the day crashes are preventable events. Categorically, crashes are a public health concern requiring examination to identify effective methods and policies to prevent them.

There are many interventions that can reduce pedestrian crashes, including clarifying the indications transmitted to the actors interacting in the traffic network via the built environment or even carrying out public education campaigns on local laws. Really, the most operational way of influencing people's decisions to cross or to yield, for example, is through the built environment. The fact that the leading cause of fatal pedestrian crashes is 'failure to yield' according the Fatality Analysis Reporting Systems (FARS) implies that the various facets that go into both motorist and pedestrian decisions leading up to crashes could improve. One of these facets is the behavioral responses that are triggered by people's surroundings. Presumably for some combination of reasons, the pedestrians involved in failure to yield crashes felt that they were able to cross safely. Improving our understanding about the effects the built environment has on human behavior can help with reducing traffic fatalities and prioritizing intervention.

Many cities have adopted a Vision Zero safety policy, an initiative that was originally envisioned by the Swedish, of reducing all traffic related fatalities to zero. In order to effectively eliminate all fatalities, then both sides of motorist-pedestrian interactions need attention. Since one of the leading causes of pedestrian fatalities has been attributed to 'failure to yield', the insights gleaned from fatality crashes offer more from the perspective of the pedestrian. That is, these data lend themselves more toward answering the question of what types of environments lead pedestrians to decide to fail to yield to motorists. On the other hand, the fatality crash data do not offer very much potential in terms of answering the opposite question of what types of environments lead motorist to fail to yield to pedestrians. Both scenarios are dangerous and can result in a traffic fatality, consequently both scenarios require evaluation to reach a Vision Zero goal.

1.2 Objectives

The objective of this report is to presents the results of an experimental study on driver yielding behavior toward pedestrians at various crossing treatments. Using these results, this

study quantifies the effect of pedestrian control devices on pedestrian safety. This report also presents the results from an online survey on Texas yielding laws with over 1,000 responses. Considering both types of data, this report aims to achieve a well-rounded quantification of the effect pedestrian control devices have on overall pedestrian safety and the current state of knowledge on proper yielding behavior.

1.3 Expected Contributions

The City of Austin is an example of a city with Vision Zero and goals to support walkability. Imagine Austin, City of Austin's plan to transition to a more multi-use, active transportation friendly city with affordable housing, and improved connectivity, exemplifies the city's desire to improve non-motorized facilities. For cities, such as City of Austin, to transition to more active transportation-friendly environment, grasping the quantifiable effects that the built environment has on pedestrian-motorist interactions supports a proactive approach to combat the recent trend in rising pedestrian traffic-related deaths.

1.4 Report Overview

The remainder of this report is organized as follows: Chapter 2 presents a comprehensive literature review driver yielding behavior. Chapter 3 provides details on the effect of crossing treatments on driver yielding rates. Chapter 4 the results of an online survey of Texas Yielding Law knowledge. Finally Chapter 9 concludes this report with a summary and a recommendation for improving crossings.

Chapter 2. Literature Review

2.1 Introduction

With a Vision Zero and an improved walkability goal in mind, traffic engineers, urban planners, and cities must do everything possible to preemptively reduce traffic-related fatalities. As cities continue to grow and densify, people are increasingly looking at modes other than vehicles to get to their destinations. People choosing to walk to their destinations more and more can bring about many benefits, such as reduced pollution at the societal level and increased cardiovascular activity at the individual person level. Generally, this active transportation renaissance has increased the demand for effective pedestrian facilities to ensure a safe built environment.

2.2 Early Re-Definition of Streets

Prior to the introduction of the automobile, city streets were filled with pedestrians at large. Not long after the introduction of the automobile, automobile users began criticizing the pedestrians using streets that had gradually become major thoroughfares. Around the 1910s the turf war between pedestrians and automobiles began and by the 1930s, the battle between pedestrians and automobile promoters had virtually ended. In the end, automobile promoters had won the backing to rebuild cities to accommodate and prioritize motorized vehicle travel (*2*).

From the very beginning of multi-modal streets, traffic engineers have encountered challenges in balancing both safety and spatial efficiency of the transportation network. Even in the early re-definition of streets, these same competing goals were the anthems of pedestrians and automobile users. Pedestrians and parents of children were concerned with “death cars” and felt that they were fighting for justice in fighting against automobiles. At the same time, automobile promotors backed regulating traffic and making streets more auto-centric to improve efficiency of travel (*2, 3*). Over time, cities have come to realize that prioritizing one mode can decrease the quality of travel for other modes, and as a result have focused on improving facilities and public education on non-motorized travel modes.

The contemporary issue of ever-increasing congestion and ever decreasing space has led cities to try to alleviate the stress on the transportation network by reverting back to mixed-use spaces and non-motorized transportation modes. Planning for a dense community filled with affordable, mixed-use spaces can make it easier for city-dwellers to access destinations by walking or biking and can control motor vehicle dependency. The City of Austin is an example of a city that has recognized the following: urban sprawl driven by limited housing supply in central city areas can lead to motor-vehicle dependent, congested cities.

In 2012, the City of Austin published its municipal comprehensive plan that directly addressed the desire to make the city more dense, sustainable, and affordable (*4*). The plan comments on facilitating walking and biking having the potential to promote community health by 1) reducing dependency on modes that produce greenhouse gas emissions and by 2) encouraging daily exercise. Imagine Austin is an example of a City that has planned to revert to the ways of the past by further prioritizing pedestrian and cyclist travel.

2.3 Pedestrian Control Devices

One way of encouraging safe pedestrian travel is through the implementation of control devices. The Manual of Uniform Traffic Control Devices (MUTCD) for Streets and Highways specifies national standards for all traffic control devices, including road markings, highway signs, and traffic signals (*5*). In the context of pedestrian facilities, control devices can include signs, beacons, signals, pavement, markings, and raised islands. Table 2.1 shows the corresponding section in the MUTCD for each type of approved pedestrian control device.

Table 2.1 Pedestrian Control Devices given by MUTCD, 2009 Edition

Control Device	Section	Title
Signs	2B.52	Pedestrian Crossing Signs
	2B.11	Yield/Stop Here for Ped Signs
	2B.52	Pedestrian Signs
Signals	4E.01	Pedestrian Signal Heads
Beacons	4F.01	Application of Pedestrian Hybrid Beacons
Pavement Markings	3B.15	Transverse Markings
	2B.18	Crosswalk Markings
Islands	3I.06	Pedestrian Islands and Medians

The Manual of Uniform Traffic Control Devices (MUTCD, Ref 1) specifies shapes, sizes, colors and application guidance for all legal control devices. The MUTCD is recognized by state laws and city ordinances as the only source for traffic control device specifications. As shown in Figure 1 the MUTCD provides choices among a variety of regulatory and warning signs for pedestrian crossings. Choices among the regulatory and warning signs for pedestrian crossing sites are generally left to the judgment of the control system designer as is the decision to implement sign combinations. The Manual does provide guidance regarding signage mounting locations but recognizing the fact that vehicle speeds, highway functional classification and character of surrounding land use may impact mounting location choices, the guidance generally includes engineering judgment as a criterion.

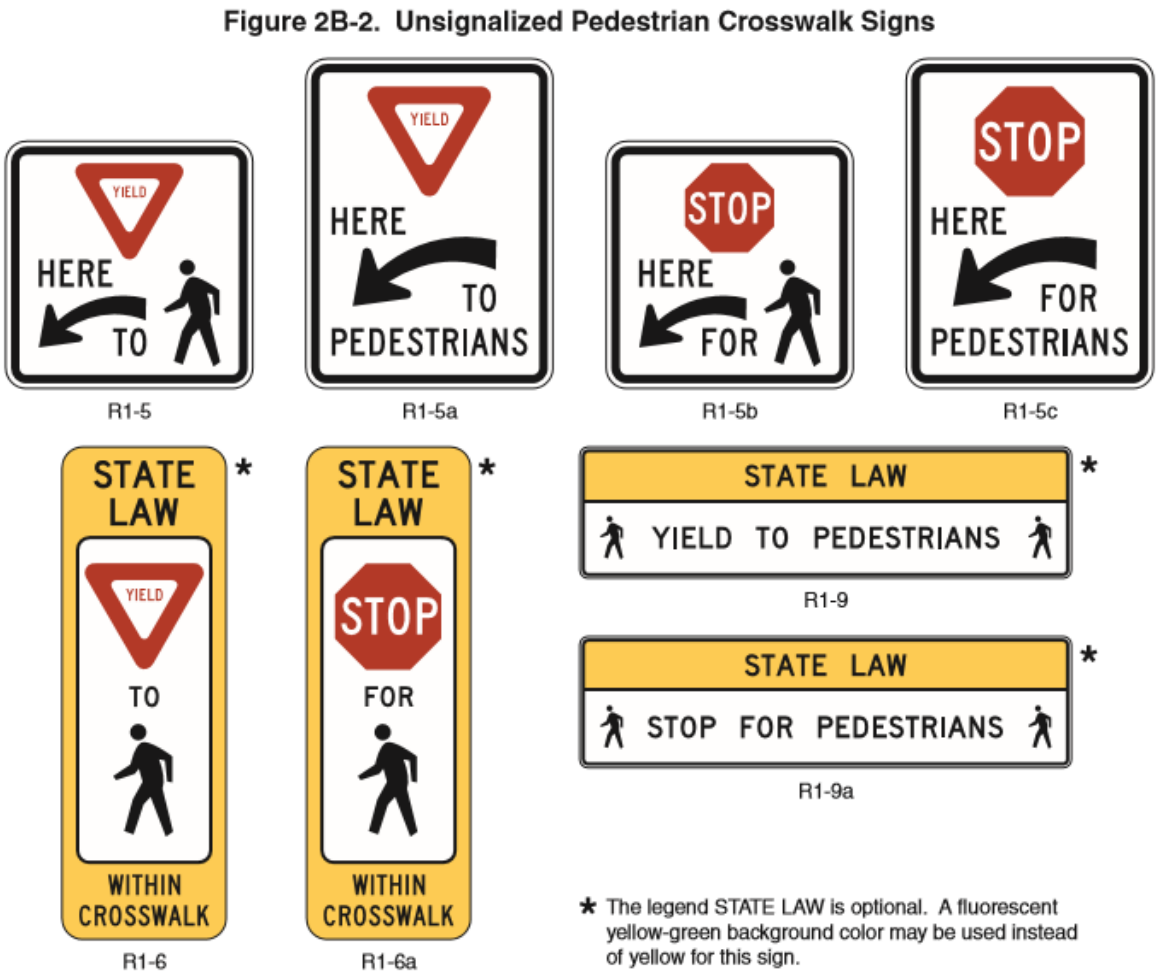


Figure 1 Eight unsignalized intersection regulatory pedestrian crossing signs (taken from MUTCD Figure 2B-2)

Specifications regarding mounting locations of **warning** signs are much less detailed than the size, shape and lettering on the signs. The manual states:

> *"Warning signs should be placed so that they provide an adequate PRT. The distances contained in Table 2C-4 are for guidance purposes and should be applied with engineering judgment. . . . The time needed for detection, recognition, decision, and reaction is called the Perception-Response Time (PRT)."*

Specifications for locations of **regulatory** pedestrian crossing signs are somewhat more specific but still leave opportunities for engineering judgment. The Manual provides the following:

> *"If yield (stop) lines and Yield Here To (Stop Here For) Pedestrians signs are used in advance of a crosswalk that crosses an uncontrolled multi-lane approach, they should be placed 20 to 50 feet in advance of the nearest crosswalk line . . . Highway agencies may develop and apply criteria for determining the*

applicability of In-Street Pedestrian Crossing signs. . . If used, the In-Street Pedestrian Crossing sign shall be placed in the roadway at the crosswalk location on the center line, on a lane line, or on a median island . . .”

Therefore, signage for unsignalized intersection crossing locations can legally employ a variety of warning and regulatory signs. Choices among the signs must be made by the designer and generally, final locations of signs are up to the designer as well. The study just completed by the research team tended to show significantly different impacts of signage locations.

This study will recognize any of the aforementioned items as a *pedestrian control device* and will treat unmarked crosswalks as locations without pedestrian control. To specify, unmarked crosswalks are locations pedestrians can legally cross. An unmarked crosswalk is the continuation of lines of a sidewalk across a road at an intersection as shown in Figure 2.2 (image from City of Austin).

Figure 2.2 Unmarked Crosswalk in Highlighted in Green.

New pedestrian facilities that are not specified by the MUTCD and do not have an Interim Approval will require an approved Request for Experimentation (RFE) before installation. An approved RFE requires the experimental sites to undergo a before and after study to determine the appropriateness of the design and its benefit to safety.

Figure 2.3 Pedestrian-Actuated Rectangular Rapid-Flashing Beacon

The only experimental pedestrian crossing improvement with active interim approval from FHWA is the pedestrian-actuated rectangular rapid-flashing beacon (RRFB). The RRFB is a relatively low-cost sign meant for use at uncontrolled crosswalks (Figure 2.3 image from FHWA). The pedestrian-actuated rectangular rapid-flashing beacon has shown high motorist yielding rates, higher even than standard yellow circular flashing warning beacons (*6*). While some studies have focused on new crossing types, there are no experimental signs or signals included in the analysis presented in this thesis.

3.1.1. Previous Studies on Pedestrian Control Devices

This section reviews previous research on the relationship between driver yielding behavior and control devices. Knowing what kinds of facilities and combinations of facilities work best under different conditions is essential to improving pedestrian safety. Previous studies and experiments have explored: the use of surrogate measures (*7*, *8*), yielding at beacons (*9*, *10*), yielding at in-street sign gateways (*9*, *11*), yielding marked versus unmarked crosswalks (*12*), and the factors that may predict the likelihood of yielding (*13*). The majority of experiments testing driver yielding behavior resorted to using decoys and staged crossings to ensure significant sample sizes are obtained in a timely fashion.

A concern with respect to designing human behavior experiments is whether the use of decoys provides results that are representative of the real world. Studies typically rely on video collection of either staged or natural to collect pedestrian data. When using staged data, the short answer to the previous question is not necessarily. A study that compared staged and non-staged pedestrian crossings found no statistical significance in yielding results (*14*), however, when using a staged approach, the variability in pedestrian behavior disappears. Differences in pedestrian aggression can affect how the pedestrian attempts to cross a location, which will in turn affect the driver's response.

3.1.2. Surrogate Measures

One of the main challenges in the safety analysis component of pedestrian crossing studies is the lack of crash data. Some large-scale, naturalistic observational studies have been conducted using cameras to create a database containing greater information about pre-crash and crash events (*7*). The lack of adequate crash data is likely attributed to the fact that there are far more collisions and conflicts occurring than are reported to the police (*7*). Typically, the majority of crashes result in damages less than the dollar amount threshold for a property damage only (PDO) report in the opinion of the reporting police officer. In this context, a safety surrogate can overcome the lack of vehicle-pedestrian crash and conflict data due to the rarity of such events. According to a large study, the approach of using conflicts as surrogate for crash data is an acceptable estimation of crash risk (*7*). Therefore, vehicle compliance can serve as a surrogate for vehicle-pedestrian crashes or conflicts.

3.1.3. Yielding at Pedestrian Beacons

Studies reviewing yielding rates at pedestrian-actuated rectangular rapid-flashing beacons (RRFB) and pedestrian hybrid beacons (PHB) have observed high yielding rates. Figure 2.3 shows an example of a user-activated RRFB, which is used to supplement standard crossing warning signs and markings. RRFBs flash at a much faster pulsing rate and shines more brightly than the standard flashing beacon (*15*). On the other hand, a PHB flashes yellow and red to alert drivers to slow and then stop for pedestrians as shown in Figure 2.4 (images from the City of Austin). PHB are most appropriate for multi-lane or higher speed or volume roads (*15*).

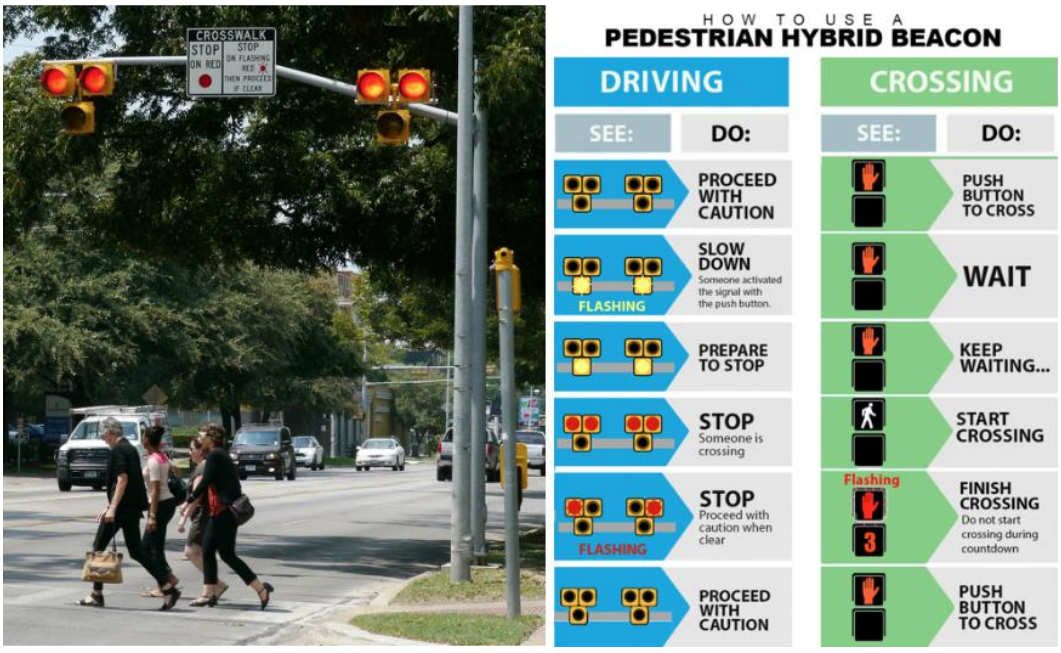


Figure 2.4 Pedestrian Hybrid Beacon Image and 'How-To' Infographic

An experimental study conducted in Texas tested driver yielding behavior Traffic Control Signals (TCSs), RRFBs, PHBs, and found yielding for RRFBs and PHBs were 86% and 89%,

respectively (*10*). In Michigan, a review of 31 sites found that compliance ranged between 95% and 100%. Moreover, other research published by FHWA shows that PHBs average 96% yielding compliance (*16*).

While these yielding rates are much better than what has been documented at unmarked and marked crosswalks, these treatments are typically much more expensive. A PHB can cost approximately $75,000 to install (*17*). And although RRFBs are considered a lower cost alternative ranging from $10,000-$15,000 to implement (*18*), RRFBs are still more expensive than a marked crosswalk.

2.3.1 Yielding at Gateway Formations

Implementation of in-street signage in gateway formation, such as R1-6 signs, can improve yielding rates as much as costly PHB and RRFB signs (*19–22*). A gateway installation has one in-street sign installed between the travel lanes in each direction, and one on both edges of the roadway in each direction. Figure 2.5 (from Hochmuth and Van Houten 2018) shows the R1-6 in-street sign in gateway formation. For comparison, a single R1-6 sign with a fixed base costs less than $300.

Bennett, Manal, and Van Houten 2014 showed that the in-street gateway configuration increased yielding to a level similar to PHBs and RRFB signs. Yielding rate without signage was 23% and increased to 82% with the gateway configuration. A few years later, Bennett and Van Houten showed using fluorescent signs without the yielding message in a gateway formation increased yielding from 7% to 33% but adding the yielding increased yielding rates from 33% to 78%. Most recently, Van Houten et al. 2018 showed that yielding remained consistently high at permanent gateway installations with little to no evidence of decline nine months post installation.

Figure 2.5 Gateway Configuration

2.3.2 Yielding at Marked Crosswalks

A number of studies have evaluated pedestrian safety at marked crosswalks and have reported a wide range of yielding rates. One of the early studies on marked crosswalks conducted in the City of San Diego concluded that marked crosswalks had more pedestrian collisions than unmarked crosswalks (*23*), and led some people to interpreting marked crosswalks as being less safe. As a result, there has been controversy over whether or not marked crosswalks at uncontrolled locations improve pedestrian safety.

More recently, Zegeer et al. 2001 reviewed crash rates at marked and unmarked crosswalks at locations to determine the safety effects of marked crosswalks. The study revealed that on two-lane roads there is no difference in pedestrian crash rates when comparing marked and unmarked crosswalks. At multilane locations, marked crosswalks were associated with a higher pedestrian crash rate. Perhaps the increase in crashes at marked locations is caused by pedestrians feeling a false sense of security and as a result acting in a less cautious manner.

Marked crosswalk compliance has high variance with values reported in the literature. The baseline results from a study evaluating whether a raised arm or similar prompt could improve driver yielding in Chicago and Michigan show the wide range of observed yielding rates at marked crosswalks. In the baseline case with no arm raised, yielding rates at marked crosswalks with no signs in Chicago and Michigan ranged between 1.9% and 31.5% (*24*). Differences in laws or law enforcement, pedestrian volumes, and societal norms may explain this large variance in yielding compliance.

3.1.4. Pedestrian Perspectives in the United States

Across the United States, approaching drivers who have enough time to see a pedestrian in the crosswalk must let the person cross by law. However, these laws are not strictly followed and rarely enforced. A survey-based study conducted across 171 cities across North America presented the perceptions of driver yielding behavior held by pedestrian safety professionals (*25*). Respondents gave evidence of differing driver yielding culture between communities, rare enforcement, and increased yielding rates on narrow, low speed highways. The professionals that were surveyed identified a number of factors to be even more influential to driver yielding than vehicle volume, driver alertness, and pedestrian visibility, such as driver behavioral norms; enforcement of laws; and pedestrian behavioral norms. Figure 2.6 illustrates the hierarchy of causes for driver yielding as interpreted by the study of North American perspectives (*25*).

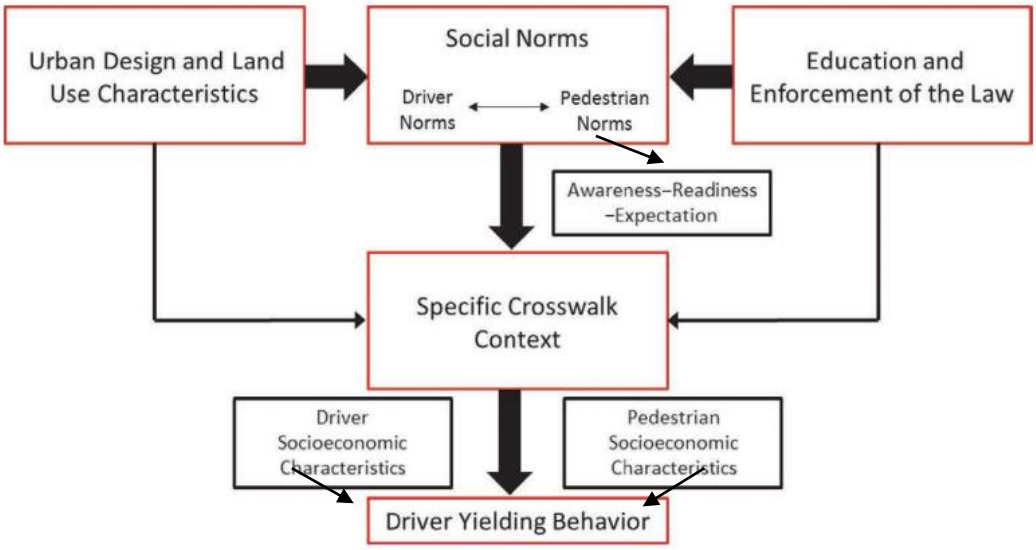


Figure 2.6 Factors that influence driver yielding behavior

In Figure 2.6 the items in the top are community-level factors, the middle row consists of site-level factors, and the bottom row represents the driver's compliance (figure modified from Schneider and Sanders 2015). Items boxed in red are major factors and items boxed in black are minor factors influencing driver yielding. The various arrows indicate the different paths of influence that factors may take. The thicker arrows indicate the most common path (*25*).

As indicated in the figure, 'Education and Enforcement' is a major factor in influencing yielding behavior. Most states only require motorists to yield to pedestrians in uncontrolled crosswalks; only nine states require that motorists come to a stop for pedestrians in certain situations. Minnesota is the only state in the U.S. to require motorists to stop for pedestrians in any portion of the roadway (*26*). Texas requires that drivers give the right of way to pedestrians at uncontrolled intersections, if the pedestrian has a walk signal, and if there is a pedestrian in the street (*27*). Indeed, education is one piece of the puzzle for improving pedestrian safety. But, achieving a built environment with expected, easy-to-interpret indications can overcome educational shortcomings.

Cities facing rapid growth or having high international tourism, such as London and New York City, are at risk for even more pedestrian safety issues related to lack of knowledge about the local urban design. In both of these cities, the municipal authority has decided to paint markings to remind pedestrians where to look before crossing the street. London, for example, has taken steps to clarify the rules of built environment by placing the phrase 'Look Right' at crosswalk endpoints. Painting explicit instructions as a safety measure to remind pedestrians that the societal norms and laws are different from other countries is an extreme example of delivering easy-to-interpret indications through the built environment.

3.1.5. Factors Influencing Driver Yielding Behavior

The results of past studies show that pedestrian facilities can improve safety, and that certain combinations of treatments and motorist characteristics influence compliance rates. The following list summarizes some notable findings from previous work:

- Driver approach speed impacts yielding compliance (*28*)

An inverse correlation exists between vehicle speed and yielding rates. Based on the observed data, there is a linear relationship between measured vehicle speed and yielding rates with an R2 of 0.99.

- Vehicles traveling at higher speeds and or within platoons have lower yield rates (*13, 28*).

Pedestrians are less visible to cars traveling behind the leading car in a platoon. Additionally, non-yielding cars might influence other approaching cars, meaning a motorist is less likely to yield to a pedestrian if none of the other motorists are yielding.

- Pedestrian characteristics influence motorist yield rates

Motorists are more likely to yield to more assertive pedestrians or those situated in a large group which, again, may be related to their increased visibility (*13, 29*).

- Crosswalk type strongly influences motorist yield rates

Yielding rates can range from a low as less than 5% compliance at marked crosswalks (*30*) to as much as 96% at PHBs (*16*).

- Red signals and other beacon devices are the most effective crossing treatment for larger arterials (*29*)

Motorist yielding compliance at sites on busy arterial streets with red signal or beacon signs were 94% or higher in both the staged and natural crossing data (29). Gateways and signage alone are likely less effective on wider roadways with higher speed limits and traffic volume where they are more susceptible to damage and are less obvious than pedestrian signals and flashing beacons.

2.4 Summary

This chapter reviewed previous research on pedestrian control devices and pedestrian safety. Based on past research, one can expect that driver yielding rates may be improved by:

- Installing pedestrian signals at crossings on arterials;
- Installing in-street signs in gateway formation, which can be as effective as expensive PHB and RRFB signs;

- Improving the visibility of pedestrians;
- Providing education regarding pedestrian crossing facilities to increase familiarity; and
- Reducing speed limits.

The rest of this report is broken up into two major chapters. The following chapter focuses on the relationship between motorists and pedestrians by comparing yielding rates among various crossing treatments using results from an experimental study. The next chapter after that will review the results from an online survey that captured the current state of the public's knowledge and understanding of Texas yielding laws.

Chapter 3. Effect of Crossing Treatments on Yielding Rates

3.1 Introduction

This chapter focuses on examining the effects crossing treatments have on pedestrian safety in Austin, TX. In general, crashes are considered rare events, resulting in relatively small sample sizes. Yielding rates can serve as a proxy for potential crashes and be used to generate conclusions about the built environment's impact on safety. These results will help improve the current knowledge on the impact crossing treatments have on driver yielding rates at various common crossing types.

3.2 Experimental Field Study Methodology

This experiment was conducted using staged-crossings made by a single decoy at ten locations varying in terms of control devices and other characteristics. The overarching questions explored in this study are:

How does driver yielding behavior change with respect to crossing treatment type?

How does driver yielding behavior change with respect to the R1-6 sign?

This section reviews the study locations, the decoy crossing technique, the data collection process, and an overview of the statistical tools used for the data analysis portion of this study.

3.2.1 Site Selection

For this study, 17 sites with characteristics common to low-volume, residential roadways in the Austin, Texas area and include a variety of crossing and signage types. Four crossing types were considered. Table 3.1 shows the complete list of sites and related characteristics. For the most part, each location included in the experiment was indeed an intersection. Number of Lanes to Cross is the total number of motor vehicle travel lanes crossed by the decoy when crossing from one side of the intersection to the other. Note that the intersections with an asterisk listed next to their number of lanes indicates that the intersection also contains bicycle lanes. Intersection Geometry indicates the general intersection geometry of the experimental location, which could be a four leg (+) intersection, a three leg (T) intersection, or a mid-block (I) location. Land-Use describes the function of the built environment adjacent to the experimental location. The section below defines each crossing type and signage type included in this study. Street to Cross refers to the street crossed by the decoy.

Table 3.1 Treatment Types and Site Characteristics

Treatment	Crossing Type	Signage Type	Street to Cross	Nearest Cross Street	Speed Limit	Geometry	Land Use
A	Concrete Island	R1-6, W11-2	North Loop	Chesterfield	30	T	residential
B	Concrete Island	OM-3L, Blind Peds Sign	Woodrow Ave	Little Deli Driveway	30	I	residential
C	Concrete Island	R1-6, W11-2, S1-1 + W16-9p	Berkman	Reagan Hill	35	T	school
D	Flexpost Island	W11-2	Springdale	Norwood Hill	40	T	residential
D	Flexpost Island	W11-2	Lakeshore Blvd	Ladybird Ln	35	T	park
E	Flexpost Island	S1-1	Denson	Chesterfield	30	T	school
F	Flexpost Island	R1-6, S1-1	Berkman	Cloverleaf	35	+	residential
F	Flexpost Island	R1-6, S1-1	Berkman	Glenvalley	35	T	residential
G	Marked Crosswalk	S1-1	51st Street	Eilers Ave	30	+	residential
H	Marked Crosswalk	None	Bullcreek	Jackson 1	35	T	offices
I	Marked Crosswalk	W11-2	Bullcreek	Jackson 2	35	T	offices
I	Marked Crosswalk	W11-2	W 30th St	Hemphill	30	+	park
J	Marked Crosswalk	R1-6, S1-1 + W16-9p	Woodrow Ave	Brentwood	30	+	residential
J	Marked Crosswalk	R1-6, S1-1 + W16-9p	Chestnut	17th Street	25	+	residential
K	Marked Crosswalk	W11-2, W11-2 + W16-9p	Chestnut	16th Street	25	+	park
L	Unmarked Crosswalk	None	Chestnut	21st Street	30	+	residential
L	Unmarked Crosswalk	None	51st Street	Martin Ave	30	+	residential

The major crossing types included in this experiment are: marked crosswalks (Figure 3.1), unmarked crosswalks (Figure 3.2), concrete refuge islands (Figure 3.3), and flexpost refuge islands (Figure 3.4). Listed below are the descriptions of the crossing types:

- Marked crosswalk: path demarcated by painted stripes on the roadway for pedestrian crossings.
- Unmarked crosswalk: undefined crossing path, may include ramps down from the sidewalk to the road, and can be thought of as an extension of a sidewalk across an intersection.
- Concrete Refuge Island: a raised median at the centerline of a roadway on which a pedestrian may stop halfway when crossing. A concrete island can have both the raised median and flexposts at the edge of the island.
- Flexpost Refuge Island: an area delineated by flexposts at the centerline of a roadway on which a pedestrian may stop halfway when crossing.

Figure 3.1 Marked crosswalk at 30th & Hemphill

Figure 3.2 Unmarked crosswalk at 51st & Eilers

Figure 3.3 Concrete refuge island with flexposts at North Loop & Chesterfield

Figure 3.4 Flexpost refuge island at Springdale & Norwood

The signs located at the selected sites include: W11-2 (Figure 3.5), advanced warning signs (Figure 3.6), family (Figure 3.7), and R1-6 (Figure 3.8). Listed below are the descriptions of the sign designation types present:

- *W11-2 Only:* there are only W11-2 signs adjacent to the crossing.
- *S1-1 Only*: there are only S1-1 signs adjacent to the crossing.
- *Reg Combo*: there is some combination of regular signs (W11-2, R1-6, and/or S1-1) adjacent to the crossing, but not including an advanced warning sign.
- *Warn Combo*: there is some combination of regular signs (W11-2, R1-6, and/or S1-1) adjacent to the crossing with an advanced warning sign (W16-9p).

Figure 3.5 W11-2 sign at Chestnut Ave & 17th

Figure 3.6 Advanced warning sign (W16-9p) Chestnut Ave & 17th

Figure 3.7 S1-1 sign at 51st & Eilers

Figure 3.8 R1-6 yield signs at North Loop & Chesterfield

These signage combinations were not present at all the crossing types therefore it was not possible to study crossing type and signage combination together.

The main sign of interest for this study is the R1-6 sign because it reminds road users of the law. The R1-6 sign has shown great potential to positively impact yielding rates in previous studies, especially in the gateway formation. The effect of the R1-6 sign was studied at marked crosswalks, flexpost refuge islands, and concrete refuge islands. However, the gateway formation of the R1-6 sign was not a part of this study.

3.2.2 Data Collection

At each location, a minimum of 30 crossing attempts were recorded. For each crossing attempt, an interaction was defined as any moment where the pedestrian decoy attempted to cross the intersection following the proper crossing technique and a car was present within the designated zone. The few instances where the decoy either indicated his intention to cross too late or too early were not considered in the data analysis. As mentioned in the Literature Review, when using a staged approach, the variability in pedestrian behavior disappears. The differences in pedestrian aggression can affect how a pedestrian attempts to cross a location, which in turn can affect the driver's response. The focus of this study was isolating the response of drivers, therefore consequently losing the variability in pedestrian behaviors was intentional.

For each site, the camera was positioned so that the crosswalk was visible as well as the intersection approach of interest. The goal was to have full sight of the decoy's position at the crosswalk as well as the approaching traffic at the yielding decision zone. The yielding decision zone is the last point at which a driver could make the decision to safely yield to a pedestrian.

Initially, the stopping sight distance (SSD) formula was used to estimate the appropriate area to use as the yielding decision zone. However, during initial testing, these distances were generally unrepresentative of natural pedestrian crossing behavior. This was likely because the SSD was calculated using the speed limit, which does not necessarily represent the actual speed of vehicles near the crossing. Using the calculated SSD as the car position when the pedestrian decoy would attempt to cross left the decoy plenty of time to cross without any perceivable reaction from the motorist. Therefore, a slightly shorter distance was used to represent more natural crossing and yielding interactions. A common yielding decision zone distance, 150 to 180 feet from the crosswalk, was used to test every intersection despite minor differences in speed limit across sites. This yielding decision zone where the motorist can choose to safely yield to those in the crosswalk or not was marked using a measuring wheel at each location. In the video recording, this location was marked by the decoy via a hand wave to the camera to clearly indicate the zone for those processing the data later.

While these were the intended procedures, the yielding decision zone was not always easily determined during the post-data collection review process. In most cases, the decoy raised his arms in the video after measuring out 150-180 feet; however, in just a small number of cases it was necessary to use the measuring tool in Google Maps to find a corresponding reference point in the video for the yielding decision zone. For cases were Google Maps was out of date, it was assumed that the decoy was indicating intent to cross at the appropriate times. These issues do not apply to most of the data collected in this experiment; however, mentioning these details may help others improve these techniques in future experimentation.

When reviewing the video footage, all interactions between vehicles and the decoy were recorded. Every vehicle that slowed or came to a stop when the decoy was exhibiting his intent to cross was counted as a 'yield' interaction. Every vehicle that neither slowed nor came to a stop for the decoy was counted as a 'no yield' interaction. Instances when the decoy attempted to cross after the vehicle had passed the yielding decision zone were not counted. Information on whether the vehicle was present in the half of the roadway in which the pedestrian was present or on the far side of the road was also tallied.

3.2.3 Crossing Technique

The crossing technique used in this experiment was largely based on previous experiments (*31–33*). One study conducted in Michigan at 31 sites across three

universities studied the relative effectiveness of various roadway treatments and signs used at midblock crossings (*33*) was especially helpful to this experiment. The Michigan study recorded decoy pedestrians to determine yielding behavior and used level of compliance as a surrogate for safety at the crossings used. This experiment differs by having the decoy remain in the crossing position after a vehicle has failed to yield to test the next vehicle for compliance until a vehicle yields or until there are no more vehicles in sight. Following this procedure allows observation of yielding rates for vehicles belonging to platoons. Shown below is the method utilized by the plainly dressed decoy pedestrian for this experiment.

1. Approach the crossing when a vehicle is in sight.
2. When the vehicle reaches the yielding decision zone, lean upper body or step into the crosswalk while making eye contact to indicate intention to cross.
3. If the approaching vehicle begins to yield, make the crossing while maintaining eye contact with the driver.
4. If additional vehicles are approaching from different lanes, wait until the intention of the vehicle in the next lane is ascertained.
5. If the approaching vehicle does not yield and there is another vehicle in sight, remain in position at the edge of the crosswalk and make another attempt to cross using the same technique.
6. If the approaching vehicle does not yield and there is not another vehicle in sight, move away from the crosswalk and return to step 1.

In addition to this method, some conditions were used to reduce the number of variables that may affect driver yielding as well as to promote consistency in data collection and analysis.

- Do not consider a crossing if there are other pedestrians attempting to cross at the same location.
- Do not count any crossings where a turning vehicle appears to yield to the decoy because it is impossible to tell whether the car was yielding or simply slowing down to turn.
- Do not count any crossings where the decoy accidentally indicates intention to cross too late, meaning the vehicle has already passed through the yielding decision zone and no longer has enough time to stop.
- Count opposing directions of traffic as separate pedestrian-motorist interactions.

3.3 Analysis Method

One-way and two-way analyses of variance (ANOVA) along with generalized linear models (GLMs) were used measure the effect of pedestrian control devices on driver yielding. GLMs are more flexible version of ordinary least squares regression because it allows response variables to have a distribution other than the normal distribution. Vehicle platooning was also tested in conjunction with pedestrian control devices to see if a driver's disposition to yield to a pedestrian was different when traveling in a platoon of vehicles versus not. In the experimental portion of this study, the decoy remained in the crossing position until a vehicle yielded or until there were no more vehicles in sight, therefore capturing the platooning effect.

3.4 Findings and Discussion

This first part of this chapter describes the results from the data collection effort and the statistical tests that were used to examine the motorist yielding behavior at various pedestrian control devices. The investigation evaluated driver yielding behavior rates with respect to crossing type, signage type, pedestrian activity, and vehicle activity.

The data collection effort included a wide variety of already existing treatments so that each sub-analysis would ensure that all possible combinations of factors being tested are included. In factorial experimentation, when a combination is missing – known as a missing cell – the estimation of the error terms becomes very difficult. The sub-analyses conducted avoided the issue of missing cells, therefore the models cannot test some factors for all of the crossing types.

3.5 Data Summary

The figures showing overall statistics (Table 3.2 and Figure 3.9) were calculated using near lane observations. Table 3.1 in the Methodology chapter contains a more detailed table of site characteristics. Pedestrian activity was counted for 15 mins in each video recording and categorized qualitatively in terms of low, medium, or high activity. Low activity means 0 and 1 pedestrians were observed, medium activity means between 2 and 4 pedestrians were observed, and high activity means between 10 and 18 pedestrians were observed within a 15 minute interval.

Table 3.2 Data Collection Summary

Intersection	Crossing Type	Signage Type	R1-6	Ped Activity	Total Obs	Yield	Yield %
Woodrow Ave @ Little Deli	Concrete Refuge Island	None	No	Med	30	5	16.67%
Berkman & Reagan Hill	Concrete Refuge Island	Warn Combo	Yes	Med	28	5	17.86%
North Loop & Chesterfield	Concrete Refuge Island	Reg Combo	Yes	High	30	20	66.67%
Springdale & Norwood Hill	Flexpost Refuge Island	W11-2 Only	No	Low	23	1	4.35%
Berkman & Glenvalley	Flexpost Refuge Island	Reg Combo	Yes	Med	37	2	5.41%
Denson & Chesterfield	Flexpost Refuge Island	Family Only	No	Med	32	3	9.38%
Berkman & Cloverleaf	Flexpost Refuge Island	Reg Combo	Yes	Med	37	4	10.81%
Lakeshore & Ladybird Lake	Flexpost Refuge Island	W11-2 Only	No	High	39	8	20.51%
Chestnut & 16th	Marked Crosswalk	Warn Combo	No	Med	30	1	3.33%
Bullcreek & Jackson 2	Marked Crosswalk	W11-2 Only	No	Low	32	3	9.38%
Bullcreek & Jackson 1	Marked Crosswalk	None	No	Low	31	3	9.68%
Chestnut & 17th	Marked Crosswalk	Warn Combo	No	Med	36	4	11.11%
51st & Eilers	Marked Crosswalk	Family Only	No	Med	38	5	13.16%
Woodrow & Brentwood	Marked Crosswalk	Warn Combo	Yes	Low	32	5	15.63%
W 30th & Hemphill	Marked Crosswalk	W11-2 Only	No	High	42	15	35.71%
Chestnut & 21st	Unmarked Crosswalk	None	No	Low	39	0	0.00%
51st & Martin	Unmarked Crosswalk	None	No	Low	52	1	1.92%

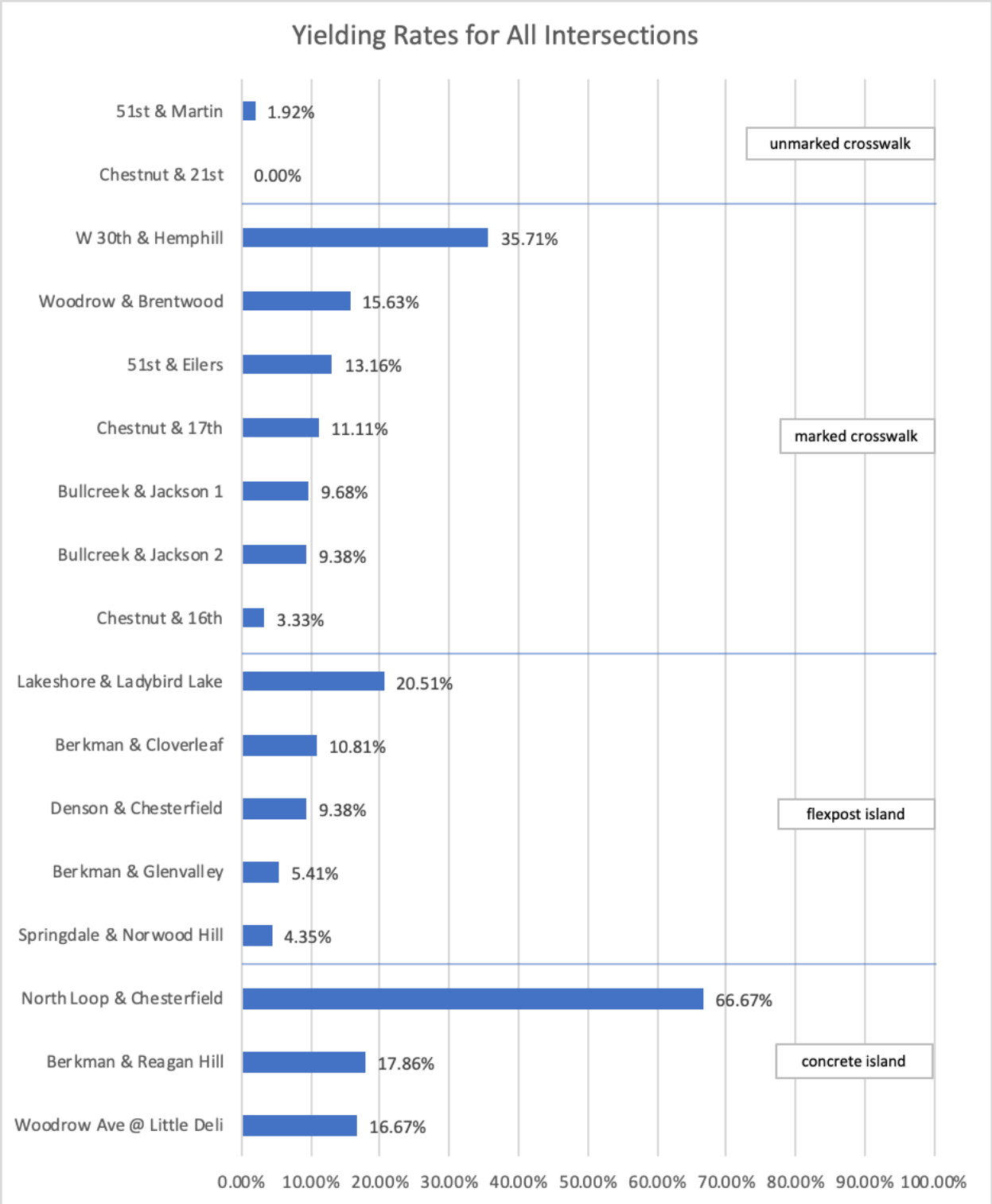


Figure 3.9 Yielding Rates for All Intersections

The highest overall yielding rate observed in the field (66.67%) occurred at North Loop & Chesterfield, which has a concrete refuge island. On the other hand, the lowest rate observed

was at Chestnut & 21st Street (0%), which has an unmarked crosswalk. Both locations have speed limits of 30 mph and are located within a residential area. The only difference noted between these two locations, besides crossing type, is the intersection geometry (Table 3.1) and level of pedestrian activity (Table 3.2).

From a qualitative standpoint, pedestrian activity seems to positively impact driver yielding behavior at the tested crossing types. The top three yielding rates were observed at locations with relatively high pedestrian activity. The locations are North Loop & Chesterfield, Lakeshore & Ladybird Lake, and W30th & Hemphill. Even though these locations have the highest yielding rates, overall these yielding rates are still very low.

In terms of overall intersection type, the concrete refuge island had the highest mean and unmarked crosswalks had the lowest mean yielding rate observed in the field. Crossings of the same type were aggregated to consider average yielding rates by crossing type. The combined results in Figure 3.10 also show that marked crosswalks and flexpost islands have similar yielding rates.

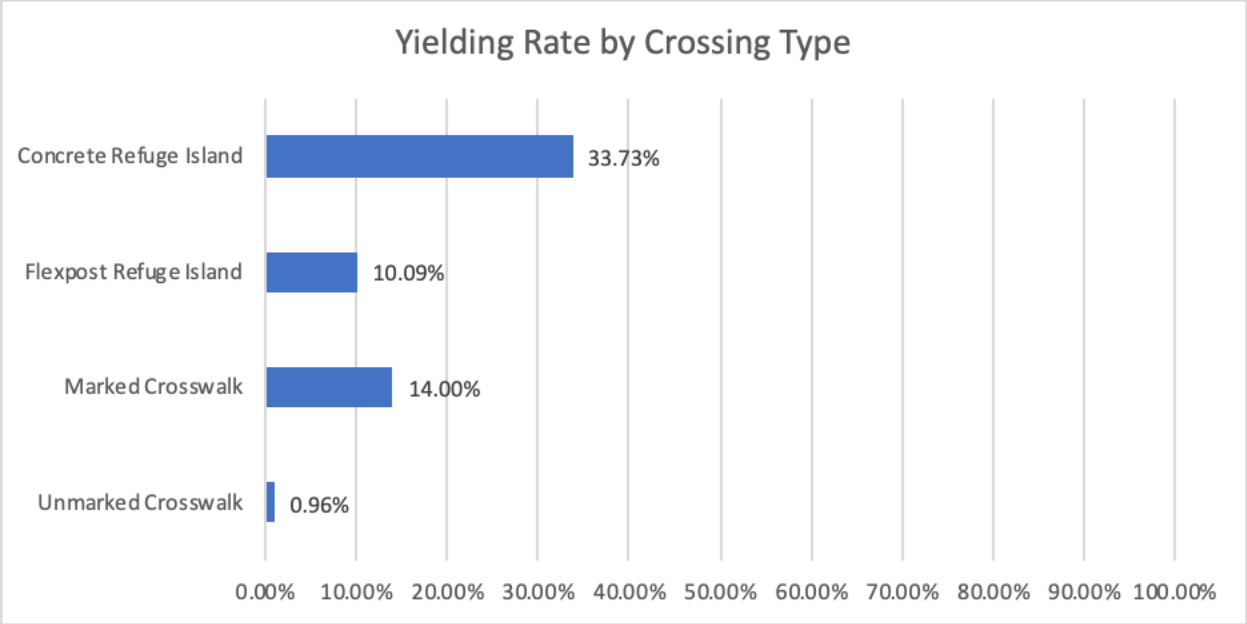


Figure 3.10 Average Yielding Rates by Crossing Type

From this representation, it is not clear why flexpost refuge island and concrete refuge islands have similar yielding rates, however, the later sections of this report indicate that pedestrian and vehicle activity affect whether or not these two treatments impact yielding similarly or differently. The coming sections will consider signage type, pedestrian activity, and vehicle activity to glean more insights to factors that explain driver yielding behavior.

3.6 Effect of Crossing Types of Motorist Yielding Behavior

One-way analysis of variance (ANOVA) was conducted to determine whether there is any difference between the means of driver yielding rates for the four crossing types. The null

hypothesis is that all crossing types have the same driver yielding rate, which upon inspection of Figure 3.10 does not appear true.

The overall F-test shows individual crossing treatments do have an effect on yielding compliance in Figure 3.11 (p-value = 0.0814). For this test, all 17 locations were considered. The F-value produced only has an 8.14% chance of occurring if there was really no difference in yielding rate among the tested crossing types. While the full dataset contains variations in, pedestrian activity, vehicle activity, and signage type, the significance of this F-test highlights the effect that crossing type can have on driver yielding behavior on its own.

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
crossing	3	13	2.80	0.0814

Least Squares Means

Effect	crossing	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
crossing	Concrete Refuge Island	0.3373	0.07896	13	4.27	0.0009	0.05	0.1667	0.5079
crossing	Flexpost Refuge Island	0.1009	0.06116	13	1.65	0.1229	0.05	-0.03123	0.2330
crossing	Marked Crosswalk	0.1400	0.05169	13	2.71	0.0179	0.05	0.02832	0.2517
crossing	Unmarked Crosswalk	0.009615	0.09670	13	0.10	0.9223	0.05	-0.1993	0.2185

Figure 3.11 Effect of Crossing Type ANOVA Result

The analysis of factor level means found statistically significant confidence intervals (CI's) at the 95% level for concrete refuge islands and marked crosswalks in Figure 3.11, where the CI bounds are shown in the Lower and Upper columns for each crossing type. The true mean yielding rate for a concrete refuge island is between 16.67% and 50.79% and for a marked crosswalk is between 2.83% and 25.27%. The CI for flexpost islands and unmarked crosswalks were not significant at either a 95% or 90% confidence level.

For the pairwise comparisons, the tests compare the difference in mean yielding compliance for all the crossing combinations. The Tukey-Kramer adjustment maintains a family-wise error rate of 10%. Only one of the p-values is less 0.10. The pairwise comparisons at a family-wise error rate of 5% were not significant. The 90% confidence interval (CI) for the pairwise comparison results are shown in Figure 3.12. The 90% CI for the pairwise comparisons is shown under the columns 'Adj Lower' and 'Adj Upper'. The interpretation for the CI is that there is a 90% chance that the difference between the true mean yielding rates at concrete refuge islands and an unmarked crosswalk is 33.77% more than the mean yielding rates at a flexpost island with a 90% CI = (10.83%, 64.45%). The difference between other crossing combinations are not significant at this confidence level but can be found in an equivalent manner (see Figure 3.12).

Differences of Least Squares Means														
Effect	crossing	crossing	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment	Adj P	Alpha	Lower	Upper	Adj Lower	Adj Upper
crossing	Concrete Refuge Island	Flexpost Refuge Island	0.2364	0.09988	13	2.37	0.0341	Tukey-Kramer	0.1332	0.1	0.05953	0.4133	-0.01709	0.4899
crossing	Concrete Refuge Island	Marked Crosswalk	0.1973	0.09437	13	2.09	0.0568	Tukey-Kramer	0.2069	0.1	0.03018	0.3644	-0.04221	0.4368
crossing	Concrete Refuge Island	Unmarked Crosswalk	0.3277	0.1248	13	2.62	0.0210	Tukey-Kramer	0.0862	0.1	0.1066	0.5488	0.01083	0.6445
crossing	Flexpost Refuge Island	Marked Crosswalk	-0.03909	0.08008	13	-0.49	0.6336	Tukey-Kramer	0.9604	0.1	-0.1809	0.1027	-0.2423	0.1642
crossing	Flexpost Refuge Island	Unmarked Crosswalk	0.09129	0.1144	13	0.80	0.4393	Tukey-Kramer	0.8542	0.1	-0.1113	0.2939	-0.1991	0.3817
crossing	Marked Crosswalk	Unmarked Crosswalk	0.1304	0.1097	13	1.19	0.2557	Tukey-Kramer	0.6440	0.1	-0.06381	0.3246	-0.1479	0.4087

Figure 3.12 Pairwise Comparisons for Crossing Types

This section used all the data to evaluate the effect of crossing types. The entire dataset contains a wide variety of pedestrian activity and signage types. Since not every signage type and every level of pedestrian activity (low, medium, high) are present in each of the four crossing types, a model cannot reliably consider these factors for the whole dataset. Models in the following sections will consider smaller subsets of data to avoid the problem of missing cells and to allow evaluation of these factors in light of the various crossing types.

3.7 Effect of Signage on Motorist Yielding Behavior

This section discusses the analyses conducted to determine the effect of signage on driver yielding behavior. A one-way analysis of variance considered signage type for the 17 intersections, and a separate linear probability model evaluated the effect of R1-6 signage type on motorist yielding behavior at the crossings except for unmarked crosswalks. The R1-6 sign is only present in residential locations. Therefore, the R1-6 analysis considered only residential land use locations with and without the sign.

3.1.6. Effect of Signage Combinations on Overall Yielding

For the model considering only signage type for all 17 intersections, the F-Value is 0.77 resulting in a p-value = 0.5647. At this F-Value, we cannot reject the null hypothesis. That is, there is no significant difference in mean driver yielding rate among the tested signage types. Signage type does not significantly impact yielding rates alone in this model. Looking at Table 3.3, the individual yielding rates observed for each signage type show quite a bit of variability (i.e., columns) and this is the reason for the test not showing statistically significant differences among the treatments.

Table 3.3 Crossing Type and Signage Type Field Data

Average of Yielding %	Signage Type					
Crossing Type	Family Only	None	Reg Combo	W11-2 Only	Warn Combo	**Grand Total**
Concrete Refuge Island		16.7%	66.7%		17.9%	**33.7%**
Flexpost Refuge Island	9.4%		8.1%	12.4%		**10.1%**
Marked Crosswalk	13.2%	9.7%		22.5%	10.0%	**14.0%**
Unmarked Crosswalk		1.0%				**1.0%**
Grand Total	**11.3%**	**7.1%**	**27.6%**	**17.5%**	**12.0%**	**14.8%**

Since there are a lot of missing cells in the table, considering signage type and crossing type in the same model is out the scope of this work. Future work could obtain samples for the missing cells to evaluate the effect of signage type at each crossing type.

3.1.7. Effect of the R1-6 Sign on Yielding

The effect of R1-6 signage on driver yielding was tested with a linear probability model at marked crosswalks, flexpost refuge islands, and concrete refuge islands. The R1-6 sign is only present in locations adjacent to residential land use. Therefore, to reduce unexplained variability in the model, only locations adjacent to residential land use with and without the R1-6 sign were considered in this model. The locations that meet the criteria are:

- North Loop & Chesterfield,
- Woodrow Ave @ Little Deli,
- Springdale & Norwood Hill,
- Berkman & Cloverleaf,
- Berkman & Glenvalley,
- 51st & Eilers,
- Chestnut & 17th, and
- Woodrow & Brentwood.

Clearly, the R1-6 presence results in a higher grand total yielding rate (25%) compared to the absence of the R1-6 sign (11%) at the intersections considered. Table 3.4 summarizes the overall average yielding rates observed in the field for the three crossing types considered in the model. The question as to whether the R1-6 sign impacts these crossing types equally or not remains. Two models are developed one with interaction and one without to address that question.

Table 3.4 Crossing Type and R1-6 Sign Presence Field Data

Average of Yielding %	R1-6 Presence		
Crossing Type	No	Yes	**Grand Total**
Concrete Refuge Island	16.7%	66.7%	**41.7%**
Flexpost Refuge Island	4.3%	8.1%	**6.9%**
Marked Crosswalk	12.1%	15.6%	**13.3%**
Grand Total	**11.3%**	**24.6%**	**18.0%**

According to the linear probability model without interaction, the R1-6 sign increases driver yielding by 8% (p=0.0378) keeping all other variables constant. Figure 3.13 shows the model results, which includes the effect of each parameter and the associated p-value. The effect of each crossing type in the model is given under the 'Estimate' column while considering marked crosswalks as the baseline. For example, the difference in driver yielding compliance at a concrete refuge island compared to the baseline, a marked crosswalk, is +25.84%. All of the parameter estimates (i.e., effects of the variables) are significant in the model (p-value < 0.05).

Analysis Of Maximum Likelihood Parameter Estimates								
Parameter		DF	Estimate	Standard Error	Wald 95% Confidence Limits		Wald Chi-Square	Pr > ChiSq
Intercept		1	0.1117	0.0327	0.0476	0.1757	11.67	0.0006
crossing	Concrete Refuge Island	1	0.2584	0.0747	0.1120	0.4047	11.97	0.0005
crossing	Flexpost Refuge Island	1	-0.0874	0.0381	-0.1622	-0.0127	5.26	0.0219
crossing	Marked Crosswalk	0	0.0000	0.0000	0.0000	0.0000	.	.
R1_6	1	1	0.0806	0.0388	0.0045	0.1567	4.31	0.0378
R1_6	0	0	0.0000	0.0000	0.0000	0.0000	.	.
Scale		0	1.0000	0.0000	1.0000	1.0000		

Figure 3.13 Linear Probability R1-6 Model Results

In residential areas, concrete refuge islands have the highest yielding compliance followed by marked crosswalks and then concrete refuge islands. The least squares mean estimates for the crossing types with residential land adjacent to the crossing are 41%, 6.5%, and 15% yielding compliance at concrete refuge islands, flexpost refuge islands, and marked crosswalks. The difference in yielding compliance between a marked crosswalk and a flexpost refuge island is 8.745% in this model (see Figure 3.14). It is not immediately clear why marked crosswalks have a slightly better yielding rate than flexpost islands, especially since flexpost islands have a marked crossing within them. The difference could likely be a result of external factors, such as the presence of vehicle platoons (See Section 0).

crossing Least Squares Means				
crossing	Estimate	Standard Error	z Value	Pr > |z|
Concrete Refuge Island	0.4104	0.06583	6.23	<.0001
Flexpost Refuge Island	0.06454	0.02248	2.87	0.0041
Marked Crosswalk	0.1520	0.03426	4.44	<.0001

Differences of crossing Least Squares Means					
crossing	crossing	Estimate	Standard Error	z Value	Pr > |z|
Concrete Refuge Island	Flexpost Refuge Island	0.3458	0.06992	4.95	<.0001
Concrete Refuge Island	Marked Crosswalk	0.2584	0.07467	3.46	0.0005
Flexpost Refuge Island	Marked Crosswalk	-0.08745	0.03815	-2.29	0.0219

Figure 3.14 Least Squares Means and Pairwise Differences

A second linear probability model with interaction between crossing type and presence of R1-6 signage produced a slightly better fit. Including interaction in the model means that the effect of the R1-6 sign depends on the crossing type. The probability of driver yielding for all of the combinations were all significant (p-value < 0.05), except for the flexpost island without an R1-6 sign estimate (see Figure 3.15). For probability of a driver yielding at a concrete refuge island with an R1-6 sign is 66.67% versus 16.67% without the sign.

crossing*r16 Least Squares Means					
crossing	r16	Estimate	Standard Error	z Value	Pr > |z|
Concrete Refuge Island	R1_6	0.6667	0.08607	7.75	<.0001
Concrete Refuge Island	None	0.1667	0.06804	2.45	0.0143
Flexpost Refuge Island	R1_6	0.08108	0.03173	2.56	0.0106
Flexpost Refuge Island	None	0.04348	0.04252	1.02	0.3066
Marked Crosswalk	R1_6	0.1563	0.06419	2.43	0.0149
Marked Crosswalk	None	0.1216	0.03800	3.20	0.0014

Figure 3.15 Model Probabilities of Driver Yielding and R1-6 Sign Presence

In this model with interaction, the concrete refuge island with an R1-6 sign is significantly different from every other combination (p-value<0.0001) listed in Figure 3.15. All the other combinations are not statistically significant.

Both the model with and without interaction provide fairly similar Goodness of Fit measurements. The Goodness of Fit criterion are shown in Figure 3.16 where the left side shows the criterion with the first model (no interaction) and the right shows that of the second model (interaction).

Criteria For Assessing Goodness Of Fit			
Criterion	DF	Value	Value/DF
Log Likelihood		-105.2138	
Full Log Likelihood		-105.2138	
AIC (smaller is better)		218.4276	
AICC (smaller is better)		218.5826	
BIC (smaller is better)		232.7162	

Criteria For Assessing Goodness Of Fit			
Criterion	DF	Value	Value/DF
Log Likelihood		-98.8088	
Full Log Likelihood		-98.8088	
AIC (smaller is better)		209.6176	
AICC (smaller is better)		209.9458	
BIC (smaller is better)		231.0506	

Figure 3.16 Goodness of Fit (Left: No Interaction, Right: Interaction)

The model assuming interaction between crossing type and R1-6 signage produces a slightly better fit because it does a better job of fitting the very high yielding compliance at a concrete refuge island with R1-6 sign (see Table 3.4). It would be good to consider other locations with concrete refuge islands and the R1-6 signage to check whether the sign really is that much more influential at that particular type of crossing.

The other signs present at the crossings might also affect driver yielding rate along with the R1-6 sign, however, because of the missing cells issue this cannot be tested. Although, based on the results from the one-way ANOVA in the previous section, signage combination is not a significant predictor of driver yielding compliance. The yielding rates collected in the field for the signage combinations present with and without the R1-6 sign are shown in Table 3.5.

Table 3.5 Signage Combinations Present with/without R1-6 Sign Field Data

	No R1-6				No R1-6 Total	Yes R1-6		Yes R1-6 Total	**Grand Total**
Crossing Type	Family Only	None	W11-2 Only	Warn Combo		Reg Combo	Warn Combo		
Concrete Refuge Island		16.7%			16.7%	66.7%		66.7%	**41.7%**
Flexpost Refuge Island			4.3%		4.3%	8.1%		8.1%	**6.9%**
Marked Crosswalk	13.2%			11.1%	12.1%		15.6%	15.6%	**13.3%**
Grand Total	**13.2%**	**16.7%**	**4.3%**	**11.1%**	**11.3%**	**27.6%**	**15.6%**	**24.6%**	**18.0%**

If desired, future work could find locations to fill in the missing cells and determine the effect, if any, that other signage combinations have along with R1-6 at these three crossing types.

3.8 Effect of Pedestrian and Vehicle Activity and on Motorist Yielding Behavior

This section considers two external factors on driver yielding behavior: pedestrian activity and vehicle activity. Taking a look at the overall results in Table 3.2, one can see that Bullcreek and Jackson 1 and Bullcreek and Jackson 2 barely show any difference in terms of yielding rates. These two locations are both marked crosswalks. Both locations have different

signage combinations, but virtually identical external factors since the two locations are adjacent to each other. The fact that these two locations have nearly identical yielding rates potentially hints that external factors like pedestrian activity and vehicle activity are more powerful influencers of driver yielding compliance compared to the four signage combinations listed in Table 3.5 (excluding the R1-6 sign). The pedestrian activity analysis was done only considering the observations at marked crosswalks and flexpost refuge islands because those are the only crossing types with data available for each of the three levels of pedestrian activity.

3.1.8. Effect of Pedestrian Activity on Overall Yielding

A one-way analysis of variance in driver yielding behavior by considering pedestrian activity, shows that pedestrian activity is a significant factor on its own. The results shown in Figure 3.17 show that overall, there is a mean difference in driver yielding when considering pedestrian activity (p=0.0008).

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
pedactivity	2	14	12.31	0.0008

Least Squares Means

Effect	pedactivity	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
pedactivity	High	0.4096	0.05879	14	6.97	<.0001	0.05	0.2835	0.5357
pedactivity	Low	0.06825	0.04157	14	1.64	0.1229	0.05	-0.02092	0.1574
pedactivity	Med	0.1096	0.03600	14	3.05	0.0087	0.05	0.03243	0.1869

Figure 3.17 Effect of Pedestrian Activity ANOVA Result

Pedestrian activity has a strong influence on driver yielding rates at flexpost refuge islands and marked crosswalks. The pairwise comparisons of the three activity levels in Figure 3.18 show that there driver yielding does not vary significantly when comparing low and medium pedestrian activity levels. A high pedestrian presence positively influences yielding compliance compared to medium/low pedestrian presence.

Differences of Least Squares Means

Effect	pedactivity	pedactivity	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment	Adj P	Alpha	Lower	Upper	Adj Lower	Adj Upper
pedactivity	High	Low	0.3414	0.07201	14	4.74	0.0003	Tukey-Kramer	0.0009	0.05	0.1870	0.4958	0.1529	0.5299
pedactivity	High	Med	0.3000	0.06894	14	4.35	0.0007	Tukey-Kramer	0.0018	0.05	0.1521	0.4479	0.1196	0.4804
pedactivity	Low	Med	-0.04140	0.05500	14	-0.75	0.4641	Tukey-Kramer	0.7369	0.05	-0.1594	0.07656	-0.1853	0.1025

Figure 3.18 Pairwise Comparisons for Pedestrian Activity

3.1.9. Effect of Pedestrian Activity at Marked Crosswalks and Flexpost Islands

A linear probability model with interaction was developed to quantify pedestrian activity influences on driver yielding probability. Including the interaction means that the effect that pedestrian activity has at one crossing is not the same at the other. All the parameters for the

probability of yielding at each crossing type and pedestrian activity level are significant in Figure 3.19.

crossing*pedact Least Squares Means					
crossing	pedact	Estimate	Standard Error	z Value	Pr > |z|
Flexpost Refuge Island	high	0.2051	0.06466	3.17	0.0015
Flexpost Refuge Island	low	0.04348	0.04252	1.02	0.3066
Flexpost Refuge Island	med	0.2195	0.06464	3.40	0.0007
Marked Crosswalk	high	0.3571	0.07394	4.83	<.0001
Marked Crosswalk	low	0.1122	0.03189	3.52	0.0004
Marked Crosswalk	med	0.09615	0.02891	3.33	0.0009

Figure 3.19 Least Squares Means Estimates for Probability of Driver Yielding

Pairwise comparisons were done to determine how and if each level of pedestrian activity makes a difference at marked crosswalks and concrete refuge islands. All the results for the pairwise comparisons are found in Figure 3.20, and the calculated probabilities of yielding are shown in Table 3.6. The pairwise comparisons of interest are the ones that compare both crossing types for a fixed pedestrian activity level and the ones that compare a fixed crossing type at two different pedestrian activity levels.

Differences of crossing*pedact Least Squares Means							
crossing	pedact	crossing	pedact	Estimate	Standard Error	z Value	Pr > |z|
Flexpost Refuge Island	high	Flexpost Refuge Island	low	0.1616	0.07739	2.09	0.0367
Flexpost Refuge Island	high	Flexpost Refuge Island	med	-0.01438	0.09143	-0.16	0.8750
Flexpost Refuge Island	high	Marked Crosswalk	high	-0.1520	0.09822	-1.55	0.1217
Flexpost Refuge Island	high	Marked Crosswalk	low	0.09288	0.07209	1.29	0.1976
Flexpost Refuge Island	high	Marked Crosswalk	med	0.1090	0.07083	1.54	0.1239
Flexpost Refuge Island	low	Flexpost Refuge Island	med	-0.1760	0.07737	-2.28	0.0229
Flexpost Refuge Island	low	Marked Crosswalk	high	-0.3137	0.08529	-3.68	0.0002
Flexpost Refuge Island	low	Marked Crosswalk	low	-0.06877	0.05315	-1.29	0.1957
Flexpost Refuge Island	low	Marked Crosswalk	med	-0.05268	0.05142	-1.02	0.3056
Flexpost Refuge Island	med	Marked Crosswalk	high	-0.1376	0.09821	-1.40	0.1611
Flexpost Refuge Island	med	Marked Crosswalk	low	0.1073	0.07208	1.49	0.1367
Flexpost Refuge Island	med	Marked Crosswalk	med	0.1234	0.07081	1.74	0.0815
Marked Crosswalk	high	Marked Crosswalk	low	0.2449	0.08052	3.04	0.0024
Marked Crosswalk	high	Marked Crosswalk	med	0.2610	0.07939	3.29	0.0010
Marked Crosswalk	low	Marked Crosswalk	med	0.01609	0.04304	0.37	0.7085

Figure 3.20 Pedestrian Activity Model Pairwise Comparisons

Table 3.6 Yielding Probabilities from Pedestrian Activity Model

Crossing Type	Probability of Yielding Low Pedestrian Activity	Probability of Yielding Med Pedestrian Activity	Probability of Yielding High Pedestrian Activity
Flexpost Refuge Island	4.348%	21.951%	20.513%
Marked Crosswalk	11.224%	9.615%	35.714%

Pedestrian Activity at Flexpost Refuge Islands

Yielding behavior differs significantly at flexpost refuge islands when comparing high pedestrian activity (~21%) to low pedestrian activity (~4%) locations. With high pedestrian activity, the probability of driver yielding improves 4.6x. The comparisons between low and medium activity and medium and high activity are not significant.

Pedestrian Activity at Marked Crosswalks

At marked crosswalks, all the pairwise comparison for pedestrian activity are statistically significant except for the comparison between medium and low pedestrian activity. That is, marked crosswalks with medium or low pedestrian activity have significantly different driver yielding behavior from those with high pedestrian activity. With high pedestrian activity, driver yielding probability can improve by up to 3.7x.

Flexpost Refuge Islands versus Marked Crosswalks

The difference in yielding probablity between a marked crosswalk and flexpost refuge island is only significant at the medium pedestrian activity level. The difference in yielding probability at the low and high levels is not significant. At the medium activity level, yielding compliance is about 2.3x better at the flexpost refuge island than at marked crosswalks.

3.1.10. Effect of Platooning on Yielding

The effect of platooning and crossing types on driver yielding behavior was also evaluated with a Two-Way ANOVA. It was suspected that perhaps one group would have a higher yielding rate over the other during the data reduction process and that considering platooning could explain additional variability in the model. Vehicle platooning becomes more likely as traffic volumes get higher, so for these generally low-volume, residential streets the likelihood of platooning is not as high as it would be in other parts of the city. For each crossing type, the number of drivers belonging and not belonging to a platoon were tallied. Table 3.7 shows the data used for this analysis. Each column shows the total number of observations used to calculate the percentage of each factor level (vehicles belonging or not belonging to a platoon) and the overall yielding rate for each. Concrete refuge islands were not eligible for the two-way analysis given the number of observations. A general rule of thumb is that a sample size of 30 is the minimum reliable size. For these crossing types the minimum number of observations in the platoon and non-platoon category were met, except for unmarked crosswalks platoon with n=29, after aggregating the results from the individual intersections shown in Table 3.2.

Table 3.7 Platooning and Crossing Two-Way ANOVA Field Data

Crossing Type	Average Non-Platoon Yielding	Total Non-Platoon Obs	Average Platoon Yielding	Total Platoon Obs
Flexpost Refuge Island	13.52%	126	8.80%	122
Marked Crosswalk	12.48%	220	17.12%	58
Unmarked Crosswalk	0.00%	79	5.56%	29
Grand Total	**11.07%**	**425**	**12.50%**	**209**

Figure 3.21 shows the interaction plot for this dataset. The horizontal axis shows the three crossing types meanwhile the vertical axis shows driver yielding compliance rates. The red line represents the yielding rates for vehicles belonging to platoons while the blue line represents rates for vehicles that did not belong to platoons. The two slopes are quite different between flexpost islands and marked crosswalks, indicating a possible interaction between crossing type and platoon presence for these two crossing types. If the interaction is significant, that means one cannot consider one factor (i.e., effect of platoon presence on driver yielding behavior) without specifying the other factor (i.e., crossing type). It appears that little to no interaction between the two factors exists when comparing marked crosswalks to unmarked crosswalks. Overall, Two-Way ANOVA was not significant (p=0.2755).

Figure 3.21 Interaction Plot for Crossing Type and Platoon Presence

A logistic regression was run to determine the probability of yielding at the three crossing types meanwhile also considering whether vehicles belong to a platoon or not. As shown in Figure 3.22, the logistic regression produced significant least squares estimates for the log odds of all the crossing and platoon presence combinations considered. Figure 3.22 also shows the pairwise comparisons using the least squares means estimated from the logistic regression. Only a few of these pairs show significant differences with a p-value < 0.05, which is shown in the far right column on the lower table.

crossing*platoon Least Squares Means								
crossing	platoon	Estimate	Standard Error	z Value	Pr > |z|	Alpha	Lower	Upper
Flexpost Refuge Island	non-platoon	-1.7918	0.2546	-7.04	<.0001	0.05	-2.2907	-1.2928
Flexpost Refuge Island	platoon	-2.2156	0.3040	-7.29	<.0001	0.05	-2.8114	-1.6197
Marked Crosswalk	non-platoon	-1.8850	0.1993	-9.46	<.0001	0.05	-2.2756	-1.4944
Marked Crosswalk	platoon	-1.6946	0.3627	-4.67	<.0001	0.05	-2.4054	-0.9838
Unmarked Crosswalk	non-platoon	-26.3653	0.8416	-31.33	<.0001	0.05	-28.0148	-24.7158
Unmarked Crosswalk	platoon	-2.6027	0.7328	-3.55	0.0004	0.05	-4.0390	-1.1664

Differences of crossing*platoon Least Squares Means							
crossing	platoon	crossing	platoon	Estimate	Standard Error	z Value	Pr > |z|
Flexpost Refuge Island	non-platoon	Flexpost Refuge Island	platoon	0.4238	0.3965	1.07	0.2852
Flexpost Refuge Island	non-platoon	Marked Crosswalk	non-platoon	0.09322	0.3233	0.29	0.7731
Flexpost Refuge Island	non-platoon	Marked Crosswalk	platoon	-0.09716	0.4431	-0.22	0.8264
Flexpost Refuge Island	non-platoon	Unmarked Crosswalk	non-platoon	24.5736	0.8793	27.95	<.0001
Flexpost Refuge Island	non-platoon	Unmarked Crosswalk	platoon	0.8109	0.7758	1.05	0.2959
Flexpost Refuge Island	platoon	Marked Crosswalk	non-platoon	-0.3306	0.3635	-0.91	0.3631
Flexpost Refuge Island	platoon	Marked Crosswalk	platoon	-0.5210	0.4732	-1.10	0.2709
Flexpost Refuge Island	platoon	Unmarked Crosswalk	non-platoon	24.1498	0.8948	26.99	<.0001
Flexpost Refuge Island	platoon	Unmarked Crosswalk	platoon	0.3871	0.7934	0.49	0.6256
Marked Crosswalk	non-platoon	Marked Crosswalk	platoon	-0.1904	0.4138	-0.46	0.6455
Marked Crosswalk	non-platoon	Unmarked Crosswalk	non-platoon	24.4803	0.8177	29.94	<.0001
Marked Crosswalk	non-platoon	Unmarked Crosswalk	platoon	0.7177	0.7594	0.95	0.3446
Marked Crosswalk	platoon	Unmarked Crosswalk	non-platoon	24.6707	1.0502	23.49	<.0001
Marked Crosswalk	platoon	Unmarked Crosswalk	platoon	0.9081	0.8177	1.11	0.2667
Unmarked Crosswalk	non-platoon	Unmarked Crosswalk	platoon	-23.7626	0.4138	-57.42	<.0001

Figure 3.22 Logistic Regression Platoon Presence Model Results

The pairwise comparison that are statistically significant and that are of interest are:

- flexpost refuge island non-platoon versus unmarked crosswalk non-platoon,
- marked crosswalk non-platoon versus unmarked crosswalk non-platoon,
- flexpost refuge island non-platoon versus marked crosswalk non-platoon, and
- unmarked crosswalk non-platoon versus unmarked crosswalk platoon.

The yielding probabilities produced from the logistic regression for all of the crossing types and platoon presence combinations are shown in Table 3.8. Looking at Figure 3.22, one can see whether any two cells in Table 3.8 are significantly different. For example, this model does not show that platooning makes a significant difference in yielding probability at marked crosswalks.

Table 3.8 Yielding Probabilities from Platooning Model

Crossing Type	Probability of Yielding Platoon	Probability of Yielding Non-Platoon
Flexpost Refuge Island	9.836%	14.286%
Marked Crosswalk	15.517%	13.182%
Unmarked Crosswalk	0.00%	6.897%

Effect of Platoon Presence

In general, platoon presence was only significant for the unmarked crosswalk scenario. The comparison between the probability of vehicles belonging or not belonging to a platoon yielding to a pedestrian at an unmarked crosswalk is significant. Locations with higher traffic are less safe for pedestrian crossings at unmarked crosswalks.

Flexpost Refuge Island versus Marked Crosswalks

The probability of yielding at a flexpost refuge island is slightly better than the probability of yielding at a marked crosswalk in the non-platoon case. The difference is only 1% in the non-platoon case, meaning that in areas with very light traffic volumes, flexpost islands offer little improvements over marked crosswalks in driver yielding probability. In the case of vehicle platoon presence (i.e., higher traffic volumes), the difference between flexpost islands and marked crosswalks is not statistically significant.

Marked Crosswalks versus Unmarked Crosswalks

The difference between an unmarked crosswalk and a marked crosswalk is significant in the non-platoon case. A marked crosswalk improves driver yielding probability about 1.9x compared to an unmarked crosswalk where traffic volumes are very light.

Flexpost Refuge Island versus Unmarked Crosswalks

The probability of yielding improves by about 2x when comparing a flexpost refuge island to an unmarked crosswalk in the significant non-platoon case.

3.9 Summary

This chapter reviewed the methodology for the driver yield analysis and the pedestrian crash analysis. For the driver yielding experimentation, this chapter described the site selection, data collection process, and the crossing technique used by the pedestrian decoy. Finally, the various types of statistical models that were used to analyze the data were also described and interpreted. The results reported here support some of the findings in the literature with respect to platoons. Some studies have reported that platooning cars tend to yield less to pedestrians, perhaps because of lack of visibility. The results from this show yielding rates for vehicles in platoons can depend on crossing type. To complement the first portion of the analysis, the following chapter considers the results of an online survey to further characterize driver yielding behavior and perspectives in Austin, TX.

Chapter 4. Survey of Texas Yielding Law Knowledge

1.1. Survey Design

The survey was designed to highlight the knowledge gaps future CoA educational campaigns should target and to shed light on the observed driver behavior from the experimental study. As pointed out in Schneider and Sanders 2015, education and enforcement of the law are major contributing factors to overall driver yielding behavior. The survey asked respondants in Austin, TX to identify the legally correct yielding conduct for various pedestrian crossings scenarios. Appendix A contains the full survey used to measure the public's understanding of laws.

The survey presents neutral persepectives and asks respondents to identify the legal yielding conduct for both a motorist and a pedestrian in each scenario. Bird's eye view schematic sketches and/or real-life photographs from a distance were provided to illustrate the following yielding scenarios:

Scenario A. Unmarked crosswalk,
Scenario B. Marked Crosswalk,
Scenario C. Flexpost Island,
Scenario D. Concrete Refuge Island,
Scenario E. Mid-block crossing between two signalized intersections,
Scenario F. Mid-block crossing between an unsignalized and a signalized intersection, and
Scenario G. A multiple threat situation.

Showing a neutral perspective for each scenario reduced the survey length and complexity. One alternative would have been to ask respondents to identify as either a pedestrian or a motorist. Then, each question could ask the survey taker to place themselves in the role they selected, and identify the correct way to yield the right of way from that perspective. However, with that approach there is no guarantee that the sample would have had a balanced number of pedestrian and motorist responses. The neutral perspective in this survey has the survey taker efficiently consider both roles for each scenario, and identify the legal conduct assuming that both parties have enough time to safely yield/stop should they choose to do so. An example of a neutral perspective is shown in Figure 4.1.

Figure 4.1 Neutral perspective shown in survey for a flexpost island

In addition to asking about proper yielding conduct at the specific crossing types, respondents were asked to identify their age, gender, highest level of education, race, and zip code. These socioeconomic and sociodemographic identifiers aided in determining the segments of the Austin population needing more educational campaign targeting.

It is possible that even though the survey questions said, "According to Texas state traffic laws, who should yield the right of way?" that some respondents may have interpreted the questions as asking for their opinion. That is, some people might have answered the "who should yield" portion of each question according to their own thoughts rather than what they think the law states as mentioned in the question.

1.2. Survey Results

For each scenario, respondents were asked to identify who should yield (pedestrian or motorist) and whether it was legal for the pedestrian to cross at the location. The survey listed rather narrow categories for age, highest level of education, and race questions. Some of these responses did not have enough responses in each category, so these were grouped into larger categories to ensure large enough sample sizes.

Survey respondents were asked to identify the legal yielding conduct for both pedestrians and motorists for seven different crossing scenarios. In terms of overall response, the ranking for highest to lowest fraction of correct responses is:

- Scenario C: Concrete Refuge Island 89.9%
- Scenario D: Flexpost Refuge Island 89.7%
- Scenario G: Multiple Threat 85.8%
- Scenario B: Marked Crosswalk 85.7%
- Scenario F: Illegal Mid-block 56.8%
- Scenario A: Unmarked crosswalk 33.1%

- Scenario E: Legal Mid-block 1.3%

Scenarios A (unmarked crosswalk), E (legal midblock), and F (illegal midblock) had the poorest overall correct response fractions and should be prioritized by educational campaigns

The following sections review the results from Scenarios A-G in more detail. As mentioned previously, Appendix A contains the full survey and Appendix B shows more detailed charts and graphs for the socioeconomic and sociodemographic breakdowns.

4.1 Data Exclusions

Not every category sampled had enough responses within it to justify including it in the statistical analysis. The following categories were excluded under education, age, and race categories because they did not have an adequate sample size:

- Grade school or less and High School or Equivalent groups were excluded from the statistical analysis because there are less than 30 responses within each group.
- The 24 and younger group was excluded because there were only 15 responses in this category.
- The only groups that had more than 30 responses are Prefer not to answer, Two or more races, and White. These three racial groups are the only ones considered in the statistical analysis.
- The statistical analysis excluded the transgender or non-binary group because there were only 6 responses

4.2 Scenario A: Unmarked Crosswalk

Scenario A asks whether the pedestrian or the motorist should legally yield the right of way, and whether the unmarked crossing is legal. Unmarked crosswalks are locations pedestrians can legally cross (Figure 2.2) and where an approaching motorist should yield to a pedestrian attempting to cross. See Appendix A for the full survey question. The results from this question are shown in Figure 4.2. Only 33.13% of respondents answered correctly, “The motorist should yield, the pedestrian crossing is legal here”. This question had the smallest fraction of correct answers among Scenarios A through D, indicating overall poor understanding of unmarked crosswalk proper yielding behavior.

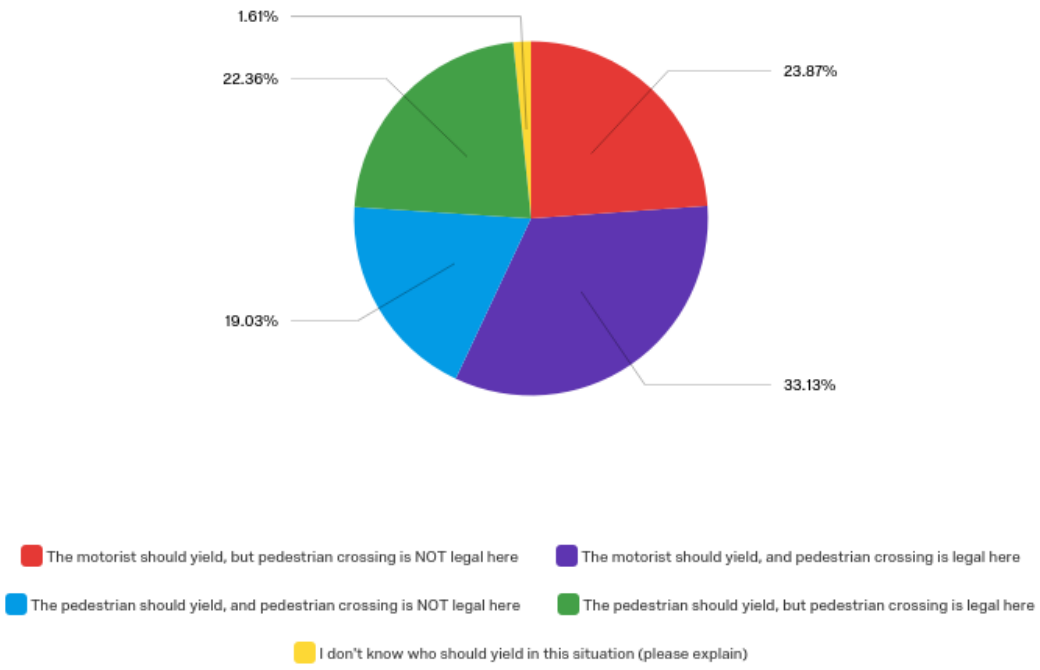


Figure 4.2 Scenario A Overall Response

For the 1.61% of respondents who indicated they did not know who should yield in this situation, the following comments were collected:

- Cars should always legally have to tie for peds like in Europe. What if they are ill or a child?
- I have heard conflicting reports from law enforcement about laws, jaywalking, etc.
- The information provided doesn't tell me whether there is a sidewalk along the left/right roadway (in direction of pedestrian's feet) which would determine whether there is a legal crosswalk.
- I am not sure if the vehicle is supposed to stop because it does not have a stop sign.
- I don't see a crosswalk, and am not sure if ped crossing is legal or illegal in this scenario, but the car should yield regardless
- Regardless of the law, you are going to get killed doing it.
- If there is a marked crossing within a block, the pedestrian should cross there instead
- The motorist should yield, but there's no way to tell if it is a legal pedestrian crossing, because we can't see what's on this side of the pedestrian and how far (eg protected crossing).. The sketch doesn't match the photo., which shows a driveway, not a cross street.
- I would yield because of safety but because there is no crossing walk I'm not sure that I am legally required to.

3.1.11. Socioeconomic Response (Education)

The Chi Square test result shows that there is no overall statistically significant relationship between education and the survey responses in the unmarked crosswalk scenario. Grade school or less and High School or Equivalent groups were excluded from the analysis because they had less than 30 responses within each group. That is, the responses breakdown does not vary significantly among the various education levels. See Table B0.1, Figure B0.1, or Figure B0.2, in the Appendix for more detailed visuals.

For all levels of education, educational campaigns should focus on spreading the definition of an unmarked crosswalk. As listed in some of the comments above, people seem to not recognize that unmarked locations are legal pedestrian crossing points.

3.1.12. Crosswalk Sociodemographic Response (Age, Race, Gender)

The following sections review the sociodemographic response for Scenario A. This scenario asked whether the pedestrian or the motorist should legally yield the right of way, and whether the unmarked crossing is legal. Unmarked crosswalks are locations pedestrians can legally cross (Figure 2.2) and where an approaching motorist should yield to a pedestrian attempting to cross.

Age

There is a statistically significant relationship between age and survey response (p-value = 0.01909). The 25-34 group was less likely to choose the correct answer than both the 35 to 54 and 55 to 74 groups. This analysis excluded the 24 and younger group because there were only 15 responses for this category.

Educational campaigns for all groups should address the fact that the pedestrian crossing is legal at an unmarked location and should prioritize reaching the 25-34 group first. The older age groups believe that the pedestrian should yield whereas the younger age groups believe that the motorist should yield. Again, it is possible that older people might have answered the “who should yield” portion of each question according to their own thoughts rather than by stating what they think Texas law states.

Figure 4.3 Scenario A Response Breakdown by Age

Race

There is no significant relationship between response and race found. See Figure B0.4, Figure B0.5, and Table B0.3 in the Appendix for detailed response breakdowns.

Gender

Females were significantly less likely to choose the correct response than males (Figure 4.4) in the unmarked crosswalk scenario (p-value = 0.00299). See Figure B0.6 and Table B0.4 in the Appendix for more details.

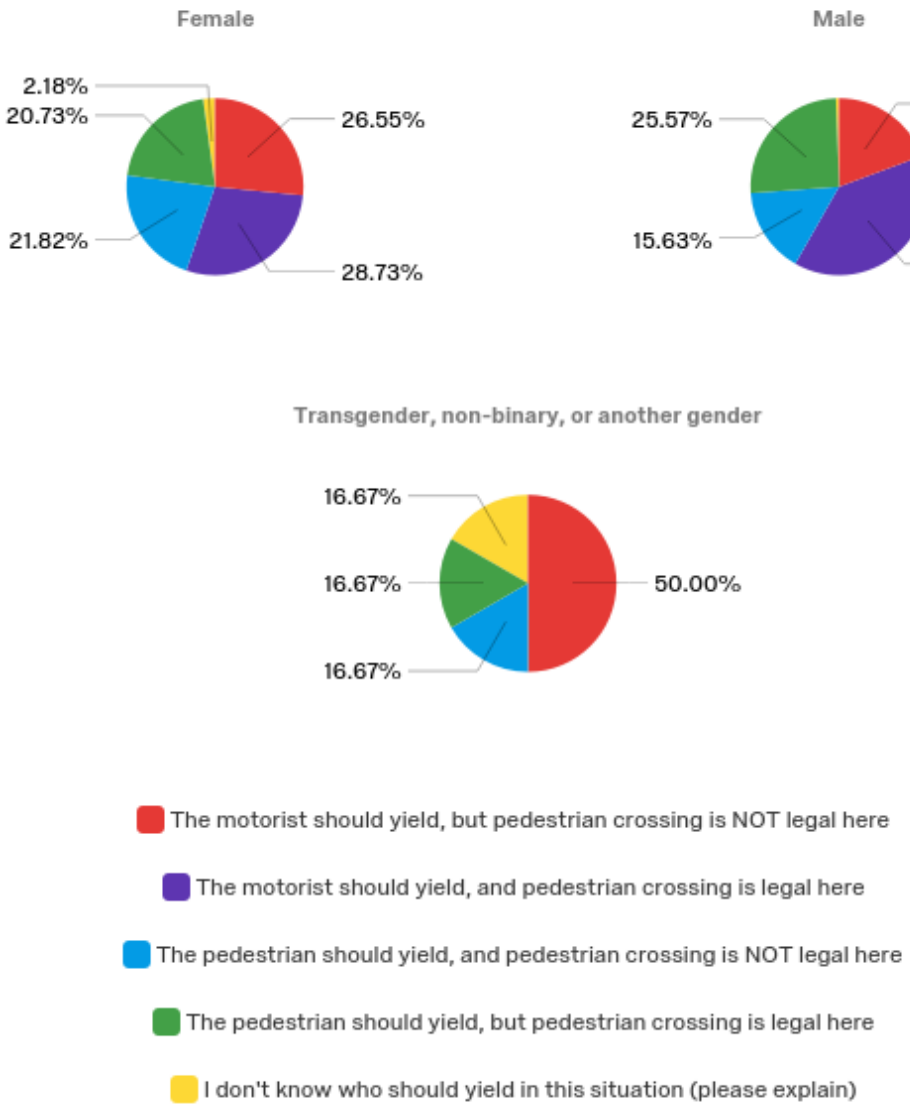


Figure 4.4 Scenario A Response Breakdown by Gender

4.3 Scenario B: Marked Crosswalk

Scenario B asks whether the pedestrian or the motorist should legally yield the right of way, and whether the marked crossing is a legal pedestrian crossing. Marked crosswalks are locations pedestrians can legally cross and where an approaching motorist should yield to a pedestrian attempting to cross. The results from this question are shown in Figure 4.5. Overall, 85.74% of respondents selected the correct answer, “The motorist should yield, the pedestrian crossing is legal here”. This scenario shows an additional 52.61% in correct responses compared to the unmarked crosswalk scenario.

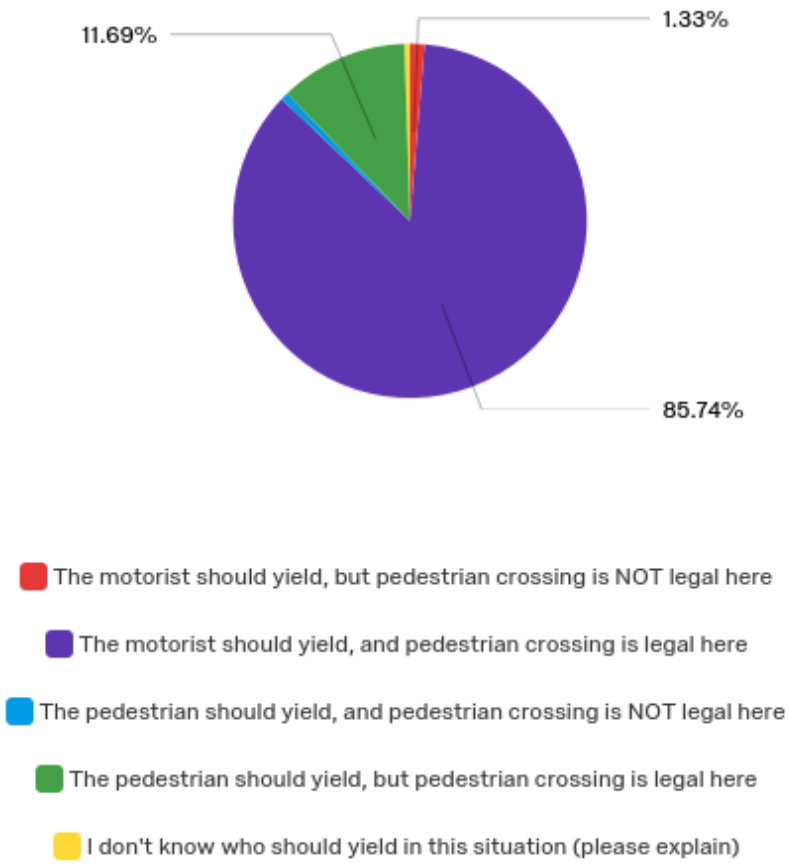


Figure 4.5 Scenario B Overall Response

For the 0.51% of respondents that indicated they did not know who should yield in this situation, the following comments were collected:

- Motorists should always yield to peds if just to avoid legal liability.
- Car doesn't have stop sign, so even though there is a pedestrian crosswalk, if I were pedestrian, I would yield to car.

3.1.13. Socioeconomic Response (Education)

There is a statistically significant relationship between education and the survey responses (p-value = 0.00034) in the marked crosswalk scenario. People that identified as having some college as their highest level of education achieved are less likely to select the correct answer than people with either a Bachelor's or Graduate degree. Over 88% of people with Bachelor's or Graduate degrees answered correctly, meanwhile 79% of those with some college answered correctly. See Figure B0.7 or Table B0.5 in the Appendix for more detailed visuals.

3.1.14. Crosswalk Sociodemographic Response (Age, Race, Gender)

The following sections review the sociodemographic response for Scenario B. This scenario asked whether the pedestrian or the motorist should legally yield the right of way, and whether the marked crossing is legal. Marked crosswalks are locations pedestrians can legally cross (Figure 3.1) and where an approaching motorist should yield to a pedestrian attempting to cross.

Age

There is significant relationship between age and survey response (p-value = 0.00005). Both the 55 to 74 and 74 and older groups are less likely to answer the marked crosswalk scenario correctly than 25 to 34 and 35 to 54-year-olds. Figure 4.6 shows that over 90% of 25 to 54-year-olds answered correctly and less than 83% of 55 to 74-year-olds answered correctly. Educational campaigns on legal conduct at marked crosswalks should prioritize reaching people 55 and older. For more detailed visuals, see Table B0.6 and Figure B0.8 in the Appendix.

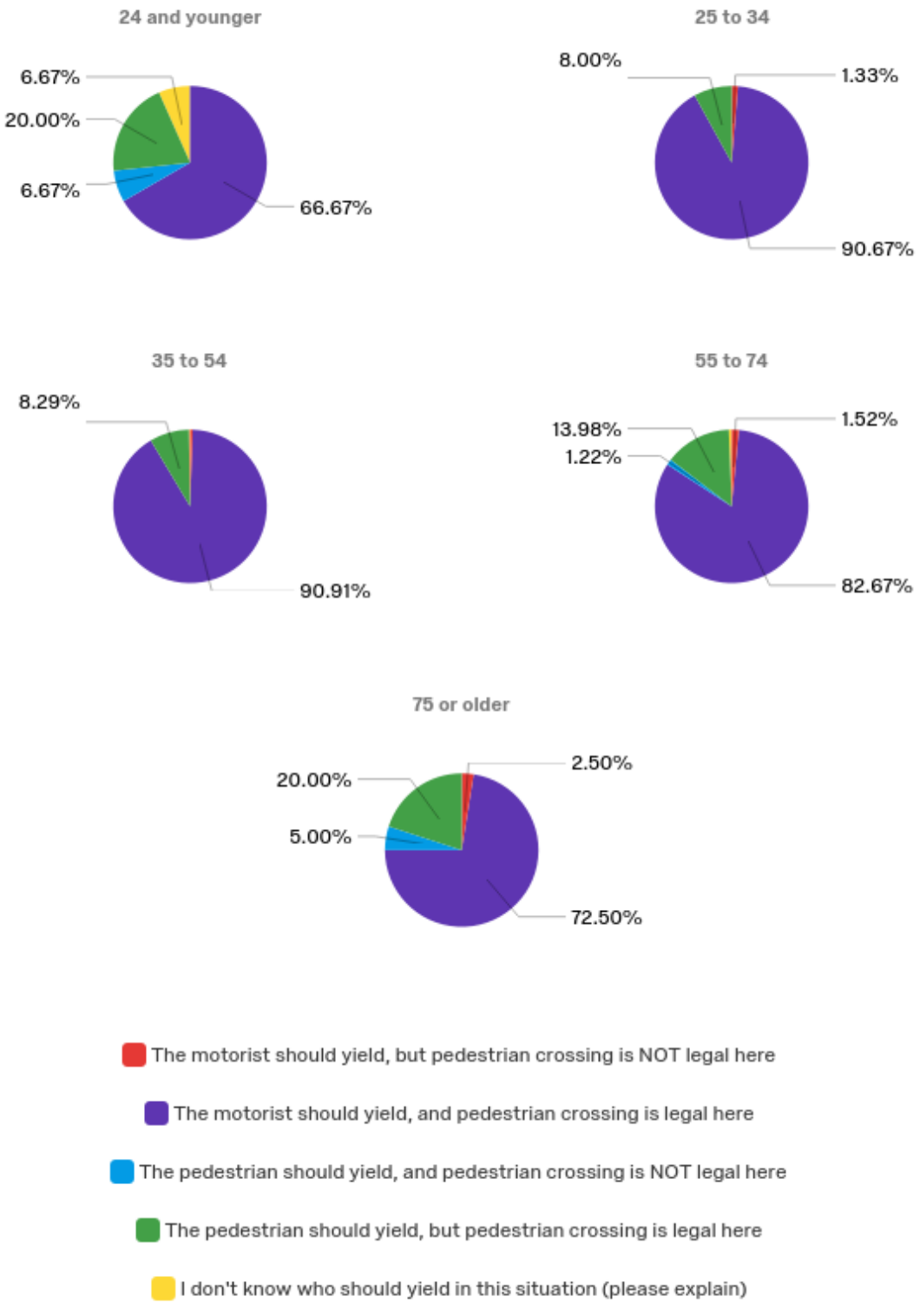

24 and younger
6.67%
20.00%
6.67%
66.67%
25 to 34
8.00%
1.33%
90.67%
35 to 54
8.29%
90.91%
55 to 74
13.98%
1.22%
1.52%
82.67%
75 or older
20.00%
5.00%
2.50%
72.50%
The motorist should yield, but pedestrian crossing is NOT legal here
The motorist should yield, and pedestrian crossing is legal here
The pedestrian should yield, and pedestrian crossing is NOT legal here
The pedestrian should yield, but pedestrian crossing is legal here
I don't know who should yield in this situation (please explain)

Figure 4.6 Scenario B Response Breakdown by Age

Race

There is no significant relationship between response and race found. See Figure B0.9, Figure B0.10, and Table B0.7 in the Appendix for detailed response breakdowns.

Gender

There is a statistically significant relationship between response and gender (p-value = 0.00291). A larger fraction of males identified the correct answer (88.1%) than females (86.2%). See Figure B0.11 and Table B0.8 in the Appendix for more details.

4.4 Scenario C: Concrete Refuge lsland

Scenario C asks whether the pedestrian or the motorist should legally yield the right of way, and whether the concrete refuge island (CRI) crossing is a legal pedestrian crossing. Figure 4.7 shows that overall 89.85% of respondents selected the correct answer, “The motorist should yield, the pedestrian crossing is legal here”. This is the scenario that had the highest fraction of overall correct responses.

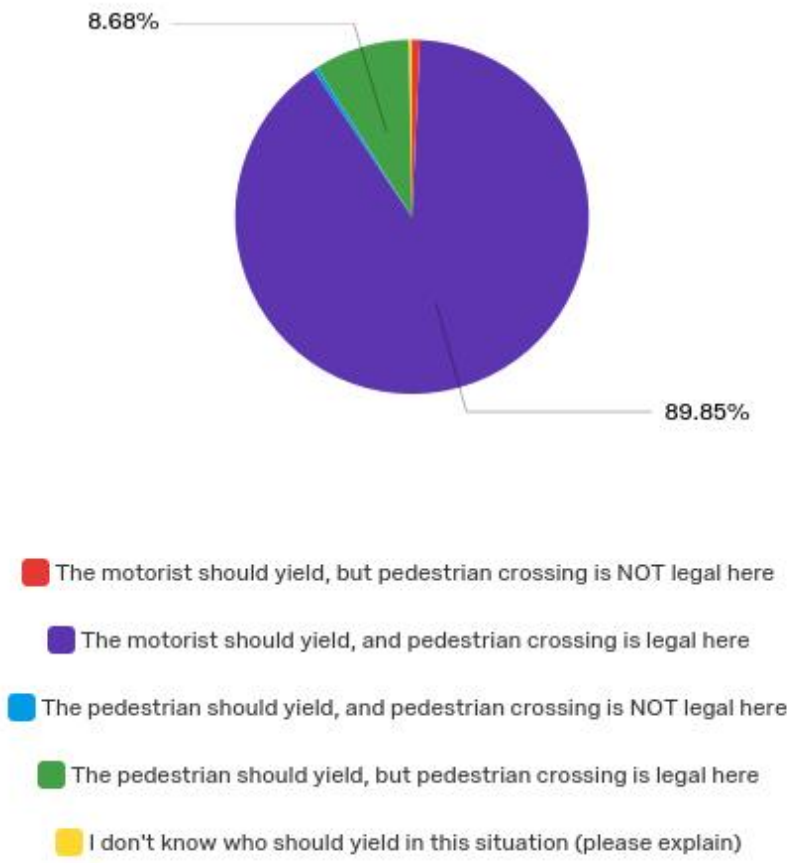


Figure 4.7 Scenario C Overall Response

For the 0.42% of respondents who indicated they did not know who should yield in this situation, the following comments were collected:

- Motorists should always yield to vulnerable road users, if just to avoid a civil claim against their estate and insurance.
- So confusing.

3.1.15. Socioeconomic Response (Education)

There is a strong statistically significant relationship between education and the survey responses (p-value < 0.00001) in the marked crosswalk scenario. As in Scenario B, people that identified as having some college as their highest level of education achieved are less likely to select the correct answer than people with either a Bachelor's or Graduate degree. Over 92% of people with Bachelor's or Graduate degrees and about 84% of those with some college answered correctly. See Figure B0.12 or Table B0.9 in the Appendix for more detailed visuals.

3.1.16. Crosswalk Sociodemographic Response (Age, Race, Gender)

The following sections review the sociodemographic response for Scenario C. This scenario asked whether the pedestrian or the motorist should legally yield the right of way, and whether the CRI crossing is legal. CRI crossing are locations pedestrians can legally cross (Figure 3.3) and where an approaching motorist should yield to a pedestrian attempting to cross.

Age

There is significant relationship between age and survey response (p-value = 0.00039). Figure 4.8 shows the 25 to 34 group had the highest fraction (over 96%) answering this question correctly followed by 35 to 54 group (91%). All other age groups are significantly less likely to select the correct answer than 25 to 34-year-olds. People in the 75 or older group were significantly more likely to select "The pedestrian should yield, but the pedestrian crossing is legal here" than all other age groups. Educational campaigns should prioritize targeting people older than 54 first and focusing on the fact that it is the motorist's legal duty to yield at a CRI. For more detailed visuals, see Table B0.10 and Figure B0.13 in the Appendix.

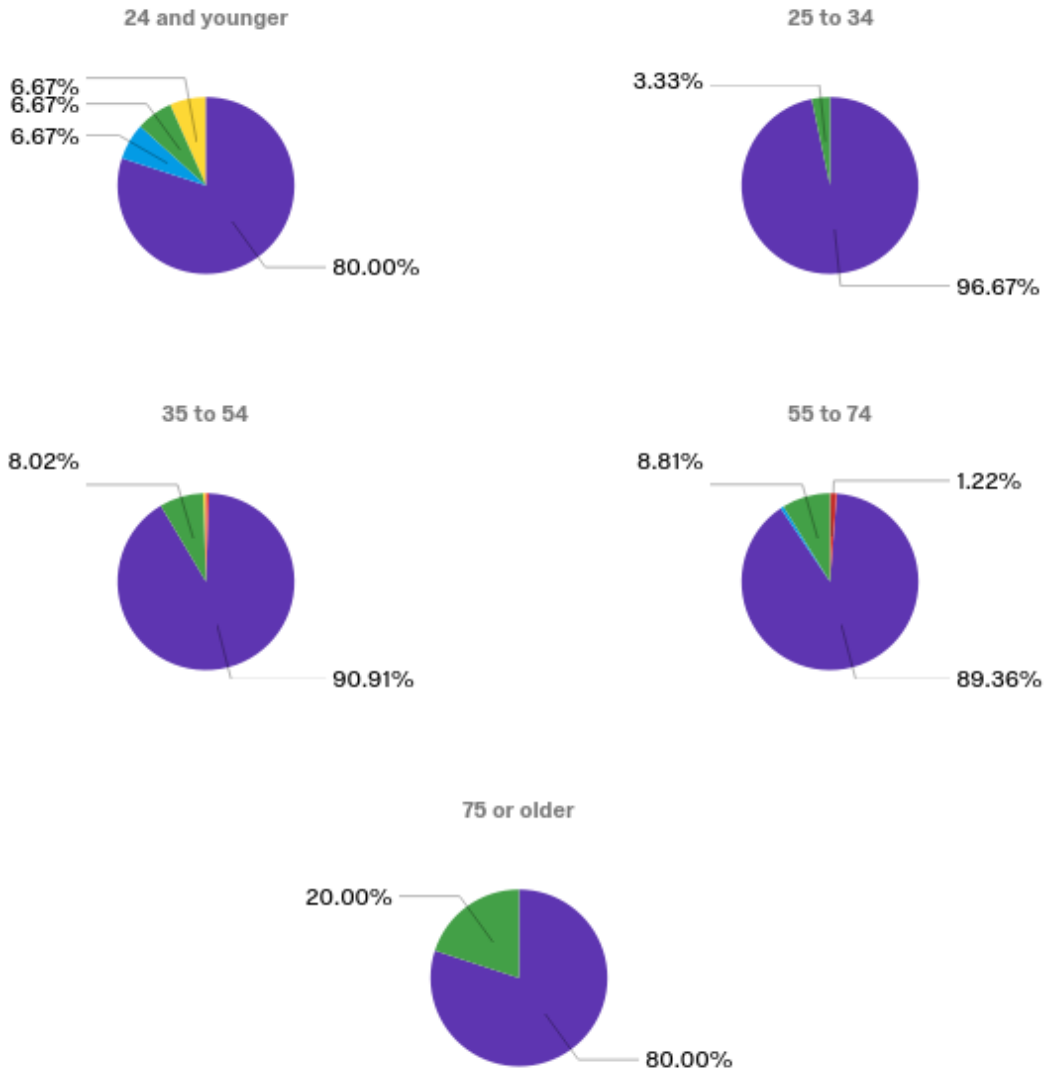

24 and younger
6.67%
6.67%
6.67%
80.00%
25 to 34
3.33%
96.67%
35 to 54
8.02%
90.91%
55 to 74
8.81%
1.22%
89.36%
75 or older
20.00%
80.00%
The motorist should yield, but pedestrian crossing is NOT legal here
The motorist should yield, and pedestrian crossing is legal here
The pedestrian should yield, and pedestrian crossing is NOT legal here
The pedestrian should yield, but pedestrian crossing is legal here
I don't know who should yield in this situation (please explain)

Figure 4.8 Scenario C Response Breakdown by Age

Race

For the three groups with a significant sample size, there is a significant relationship between response and race. The *Prefer not to answer* group had the highest correct response fraction (92%) followed by the *White* group (91%). The *Two or more races* group (81% correct response) has significantly lower likelihood of selecting the correct answer compared to people in the *White* group. Table B0.11 and Figure B0.14 in the Appendix show the sample sizes for each group including those with a sample size too small to draw conclusions.

Gender

There is a statistically significant relationship between response and gender (p-value = 0.00277). A larger fraction of males identified the correct answer (92%) than females (90%). See Figure B0.15 and Table B0.12 in the Appendix for more details.

4.5 Scenario D: Flexpost Refuge Island

Scenario D asks whether the pedestrian or the motorist should legally yield the right of way, and whether the flexpost refuge island (FI) crossing is a legal pedestrian crossing. See Appendix A for the full survey question and a visual representation of an FI. The results from this question are shown in Figure 4.9. Overall, 89.70% of respondents selected the correct answer, "The motorist should yield, the pedestrian crossing is legal here".

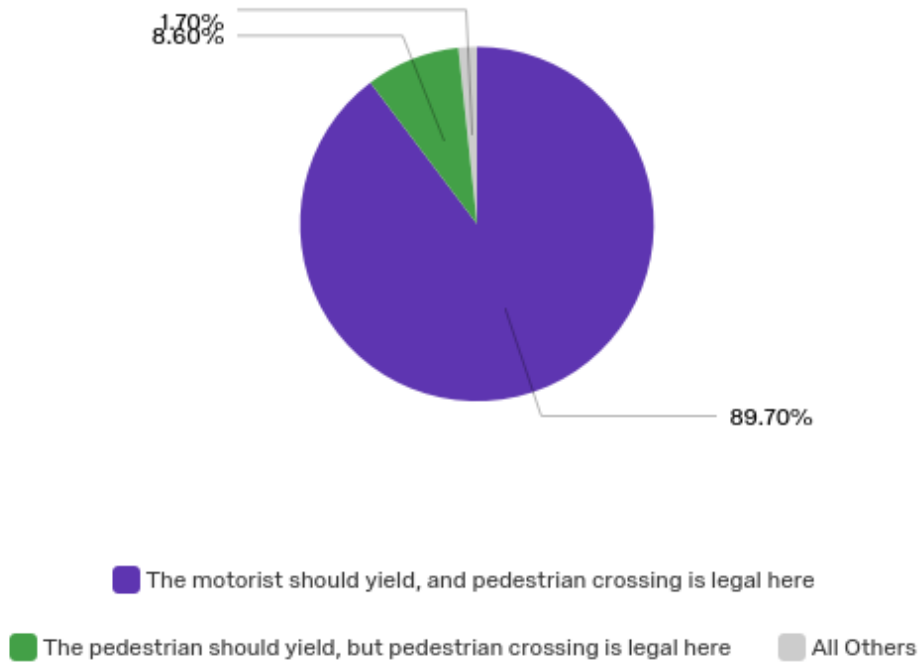


Figure 4.9 Scenario D Response Overall

For the 0.32% of respondents that indicated they did not know who should yield in this situation, the following comments were collected:

- Motorists should ethically and legally always yield.
- The diagram and the picture are different. The picture appears the peds has not yet entered into the crosswalk while the diagram seems to indicate they have. If they have not left the curb, the car does not need to yield. If they have, the car should yield.
- I could not read what the signs say. I assume they indicate who yields.
- How is this different from Scenario C?

3.1.17. Socioeconomic Response (Education)

There is a strong statistically significant relationship between education and the survey responses (p-value < 0.00001) in the marked crosswalk scenario. As in Scenario B & C, people that identified as having Some college as their highest level of education are less likely to select the correct answer than people with a degree. Over 93% of people with Graduate degrees and about 87% those with some college answered correctly. See Figure B0.16 or Table B0.13 in the Appendix for more detailed visuals.

3.1.18. Crosswalk Sociodemographic Response (Age, Race, Gender)

The following sections review the sociodemographic response for Scenario D. This scenario asked whether the pedestrian or the motorist should legally yield the right of way, and whether the FPI crossing is legal. FPI crossing are locations pedestrians can legally cross (Figure 3.4) and where an approaching motorist should yield to a pedestrian attempting to cross.

Age

There is a significant relationship between age and survey response (p-value = 0.01210). The 25 to 34 group had the highest fraction (93%) answering this question correctly followed by 35 to 54 group (92%). People in the 55 to 74 group were significantly less likely to select the correct answer than people in the 35 to 54 group. Overall, the 75 and older group had the lowest correct response fraction. Educational campaigns should prioritize targeting the 75 and older group first given that they are significantly less likely to select the correct answer than those in the 25 to 34 and 35 to 54 groups. For more detailed visuals, see Figure B0.17 and Table B0.14 in the Appendix.

Race

There is no statistically significant relationship between response and race found in this sample (p=0.20137). See Figure B0.18, Figure B0.19, or Table B0.15 in the Appendix for the response breakdown by race.

Gender

There is no statistically significant relationship between response and race found in this sample (p=0.10904). See Table B0.16, Figure B0.20, Figure B0.21 in the Appendix for the response breakdown by gender.

4.6 Scenario E: Legal Mid-block Crossing

Scenario E asks whether a mid-block crossing between a signalized intersection and an unsignalized intersection (represented by the yellow area in Figure 4.10) is a legal pedestrian crossing. This question also asks whether the right-of-way belongs to the pedestrian or the motorist. At this type of midblock crossing, the pedestrian can legally cross but must yield the right-of-way to vehicles. In this survey this is the only legal crossing where the right-of-way does not belong to the pedestrian.

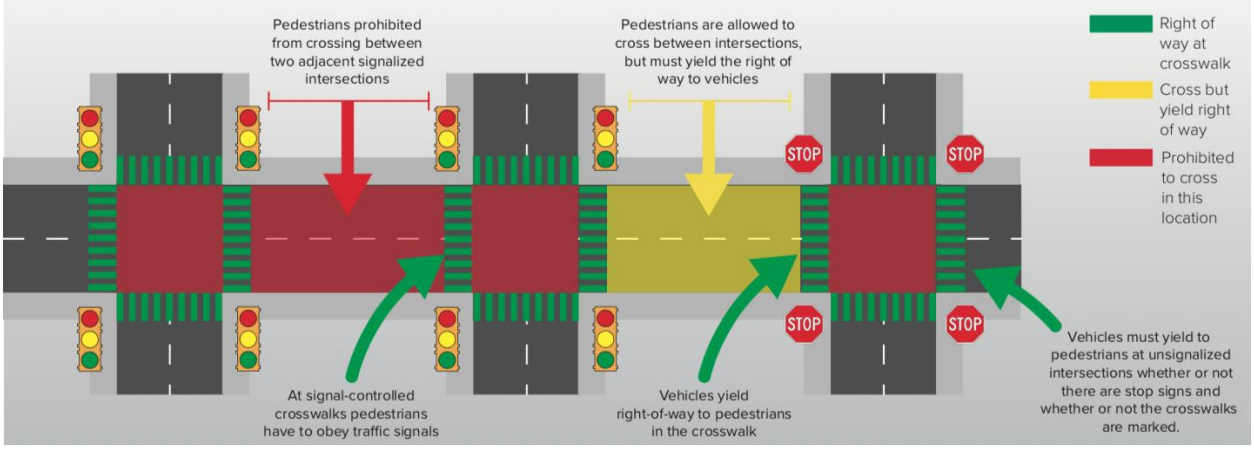


Figure 4.10 Pedestrian Safety and the Law (from City of Austin)

The results from this question are shown in Figure 4.11. Overall, only 1.29% of respondents selected the correct answer, “The pedestrian should yield, but the pedestrian crossing is legal here”. Even though this question had a poor correct response fraction, most people (59.23%) indicated that the pedestrian should yield at this location.

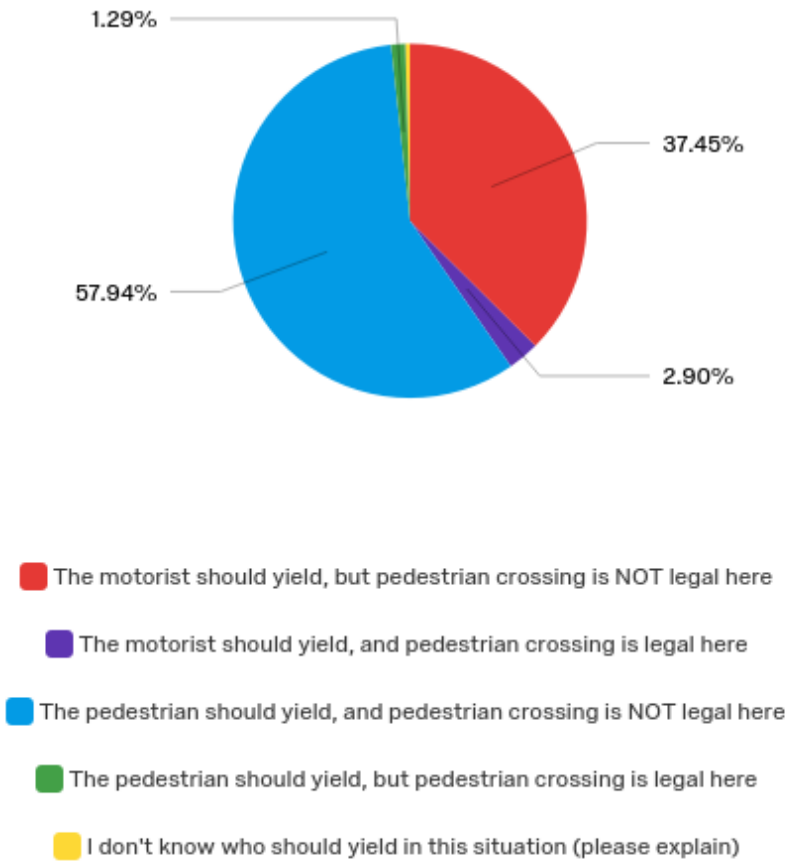


Figure 4.11 Scenario E Response Overall

For the 0.43% of respondents who indicated they did not know who should yield in this situation, the following comment was collected:

- Motorists should always yield to avoid lawsuits and criminal investigation.

3.1.19. Socioeconomic Response (Education)

There is no statistically significant relationship between response and education found in this sample (p=0.10904). Grade school or less and High School or Equivalent groups were excluded from the analysis because these groups had less than 30 responses within each group. See Figure B0.22 and Table B0.17 in the Appendix for the response breakdown by education.

3.1.20. Crosswalk Sociodemographic Response (Age, Race, Gender)

The following sections review the sociodemographic response for Scenario E. This scenario asked whether the pedestrian or the motorist should legally yield the right of way when crossing at a midblock location between a signalized and unsignalized intersection (see the yellow area in Figure 4.10).

Age

There is a significant relationship between age and survey response (p-value < 0.00001). This analysis excluded the 24 and younger group because there were only 15 responses for this category. Figure 4.12 shows that the 75 years or older group had the highest fraction (10%) correct response fraction followed by 34 to 54 group (1.3%). People in all of the other groups were significantly less likely to select the correct answer than people in the 75 years or older group. Future educational campaigns should prioritize targeting all groups, however, because the correct response fraction is only 1.3% for this scenario. For more detailed visuals, see Figure B0.23 and Table B0.18 in the Appendix.

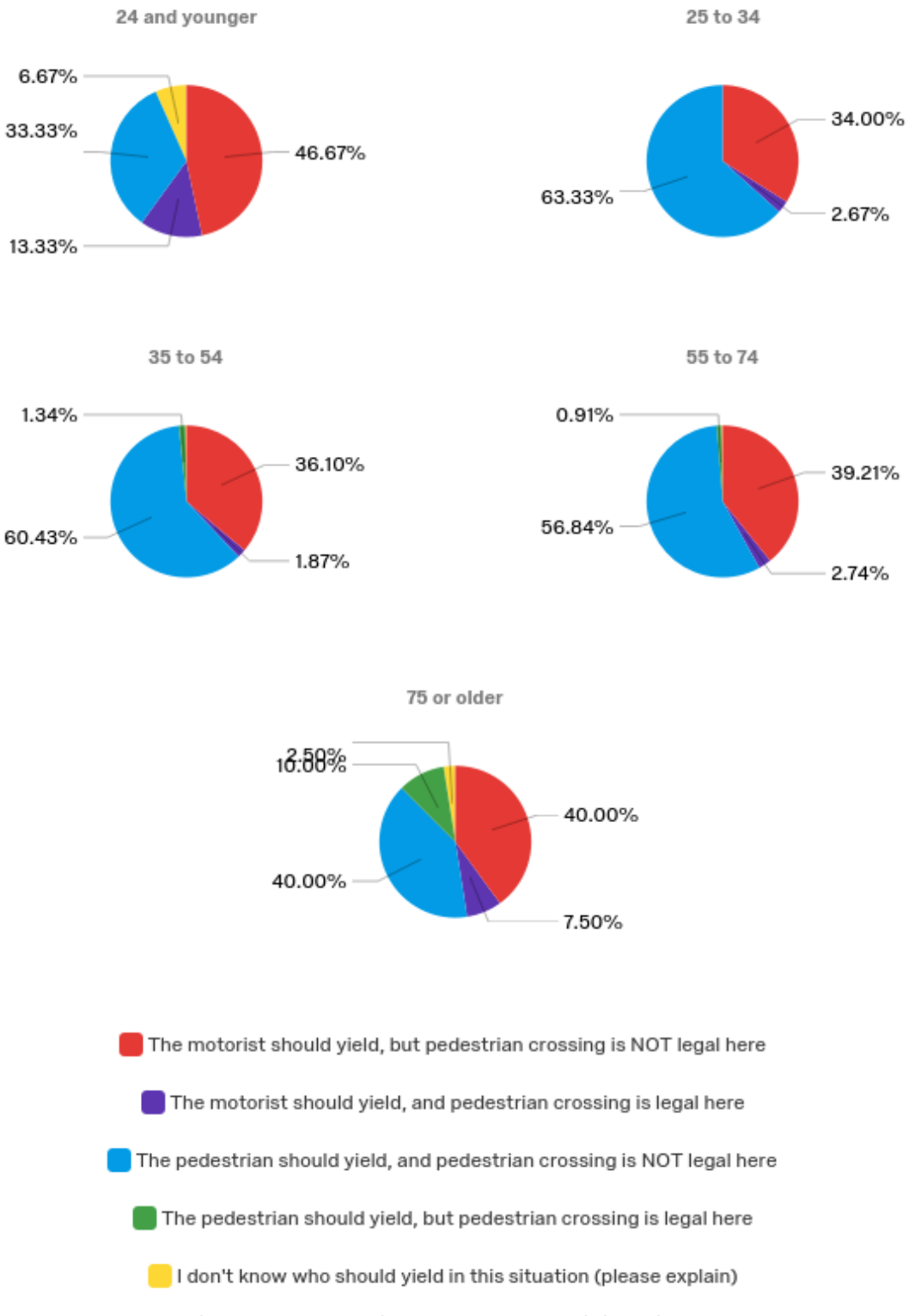


Figure 4.12 Scenario E Response Breakdown by Age

Race

There is no statistically significant relationship between response and race found in this sample (p=0.36096) for this scenario. See Figure B0.24, Figure B0.25, or Table B0.19 in the Appendix for the response breakdown by race.

Gender

There is no statistically significant relationship between response and race found in this sample (p=0.10904). See Figure B0.26, Figure B0.27, and Table B0.20 in the Appendix for the response breakdown by gender.

4.7 Scenario F: Illegal Mid-block Crossing

Scenario F asks whether a mid-block crossing between two signalized intersections (represented by the red area in Figure 4.10) is a legal pedestrian crossing. This question also asks whether the right-of-way belongs to the pedestrian or the motorist. At this type of midblock crossing, the pedestrian cannot legally cross. This is the only scenario presented where the pedestrian has neither the right-of-way does nor can legally cross.

The results from this question are shown in Figure 4.13 and Figure 4.14. 56.82% of respondents selected the correct answer, “The pedestrian should yield, and the pedestrian crossing is illegal here”. Overall, 92.64% of respondents identified the pedestrian crossing as being illegal at this location.

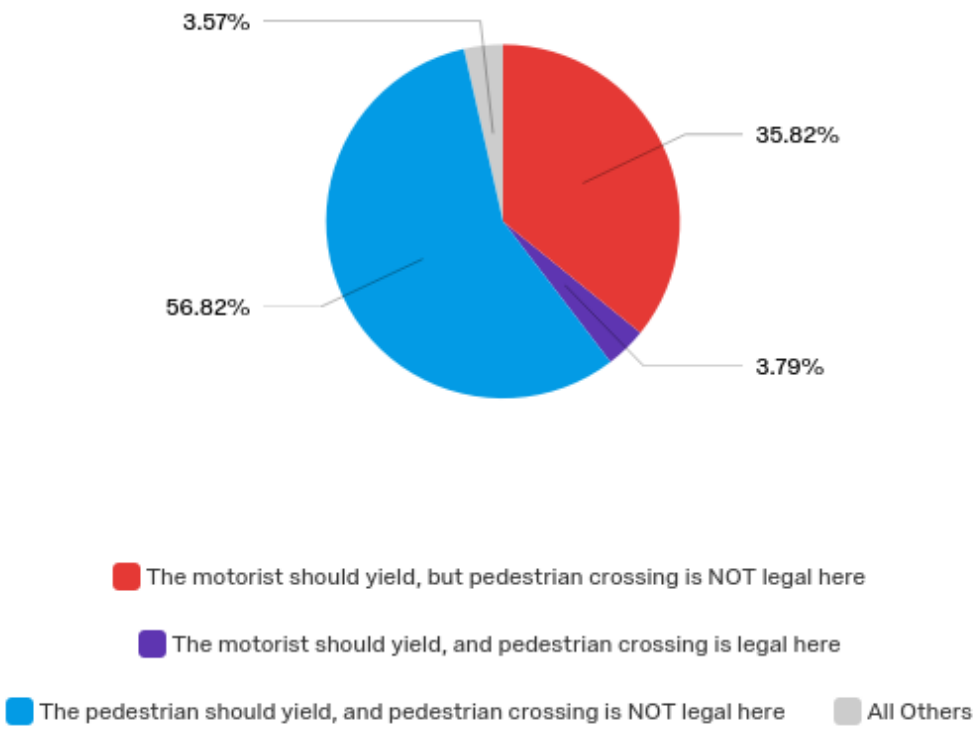


Figure 4.13 Scenario F Response Overall

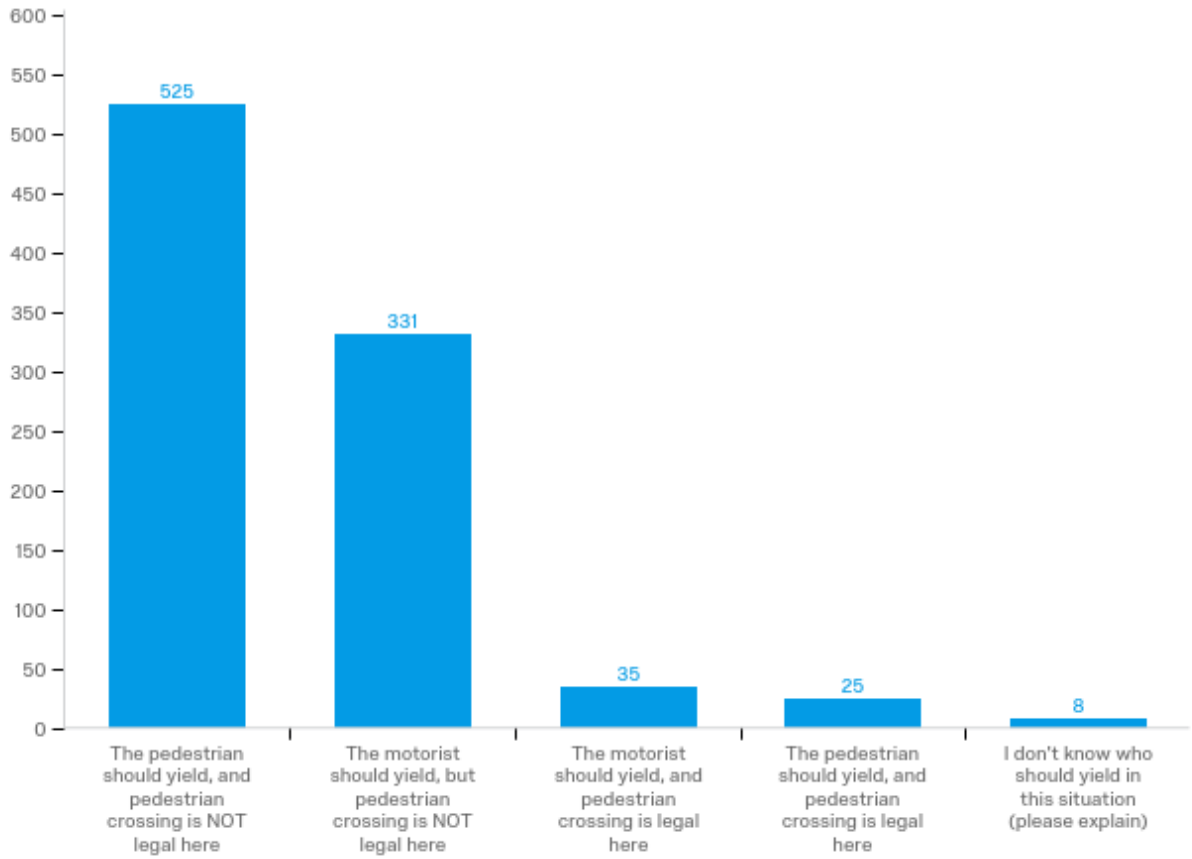


Figure 4.14 Scenario F Overall Response (Count)

For the 0.7% of respondents who indicated they did not know who should yield in this situation, the following comments were collected:

- Motorists always need to yield to vulnerable road users.
- The pedestrian should yield, but I don't know if it's legal to cross. Since both intersections are not signaled, I think it depends on the distance between the intersections. I think if it's 100 yards or more, then it is legal to cross.
- I can’t tell if the stoplight is green, yellow or red
- It depends on the light? I'm confused by the placement of the stoplight.
- How is this different than Scenario E?

3.1.21. Socioeconomic Response (Education)

There is no statistically significant relationship between response and education found in this sample (p=0.57486). Grade school or less and High School or Equivalent groups were excluded from the analysis because these groups had less than 30 responses within each group. See Figure B0.28 and Table B0.21 in the Appendix for the response breakdown by education.

3.1.22. Crosswalk Sociodemographic Response (Age, Race, Gender)

The following sections review the sociodemographic response for Scenario F. This scenario asked whether the pedestrian or the motorist should legally yield the right of way when crossing at a midblock location between two signalized intersections (see the red area in Figure 4.10).

Age

There is no statistically significant relationship between response and age found in this sample (p=0.24614). See Figure B0.29 and Table B0.22 in the Appendix for the response breakdown by age.

Race

There is no statistically significant relationship between response and race found in this sample (p=0.21105) for this scenario. See Figure B0.30 and Table B0.23 and in the Appendix for the response breakdown by race.

Gender

There is no statistically significant relationship between response and race found in this sample (p=0.44681). See Figure B0.31 and Table B0.24 in the Appendix for the response breakdown by gender.

4.8 Scenario G: Multiple Threat

Scenario G asks about who has the duty to yield the right-of-way in a multiple threat situation. A multiple threat situation is one where more than one vehicle approaches a crosswalk from more than one lane (See Figure 4.15). At this type of midblock crossing, the pedestrian can legally cross and all vehicles approaching the crosswalk should yield.

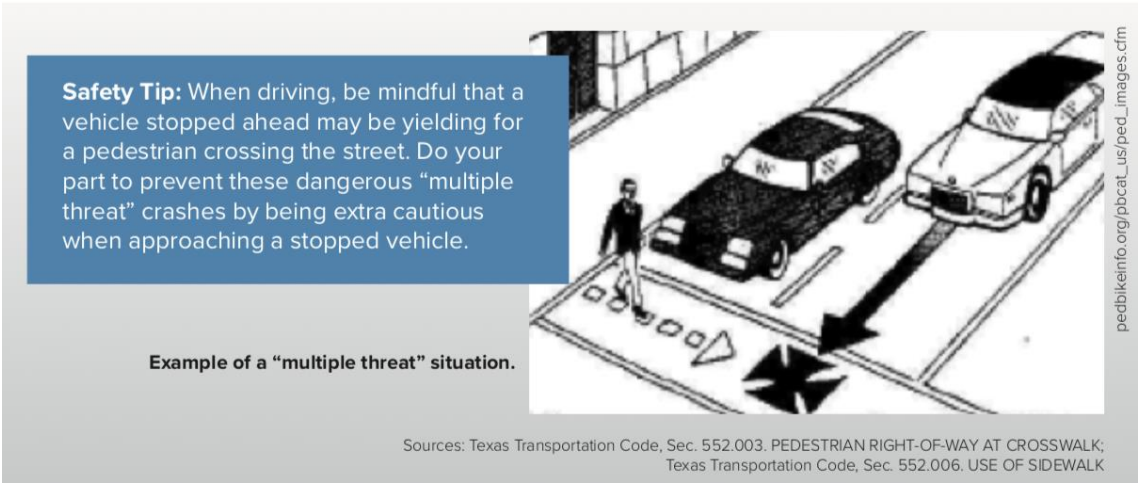


Figure 4.15 Multiple Threat Situation (from City of Austin)

The results from this question are shown in Figure 4.16 and Figure 4.17. For this scenario, 85.79% of respondents selected the correct answer, “Both motorists A and B”.

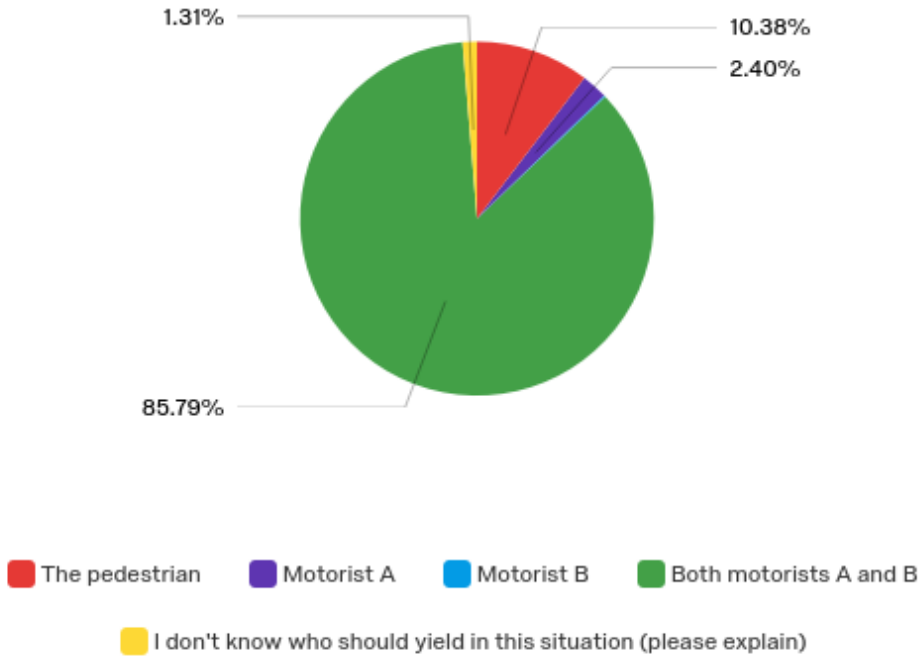


Figure 4.16 Scenario G Response Overall Response

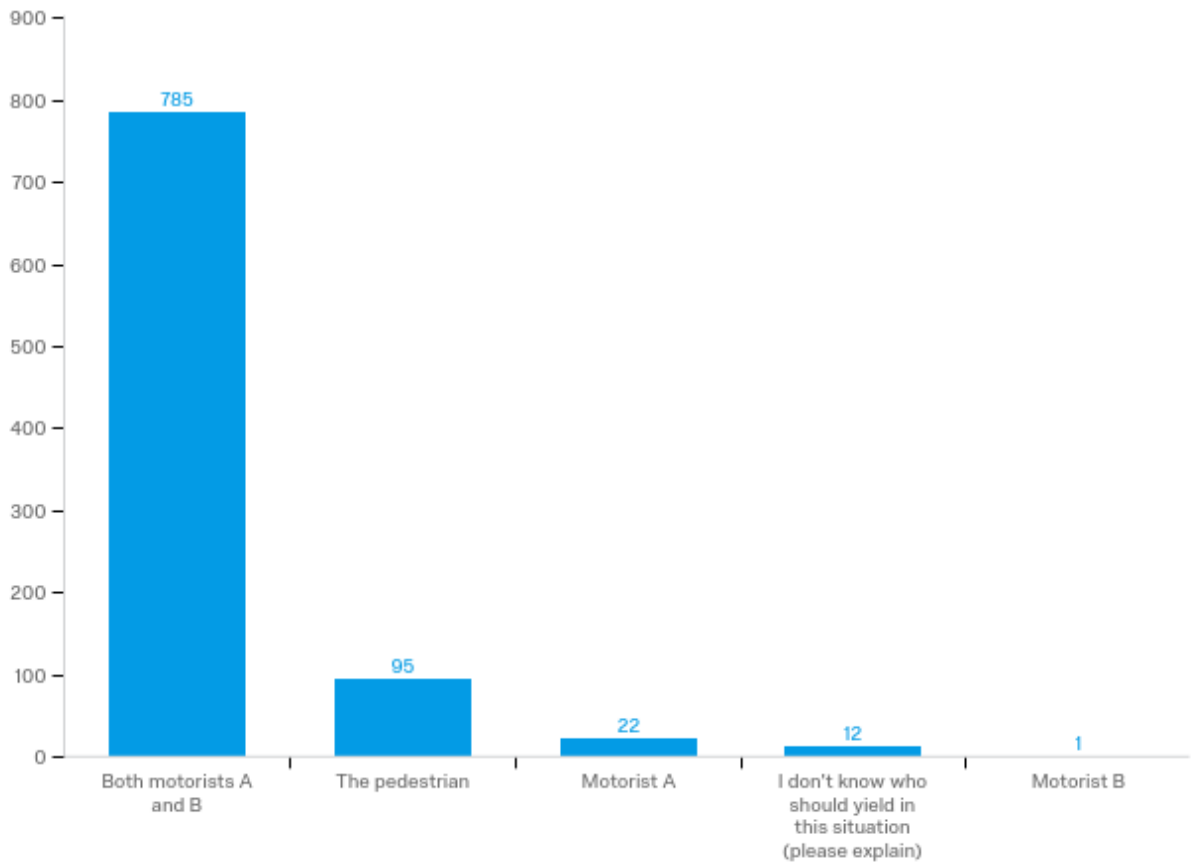


Figure 4.17 Scenario G Overall Response (Count)

For the 1.31% of respondents that indicated they did not know who should yield in this situation, the following comments were collected:

- Cars should stop if just to avoid lawsuits.
- Is there signage for this right of way?
- Both A and B should stop, but I would not be confident that both would in this situation in Austin.
- It's unsafe for pedestrian to go not knowing if second car will yield.
- Car B is blocking the view of Car A so for safety the pedestrian should yield.
- Pedestrian should have the right to cross - both drivers need to be able to stop when there is traffic on crosswalk.

3.1.23. Socioeconomic Response (Education)

There is no statistically significant relationship between response and education in this sample ($p=0.29468$). Grade school or less and High School or Equivalent groups were excluded from the analysis because these groups had less than 30 responses within each group. See Table B0.21 in the Appendix for the response breakdown by education.

3.1.24. Crosswalk Sociodemographic Response (Age, Race, Gender)

The following sections review the sociodemographic response for Scenario G. This scenario asked whether the pedestrian or the motorist(s) should legally yield the right of way in a multiple threat situation (shown in Figure 4.15).

Age

There is a significant relationship between age and survey response (p-value = 0.01208). This analysis excluded the 24 and younger group because there were only 15 responses for this category. Figure 4.18 shows that the 25 to 34 group had the highest fraction (91.3%) correct response fraction followed by 55 to 74 group (86.6%). People in the 75 or older group were significantly less likely to select the correct answer than people in the 25 to 34 group. For more detailed visuals, see Figure B0.34 and Table B0.26 in the Appendix.

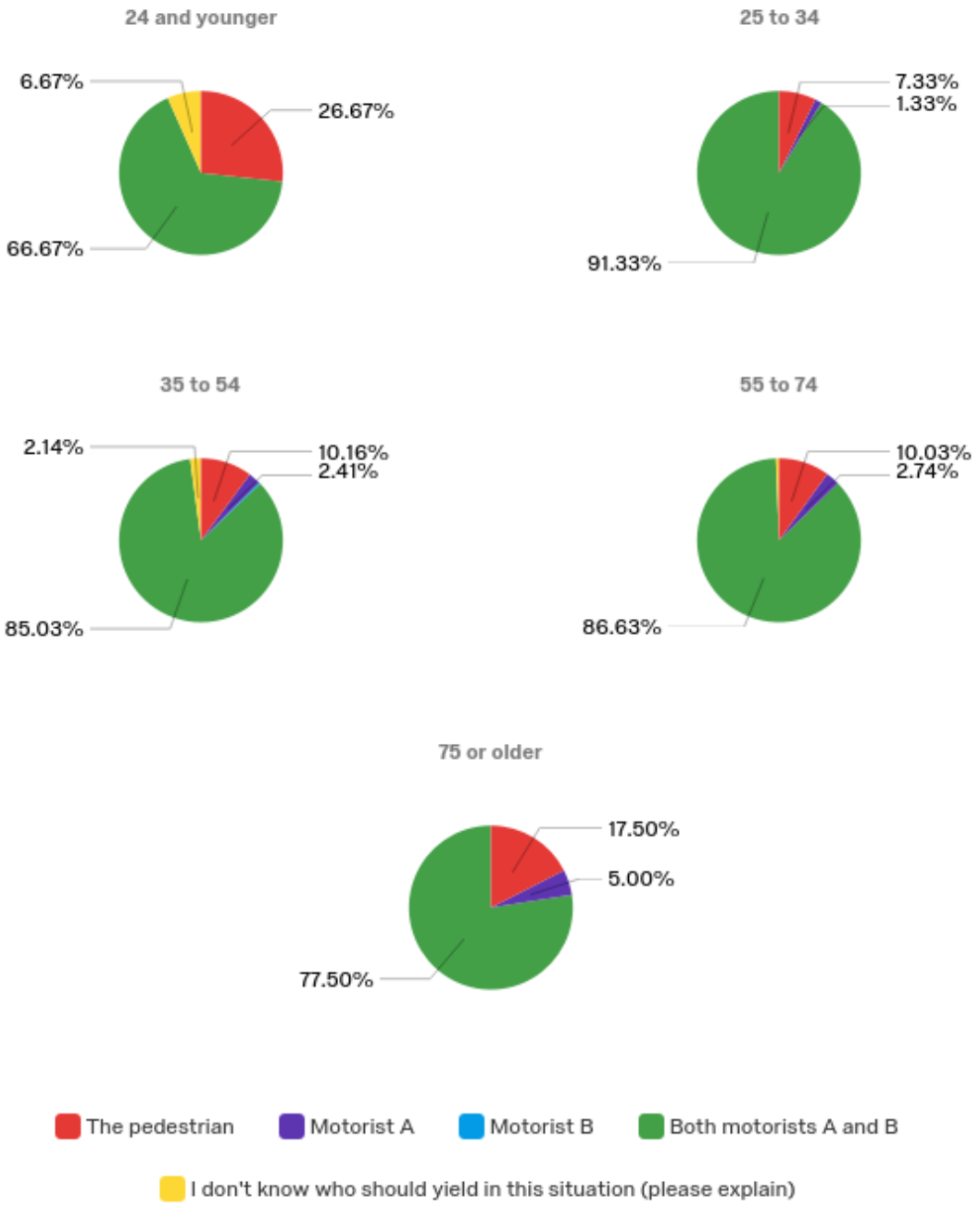


Figure 4.18 Scenario G Response Breakdown by Age

Race

There is no statistically significant relationship between response and race found in this sample (p=0.12565) for this scenario. See Figure B0.35, Figure B0.36, and Table B0.27 in the Appendix for the response breakdown by race.

Gender

There is a statistically significant relationship between response and gender (p-value = 0.00025). Figure 4.19 shows that a larger fraction of females identified the correct answer (86.5%) than males (85.8%). A higher fraction of females indicated they did not know who should yield in this situation, meanwhile a higher fraction of males indicated the pedestrian should yield. The statistical analysis excluded the transgender or non-binary group because there were only 6 responses. See Figure B0.37 and Table B0.28 in the Appendix for more details.

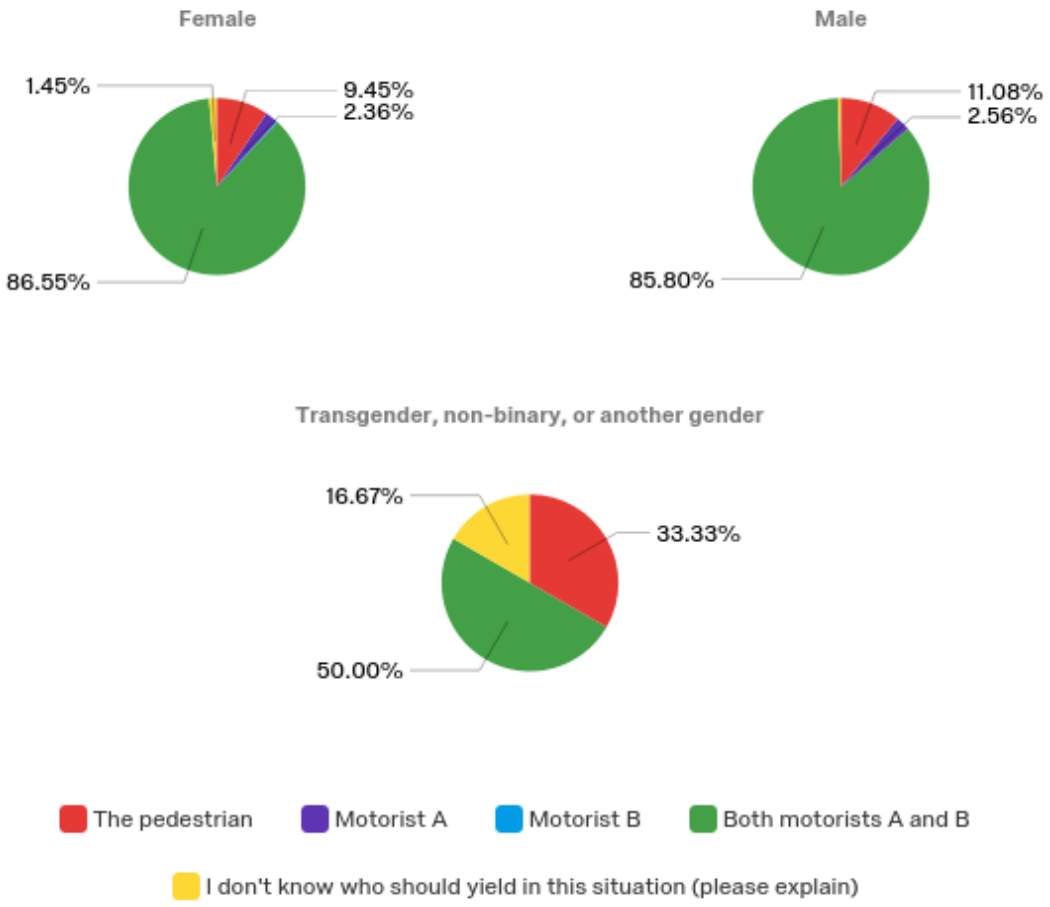


Figure 4.19 Scenario G Response Breakdown by Gender

4.9 Summary

Survey respondents were asked to identify the legal yielding conduct for both pedestrians and motorists for seven different crossing scenarios. In terms of overall response, the ranking for highest to lowest fraction of correct responses is:

- Scenario C: Concrete Refuge Island 89.9%
- Scenario D: Flexpost Refuge Island 89.7%
- Scenario G: Multiple Threat 85.8%
- Scenario B: Marked Crosswalk 85.7%

- Scenario F: Illegal Mid-block 56.8%
- Scenario A: Unmarked crosswalk 33.1%
- Scenario E: Legal Mid-block 1.3%

Scenarios A (unmarked crosswalk), E (legal midblock), and F (illegal midblock) had the poorest overall correct response fractions and should be prioritized by educational campaigns.

For the top three worst response scenarios, the following summarizes the statically significant socioeconomic and sociodemographic factors found in this survey sample:

- **Scenario F: Illegal Mid-block Crossing**
  - *No significant factors found*. All socioeconomic and sociodemographic groups should be targeted equally.
- **Scenario A: Unmarked Crosswalk**
  - *Age*. 25-34 group significantly less likely to select the correct answer than 35 to 74 group.
  - *Gender*. Males are more likely to select correct answer.
- **Scenario E: Legal Mid-block Crossing**
  - *Age*. Younger than 75 were significantly less likely to select correct answer. However, only 10% of 75 and older group responded correctly.

Conclusions

Understanding how different types of crossing treatments affect driver propensity to yield to pedestrians and the educational gaps in terms of legal yielding procedures can help transportation professionals better address pedestrian safety concerns. Examining both motorist yielding behavior and level of understanding of Texas yielding laws delivers a comprehensive look at pedestrian safety.

4.10 Effect of Pedestrian Control Devices on Yielding Behavior

The investigation evaluated driver yielding behavior rates with respect to crossing type for a variety of factors and considered the effect of R1-6 sign, pedestrian activity, and vehicle activity for the crossing types. A list summarizing the key findings follows.

- *Concrete islands result in the highest yielding rates out of the tested crossing types.* The concrete refuge island category showed the highest mean yielding compliance in the field (66.67%). The R1-6 sign with the concrete refuge island is the most powerful crossing and signage combination in this study. The 95% CI produced for mean yielding compliance at a concrete refuge island is (16.67% - 50.79%).

- *Marked crosswalks and flexpost islands have very similar average yielding rates.* Flexpost islands offer little improvements over marked crosswalks in terms of driver yielding probability. High pedestrian activity at both types of crossings improves driver yielding probability compared to low pedestrian activity significantly. At medium pedestrian activity level, yielding compliance is about 2.3x better at the flexpost island than at marked crosswalks. When considering yielding propensity for vehicles that do not belong to a platoon, a flexpost island only offers about 1% improvement in yielding probability compared to a marked crosswalk.

- *Unmarked crosswalks have the worst yielding rates observed.* The average yielding rate observed in the field for unmarked crosswalks was less than 1%.

- *There is no significant difference in yielding rate by signage type, however, future work could consider crossing types as a second factor.* Certain signage configurations were only observed at specific crosswalk types, meaning there are a lot of missing cells. With this dataset, it was not possible to construct a fully crossed two-way analysis of variance.

- *The effect of the R1-6 sign is significant on driver yielding compliance.* When assuming no interaction between the R1-6 sign and crossing type, the effect of the sign is an +8% improvement on yielding compliance. When assuming interaction, the effect of the R1-6 sign depends on the crossing type. For concrete refuge islands, probability of yielding goes up by +50% ,which is 4x with the R1-6 sign. For flexpost islands, the sign improves

yielding probability by an additional +4%, which doubles the probability. And at marked crosswalks, again compliance doubles by adding 3% to compliance probability with the sign.

- *Overall, high pedestrian activity levels impact driver yielding.* High pedestrian activity can positively impact driver yielding rates, but there is no significant difference in driver yielding behavior in comparing locations with medium and low pedestrian activity. When considering crossing treatment options for residential, low-volume streets with medium to low pedestrian activity, the effect that pedestrian activity will have on driver yielding propensity is minimal.

- *Vehicles belonging to platoons have a lower probability of yielding to pedestrians at unmarked crosswalks.* Platooning did not have a significant effect at flexpost islands and marked crosswalks but did at unmarked crosswalks. Locations with higher traffic volumes and more vehicle platooning are less safe for pedestrians to cross at unmarked crossings.

- *Upgrading an unmarked crosswalk to a marked crosswalk or flexpost refuge island where vehicle volumes are very light can improve pedestrian safety.* For locations where there are little to no vehicle platoons, upgrading an unmarked crossing to a marked crosswalk can improve yielding probability up to 2x. However, the probability of driver yielding at either of these upgraded crossings is still very low at less than 20%.

4.11 Survey of Public Knowledge on Texas Yielding Laws

- *Less than 2% of survey respondents identified the correct answer for the legal mid-block crossing scenario.* Age is a significant factor. People younger than 75 were less likely to select the correct answer. However, only 10% of the 75 and older group responded correctly.

- *About 57% of survey respondents identified the correct answer to the illegal mid-block crossing scenario.* No significant factors were found. All socioeconomic and sociodemographic groups should be targeted equally.

- *Age and Gender are significant factors for determining likeliness of responding correctly to the unmarked crosswalk scenario.* Only 33% of respondents responded correctly. The 25-34 group is significantly less likely to select the correct answer than the 35 to 74 group. Males are more likely to select the correct answer.

4.12 Recommendations

In light of these findings, the following list provides recommendations for addressing pedestrian safety issues:

- Prioritize upgrading unmarked crossings to become marked crosswalks instead of flexpost refuge islands. The effect of a flexpost island is very similar to the effect of a marked crosswalk on driver yielding, except for at locations with medium pedestrian activity (see Sections 0 and 0). Flexpost islands are harder to maintain and are more predisposed to damage from objects that strike them.

- Add the R1-6 sign to crossings whenever possible because the sign improves driver yielding significantly, especially at concrete refuge islands.

- Test the R1-6 sign in gateway formation at marked crosswalks. Based on the literature review, an R1-6 sign gateway configuration at a marked crosswalk could offer much more in terms of yielding improvements at a very reasonable cost.

- Prioritize education on unmarked crossings, which is one of the top three scenarios with the worst response rate. Unmarked crossings have the worst yielding rates and have the worst correct response rate in the survey. Millennials (ages 24 to 39 in 2020) were significantly less likely to answer this question in the survey correctly. Educational campaign efforts could partner with local businesses and companies that have high fractions of millennial customers/employees to disseminate information about proper yielding at unmarked crosswalks.

- Prioritize education on legal mid-block crossings and illegal mid-block crossings, which also were part of the top three with the worst response rate. All socioeconomic and sociodemographic groups should be targeted equally.

References

1. NHTSA. NHTSA's 2021 Estimate of Traffic Deaths Shows 16-Year High. https://www.nhtsa.gov/press-releases/early-estimate-2021-traffic-fatalities. Accessed Sep. 30, 2022.
2. Norton, P. D. *Fighting Traffic : The Dawn of the Motor Age in the American City*. MIT Press, 2008.
3. Ladd, B. *Autophobia : Love and Hate in the Automotive Age*. University of Chicago Press, 2008.
4. City of Austin. *Imagine Austin Comprehensive Plan*. 2012.
5. Federal Highway Administration. Manual on Uniform Traffic Control Devices (MUTCD). https://mutcd.fhwa.dot.gov/. Accessed Nov. 13, 2018.
6. Knopp, M. C. Interim Approval 21 – Rectangular Rapid-Flashing Beacons at Crosswalks.
7. NHSTA. *The 100-Car Naturalistic Driving Study; Phase II - Results of the 100-Car Field Experiment*. 2006.
8. Stapleton, S., T. Kirsch, T. J. Gates, and P. T. Savolainen. Factors Affecting Driver Yielding Compliance at Uncontrolled Midblock Crosswalks on Low-Speed Roadways. *Transportation Research Record: Journal of the Transportation Research Board*, No. 2661, 2017, pp. 95–102. https://doi.org/10.3141/2661-11.
9. Western Michigan University. *User Guide for R1-6 Gateway Treatment for Pedestrian Crossings*. 2016.
10. Fitzpatrick, K., V. Iragavarapu, M. A. Brewer, D. Lord, J. Hudson, R. Avelar, and J. Robertson. *Characteristics of Texas Pedestrian Crashes and Evaluation off Driver Yielding at Pedestrian Treatments*. 2014.
11. Bennett, M. K. *Use of a Gateway In-Street Sign Treatment to Increase Yielding to Pedestrians at Crosswalks*. Western Michigan University, 2013.
12. Zegeer, C., J. Stewart, H. Huang, and P. Lagerwey. Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations: Analysis of Pedestrian Crashes in 30 Cities. *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 1773, No. September, 2001, pp. 56–68. https://doi.org/10.3141/1773-07.
13. Schroeder, B. J., and N. M. Rouphail. Event-Based Modeling of Driver Yielding Behavior at Unsignalized Crosswalks. *Journal of transportation engineering*, Vol. 137, No. 7, 2011, pp. 455–465. https://doi.org/10.1061/(ASCE)TE.1943-5436.0000225.
14. Fitzpatrick, K., R. Avelar, I. Potts, M. Brewer, J. Robertson, C. Fees, J. Hutton, L. Lucas, and K. Bauer. *Investigating Improvements to Pedestrian Crossings with an Emphasis on the Rectangular Rapid-Flashing Beacon*. 2015.
15. Sundstrom, C., and D. Nabors. Bicycle Safety Guide and Countermeasure Selection System. *Federal Highway Administration*. http://pedbikesafe.org/BIKESAFE/index.cfm. Accessed Nov. 14, 2018.
16. Fitzpatrick, K., R. Avelar, M. Pratt, M. Brewer, J. Robertson, T. Lindheimer, and J. Miles. *Evaluation of Pedestrian Hybrid Beacons and Rapid Flashing Beacons*. 2016.
17. City of Austin. Pedestrian Hybrid Beacons PHB. http://austintexas.gov/page/pedestrian-hybrid-beacons. Accessed Nov. 13, 2018.
18. FHWA. Rectangular Rapid Flash Beacon (RRFB). https://safety.fhwa.dot.gov/intersection/conventional/unsignalized/tech_sum/fhwasa09009/. Accessed Nov. 13, 2018.

19. Bennett, M. K., H. Manal, and R. Van Houten. A Comparison of Gateway In-Street Sign Configuration to Other Driver Prompts to Increase Yielding to Pedestrians at Crosswalks. *Journal of Applied Behavior Analysis*, Vol. 47, No. 1, 2014, pp. 3–15. https://doi.org/10.1002/jaba.103.
20. 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*, Vol. 2586, No. 2586, 2016, pp. 100–105. https://doi.org/10.1097/SHK.0000000000000517.
21. Hochmuth, J., and R. Van Houten. Influence of Advanced Placement of the In-Street Sign Gateway on Distance of Yielding from the Crosswalk. *Transportation Research Record: Journal of the Transportation Research Board*, 2018, p. 036119811877648. https://doi.org/10.1177/0361198118776480.
22. Van Houten, R., J. Hochmuth, D. Dixon, and C. McQuiston. Safety Benefits of the Gateway R1-6 Treatment: An Examination of Effects on Drivers Yielding to Pedestrians, Speed at Crosswalks, and Sign Durability. *ITE Journal (Institute of Transportation Engineers)*, Vol. 88, No. 3, 2018, pp. 31–39.
23. Herms, F. Pedestrian Crosswalk Study: Accidents in Painted and Unpainted Crosswalks. *Transportation Research Board*, No. Record No. 406, Washinton, D.C, USA, 1972, p. (No. HS-012 258).
24. Crowley-Koch, B. J., R. Van Houten, and E. Lim. Effects of Pedestrian Prompts on Motorist Yielding At Crosswalks. *Journal of Applied Behavior Analysis*, Vol. 44, No. 1, 2011, pp. 121–126. https://doi.org/10.1901/jaba.2011.44-121.
25. 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*, Vol. 2519, 2015, pp. 39–50. https://doi.org/10.3141/2519-05.
26. Shinkle, D. Pedestrian Crossing: 50 State Summary. *National Conference of State Legislatures*.
27. TxDPS. Texas Driver Handbook. No. September, 2017, p. 26.
28. Bertulis, T., and D. Dulaski. Driver Approach Speed and Its Impact on Driver Yielding to Pedestrian Behavior at Unsignalized Crosswalks. *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 2464, No. 2464, 2014, pp. 46–51. https://doi.org/10.3141/2464-06.
29. Turner, S., K. Fitzpatrick, M. Brewer, and E. Park. Motorist Yielding to Pedestrians at Unsignalized Intersections: Findings from a National Study on Improving Pedestrian Safety. *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 1982, 2006, pp. 1–12. https://doi.org/10.3141/1982-03.
30. Crowley-Koch, B. J., R. Van Houten, and E. Lim. Effects of Pedestrian Prompts on Motorist Yielding At Crosswalks. *Journal of Applied Behavior Analysis*, Vol. 44, No. 1, 2011, pp. 121–126. https://doi.org/10.1901/jaba.2011.44-121.
31. Van Houten, R., J. Laplante, and T. Gustafson. *Evaluating Pedestrian Safety Improvements*. 2012.
32. Fitzpatrick, K., S. Turner, and M. A. Brewer. Improving Pedestrian Safety at Unsignalized Intersections. *ITE Journal (Institute of Transportation Engineers)*, Vol. 77, No. 5, 2007, pp. 34–41. https://doi.org/10.17226/13962.
33. Stapleton, S., T. Kirsch, T. J. Gates, and P. T. Savolainen. Factors Affecting Driver

Yielding Compliance at Uncontrolled Midblock Crosswalks on Low-Speed Roadways. *Transportation Research Record: Journal of the Transportation Research Board*, No. 2661, 2017, pp. 95–102. https://doi.org/10.3141/2661-11.

Appendix A Driver-Pedestrian Yielding Behavior Survey

This short survey is being conducted by the Center for Transportation Research at the University of Texas at Austin. By taking this survey, you are providing the research team and the City of Austin with important information regarding pedestrian-motorist interactions to help improve traffic safety in Austin.

Thank you for your time. If you have any questions regarding this survey, please contact Carolina Baumanis (cbaumanis@utexas.edu).

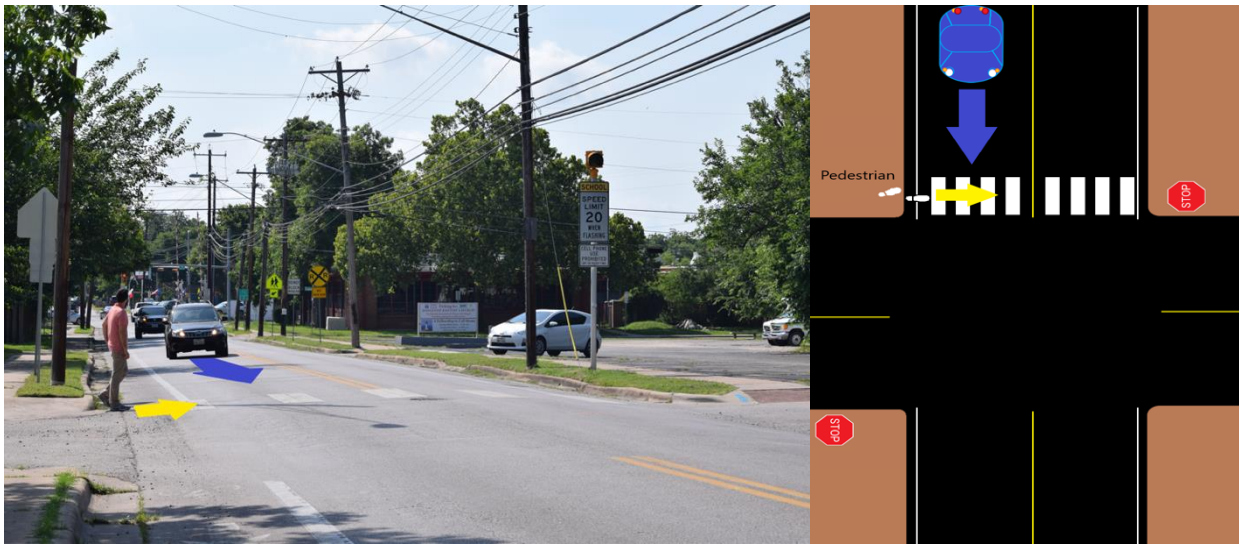
If you do not wish to take this survey, please exit out of this page.

Q1 Consider scenario A where a pedestrian is beginning to cross the street. Assume that an approaching motorist would have enough time and space to safely stop and allow the pedestrian to cross. Also, assume that the pedestrian has enough time and space to stop his crossing attempt. According to Texas state traffic laws, who should yield the right of way?

- The motorist should yield, but pedestrian crossing is **NOT legal** here
- The motorist should yield, and pedestrian crossing is legal here
- The pedestrian should yield, and pedestrian crossing is **NOT legal** here
- The pedestrian should yield, but pedestrian crossing is legal here
- I don't know who should yield in this situation (please explain)

_____

Q2 Consider scenario B where a pedestrian is beginning to cross the street. Assume that an approaching motorist would have enough time and space to safely stop and allow the pedestrian to cross. Also, assume that the pedestrian has enough time and space to stop his crossing attempt. According to Texas state traffic laws, who should yield the right of way?



- The motorist should yield, but pedestrian crossing is NOT legal here
- The motorist should yield, and pedestrian crossing is legal here
- The pedestrian should yield, and pedestrian crossing is NOT legal here
- The pedestrian should yield, but pedestrian crossing is legal here
- I don't know who should yield in this situation (please explain)

Q3 Consider scenario C where a pedestrian is beginning to cross the street. Assume that an approaching motorist would have enough time and space to safely stop and allow the pedestrian to cross. Also, assume that the pedestrian has enough space to stop his crossing attempt. According to Texas state traffic laws, who should yield the right of way?

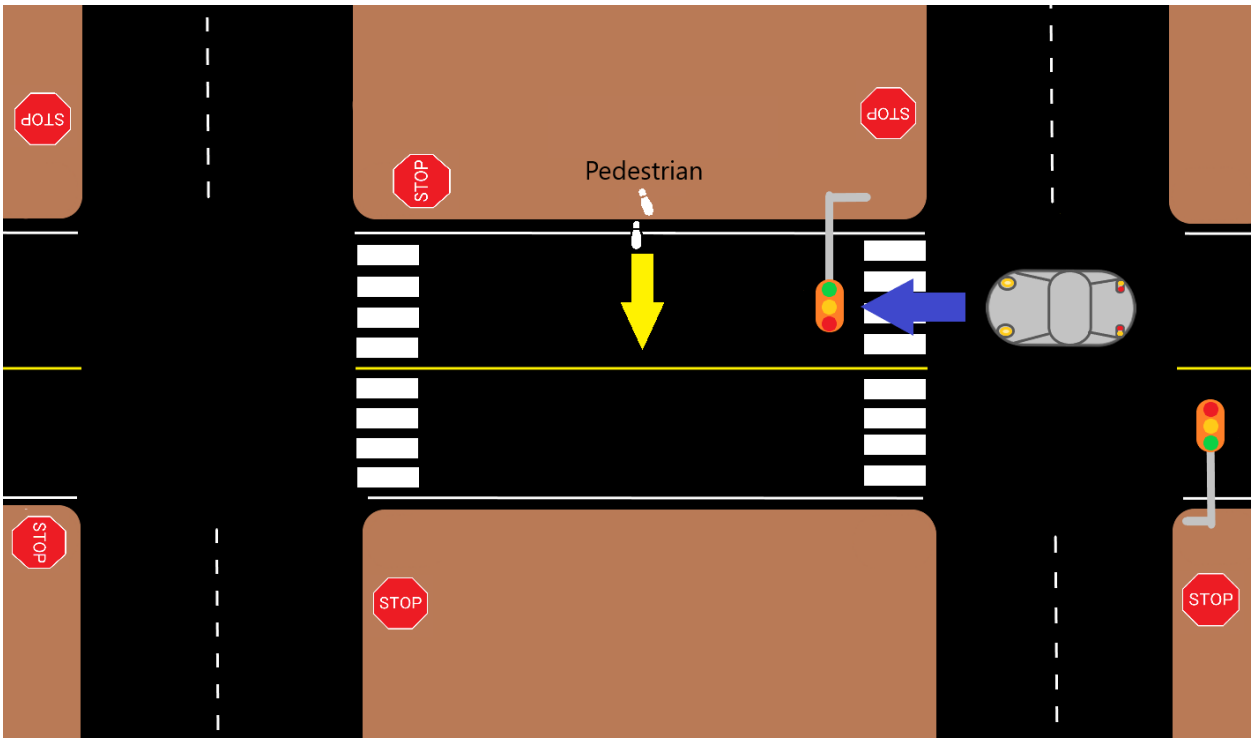
- The motorist should yield, but pedestrian crossing is NOT legal here
- The motorist should yield, and pedestrian crossing is legal here
- The pedestrian should yield, and pedestrian crossing is NOT legal here
- The pedestrian should yield, but pedestrian crossing is legal here
- I don't know who should yield in this situation (please explain)

Q4 Consider scenario D where a pedestrian is beginning to cross the street. Assume that an approaching motorist would have enough time and space to safely stop and allow the pedestrian to cross. Also, assume that the pedestrian has enough space to stop his crossing attempt. According to Texas state traffic laws, who should yield the right of way?

- The motorist should yield, but pedestrian crossing is NOT legal here

- The motorist should yield, and pedestrian crossing is legal here
- The pedestrian should yield, and pedestrian crossing is NOT legal here
- The pedestrian should yield, but pedestrian crossing is legal here
- I don't know who should yield in this situation (please explain)

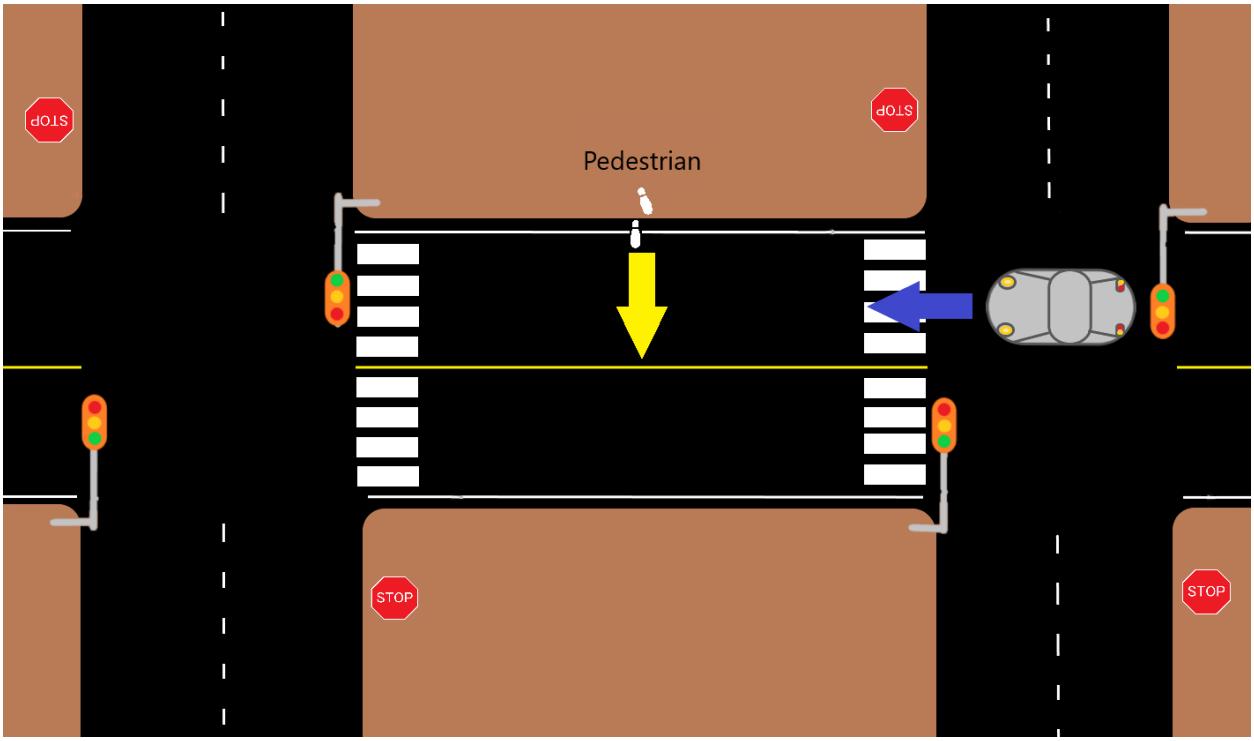
Q5 Consider scenario E where a pedestrian is beginning to cross the street. Assume that an approaching motorist would have enough time and space to safely stop and allow the pedestrian to cross. Also, assume that the pedestrian has enough space to stop his crossing attempt. According to Texas state traffic laws, who should yield the right of way?



- The motorist should yield, but pedestrian crossing is NOT legal here
- The motorist should yield, and pedestrian crossing is legal here
- The pedestrian should yield, and pedestrian crossing is NOT legal here
- The pedestrian should yield, but pedestrian crossing is legal here
- I don't know who should yield in this situation (please explain)

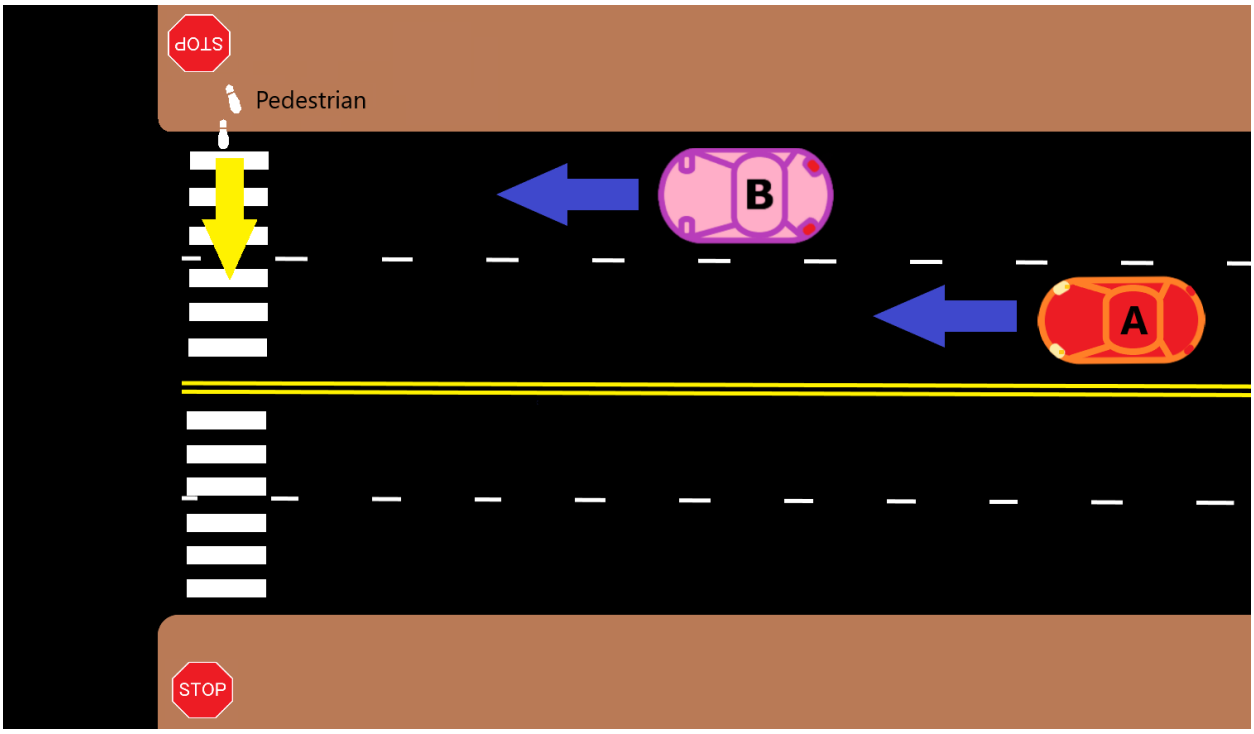
Q6 Consider scenario F where a pedestrian is beginning to cross the street. Assume that an approaching motorist would have enough time and space to safely stop and allow the pedestrian

to cross. Also, assume that the pedestrian has enough time and space to stop his crossing attempt. According to Texas state traffic laws, who should yield the right of way?



- The motorist should yield, but pedestrian crossing is NOT legal here
- The motorist should yield, and pedestrian crossing is legal here
- The pedestrian should yield, and pedestrian crossing is NOT legal here
- The pedestrian should yield, and pedestrian crossing is legal here
- I don't know who should yield in this situation (please explain)

Q7 Consider Scenario G where Car B has slowed to yield to the pedestrian while Car A is approaching the crosswalk. Assume that the motorists would have enough time and space to stop safely. Also, assume that the pedestrian has enough time and space to stop his crossing attempt. According to Texas state traffic laws, who should yield the right of way?



- The pedestrian
- Motorist A
- Motorist B
- Both motorists A and B
- I don't know who should yield in this situation (please explain)

Q8 What is your gender?

- Female
- Male
- Transgender, non-binary, or another gender

Q9 What age group are you in?

- 17 years or younger
- 18 to 24 years old
- 25 to 34 years old
- 35 to 44 years old
- 45 to 54 years old

- 55 to 64 years old
- 65 to 74 years old
- 75 years or older

Q10 What is your highest level of education?

- No schooling completed
- Nursery school
- Grades 1 through 11
- 12th grade, no diploma
- Regular high school diploma
- GED or alternative credit
- Some college credit, but less than 1 year of college
- 1 or more years of college credit, no degree
- Trade/technical/vocational training
- Associate's degree
- Bachelor's degree
- Master's degree
- Professional degree beyond Bachelor's degree
- Doctorate degree

Q11 Which best describes your race?

- American Indian or Alaska Native
- Asian
- Black or African American
- Native Hawaiian or Other Pacific Islander
- White
- Two or more races
- None of the above
- Prefer not to answer

Q12 What is your home zip code?

_____

Appendix B: Driver-Pedestrian Yielding Survey Detailed Results

Scenario A: Unmarked Crosswalk

Table B0.1 Scenario A Response Percentages by Education

#	Field	The motorist should yield, but pedestrian crossing is NOT legal here	The motorist should yield, and pedestrian crossing is legal here	The pedestrian should yield, and pedestrian crossing is NOT legal here	The pedestrian should yield, but pedestrian crossing is legal here	I don't know who should yield in this situation (please explain)	Total
Grade school or less	Grade school or less	28.57% 2	14.29% 1	14.29% 1	28.57% 2	14.29% 1	7
High School or Equivalent	High School or Equivalent	11.54% 3	26.92% 7	34.62% 9	23.08% 6	3.85% 1	26
Some college	Some college	28.23% 35	29.84% 37	24.19% 30	17.74% 22	0.00% 0	124
Associate's Degree or Trade/Technical	Associate's Degree or Trade/Technical	19.61% 10	39.22% 20	17.65% 9	23.53% 12	0.00% 0	51
Bachelor's Degree	Bachelor's Degree	26.08% 97	29.30% 109	19.89% 74	23.12% 86	1.61% 6	372
Graduate Degree	Graduate Degree	21.34% 70	36.89% 121	16.16% 53	23.48% 77	2.13% 7	328

Showing rows 1 - 6 of 6

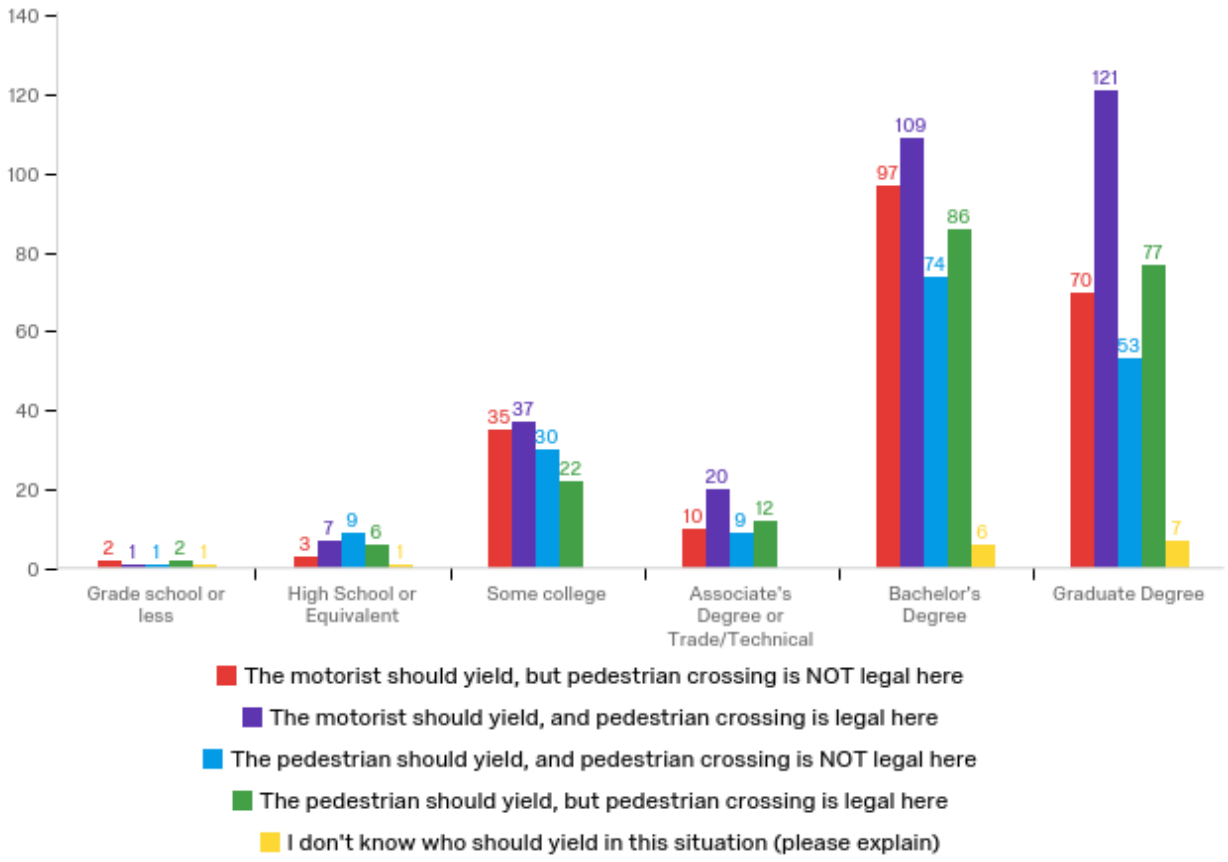

140
120
100
80
60
40
20
0
2 1 1 2 1
3 7 9 6 1
35 37 30 22
10 20 9 12
97 109 74 86 6
70 121 53 77 7
Grade school or less
High School or Equivalent
Some college
Associate's Degree or Trade/Technical
Bachelor's Degree
Graduate Degree
The motorist should yield, but pedestrian crossing is NOT legal here
The motorist should yield, and pedestrian crossing is legal here
The pedestrian should yield, and pedestrian crossing is NOT legal here
The pedestrian should yield, but pedestrian crossing is legal here
I don't know who should yield in this situation (please explain)

Figure B0.1 Scenario A Response Counts by Education

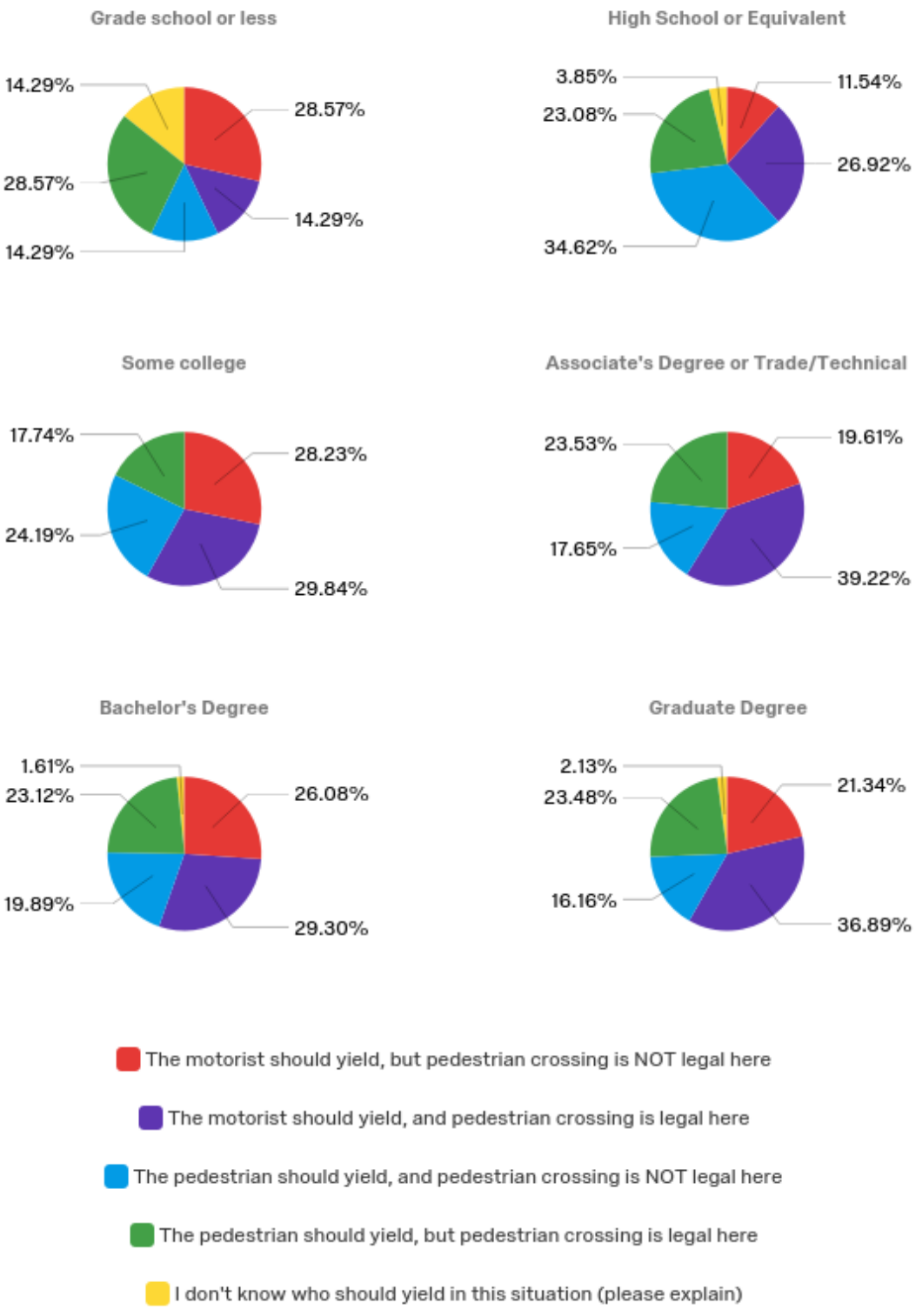


Figure B0.2 Scenario A Response by Education

Table B0.2 Scenario A Response Percentages by Age

Field	The motorist should yield, but pedestrian crossing is NOT legal here	The motorist should yield, and pedestrian crossing is legal here	The pedestrian should yield, and pedestrian crossing is NOT legal here	The pedestrian should yield, but pedestrian crossing is legal here	I don't know who should yield in this situation (please explain)	Total
55 to 74	17.02% 56	38.30% 126	18.24% 60	25.23% 83	1.22% 4	329
35 to 54	27.01% 101	31.28% 117	17.11% 64	22.99% 86	1.60% 6	374
25 to 34	32.00% 48	22.67% 34	23.33% 35	19.33% 29	2.67% 4	150
75 or older	22.50% 9	37.50% 15	25.00% 10	15.00% 6	0.00% 0	40
24 and younger	20.00% 3	20.00% 3	46.67% 7	6.67% 1	6.67% 1	15

Showing rows 1 - 5 of 5

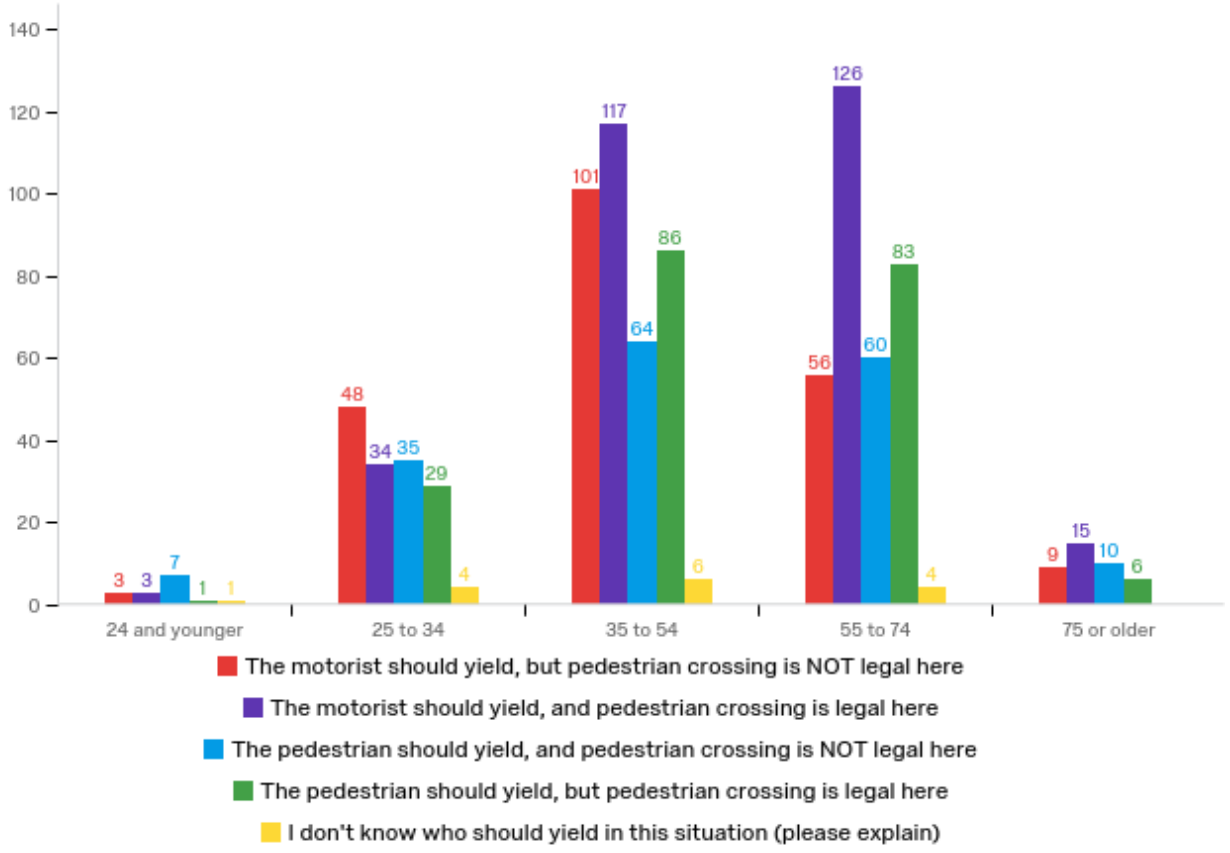


Figure B0.3 Scenario A Response Counts by Education

Figure B0.4 Scenario A Response by Race

Table B0.3 Scenario A Response Percentages by Race

#	Field	The motorist should yield, but pedestrian crossing is NOT legal here	The motorist should yield, and pedestrian crossing is legal here	The pedestrian should yield, and pedestrian crossing is NOT legal here	The pedestrian should yield, but pedestrian crossing is legal here	I don't know who should yield in this situation (please explain)	Total
1	American Indian or Alaska Native	0.00% 0	33.33% 1	33.33% 1	0.00% 0	33.33% 1	3
2	Asian	20.83% 5	29.17% 7	25.00% 6	25.00% 6	0.00% 0	24
3	Black or African American	25.00% 3	25.00% 3	25.00% 3	25.00% 3	0.00% 0	12
4	Native Hawaiian or Other Pacific Islander	0.00% 0	100.00% 1	0.00% 0	0.00% 0	0.00% 0	1
5	White	24.52% 180	32.43% 238	18.66% 137	22.75% 167	1.63% 12	734
6	Two or more races	19.35% 6	35.48% 11	22.58% 7	19.35% 6	3.23% 1	31
7	None of the above	11.11% 3	29.63% 8	33.33% 9	25.93% 7	0.00% 0	27
8	Prefer not to answer	26.32% 20	34.21% 26	17.11% 13	21.05% 16	1.32% 1	76

Showing rows 1 - 8 of 8

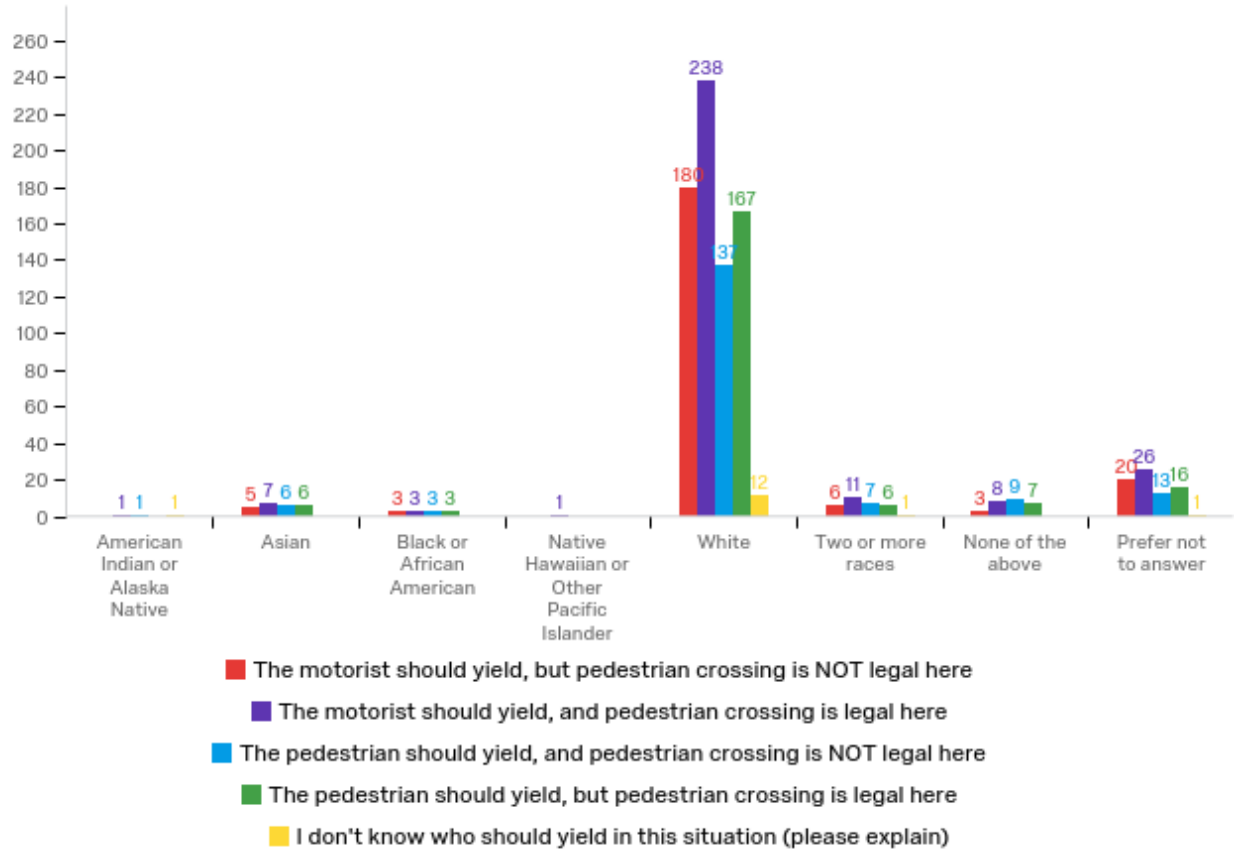


Figure B0.5 Scenario A Response Counts by Race

Table B0.4 Scenario A Response Percentages by Gender

#	Field	The motorist should yield, but pedestrian crossing is NOT legal here	The motorist should yield, and pedestrian crossing is legal here	The pedestrian should yield, and pedestrian crossing is NOT legal here	The pedestrian should yield, but pedestrian crossing is legal here	I don't know who should yield in this situation (please explain)	Total
1	Female	26.55% 146	28.73% 158	21.82% 120	20.73% 114	2.18% 12	550
2	Male	19.32% 68	38.92% 137	15.63% 55	25.57% 90	0.57% 2	352
3	Transgender, non-binary, or another gender	50.00% 3	0.00% 0	16.67% 1	16.67% 1	16.67% 1	6

Showing rows 1 - 3 of 3

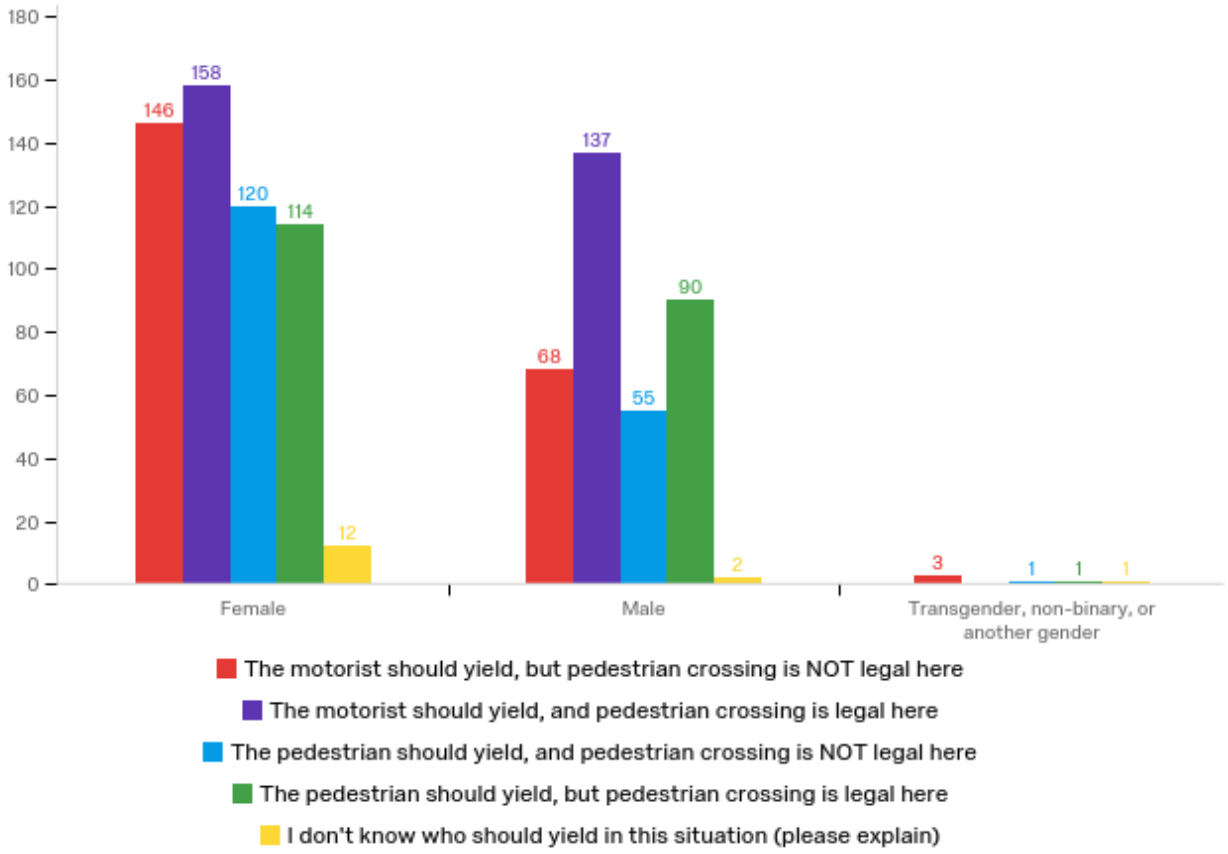


Figure B0.6 Scenario A Response Counts by Gender

Scenario B: Marked Crosswalk

Table B0.5 Scenario B Response Percentages by Education

#	Field	The motorist should yield, but pedestrian crossing is NOT legal here	The motorist should yield, and pedestrian crossing is legal here	The pedestrian should yield, and pedestrian crossing is NOT legal here	The pedestrian should yield, but pedestrian crossing is legal here	I don't know who should yield in this situation (please explain)	Total
Grade school or less	Grade school or less	0.00% 0	71.43% 5	0.00% 0	14.29% 1	14.29% 1	7
High School or Equivalent	High School or Equivalent	3.85% 1	65.38% 17	3.85% 1	26.92% 7	0.00% 0	26
Some college	Some college	3.23% 4	79.03% 98	2.42% 3	15.32% 19	0.00% 0	124
Associate's Degree or Trade/Technical	Associate's Degree or Trade/Technical	1.96% 1	84.31% 43	0.00% 0	13.73% 7	0.00% 0	51
Bachelor's Degree	Bachelor's Degree	0.27% 1	89.52% 333	0.54% 2	9.41% 35	0.27% 1	372
Graduate Degree	Graduate Degree	0.91% 3	88.72% 291	0.30% 1	9.45% 31	0.61% 2	328

Showing rows 1 - 6 of 6

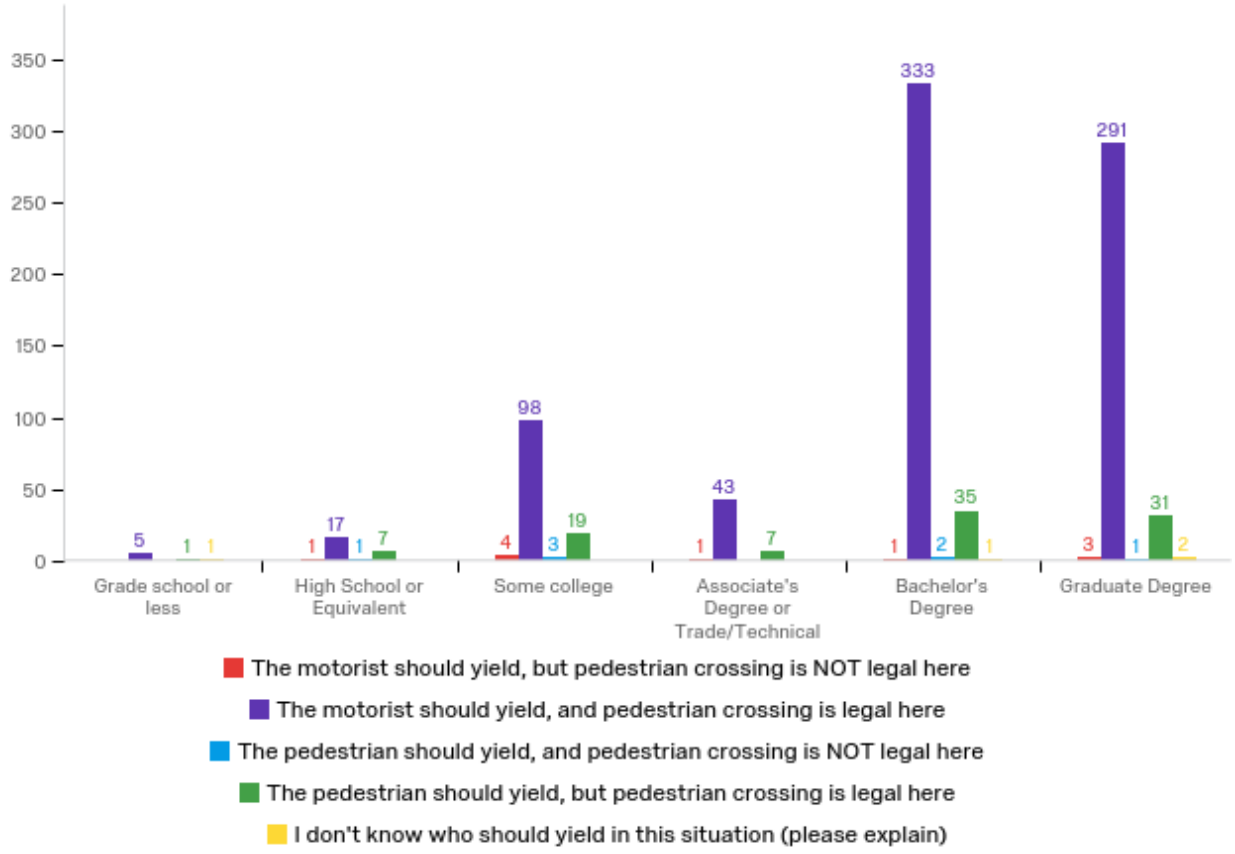


Figure B0.7 Scenario B Response Counts by Education

Table B0.6 Scenario B Response Percentages by Age

#	Field	The motorist should yield, but pedestrian crossing is NOT legal here	The motorist should yield, and pedestrian crossing is legal here	The pedestrian should yield, and pedestrian crossing is NOT legal here	The pedestrian should yield, but pedestrian crossing is legal here	I don't know who should yield in this situation (please explain)	Total
55 to 74	55 to 74	1.52% 5	82.67% 272	1.22% 4	13.98% 46	0.61% 2	329
35 to 54	35 to 54	0.53% 2	90.91% 340	0.00% 0	8.29% 31	0.27% 1	374
25 to 34	25 to 34	1.33% 2	90.67% 136	0.00% 0	8.00% 12	0.00% 0	150
75 or older	75 or older	2.50% 1	72.50% 29	5.00% 2	20.00% 8	0.00% 0	40
24 and younger	24 and younger	0.00% 0	66.67% 10	6.67% 1	20.00% 3	6.67% 1	15

Showing rows 1 - 5 of 5

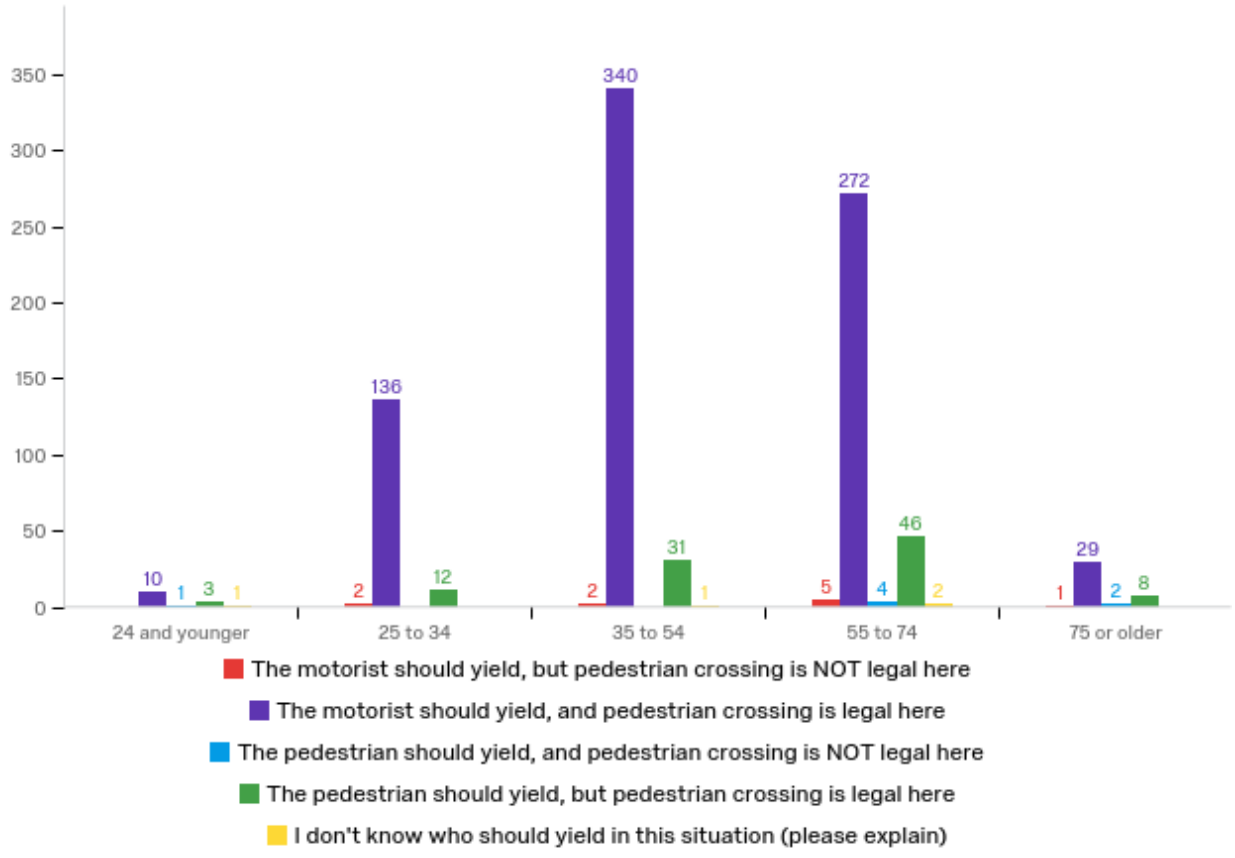


Figure B0.8 Scenario B Response Counts by Age

Table B0.7 Scenario B Response Percentages by Race

#	Field	The motorist should yield, but pedestrian crossing is NOT legal here	The motorist should yield, and pedestrian crossing is legal here	The pedestrian should yield, and pedestrian crossing is NOT legal here	The pedestrian should yield, but pedestrian crossing is legal here	I don't know who should yield in this situation (please explain)	Total
1	American Indian or Alaska Native	0.00% 0	33.33% 1	0.00% 0	33.33% 1	33.33% 1	3
2	Asian	0.00% 0	100.00% 24	0.00% 0	0.00% 0	0.00% 0	24
3	Black or African American	0.00% 0	91.67% 11	0.00% 0	8.33% 1	0.00% 0	12
4	Native Hawaiian or Other Pacific Islander	0.00% 0	100.00% 1	0.00% 0	0.00% 0	0.00% 0	1
5	White	1.23% 9	86.78% 637	0.82% 6	10.76% 79	0.41% 3	734
6	Two or more races	0.00% 0	83.87% 26	0.00% 0	16.13% 5	0.00% 0	31
7	None of the above	0.00% 0	85.19% 23	0.00% 0	14.81% 4	0.00% 0	27
8	Prefer not to answer	1.32% 1	84.21% 64	1.32% 1	13.16% 10	0.00% 0	76

Showing rows 1 - 8 of 8

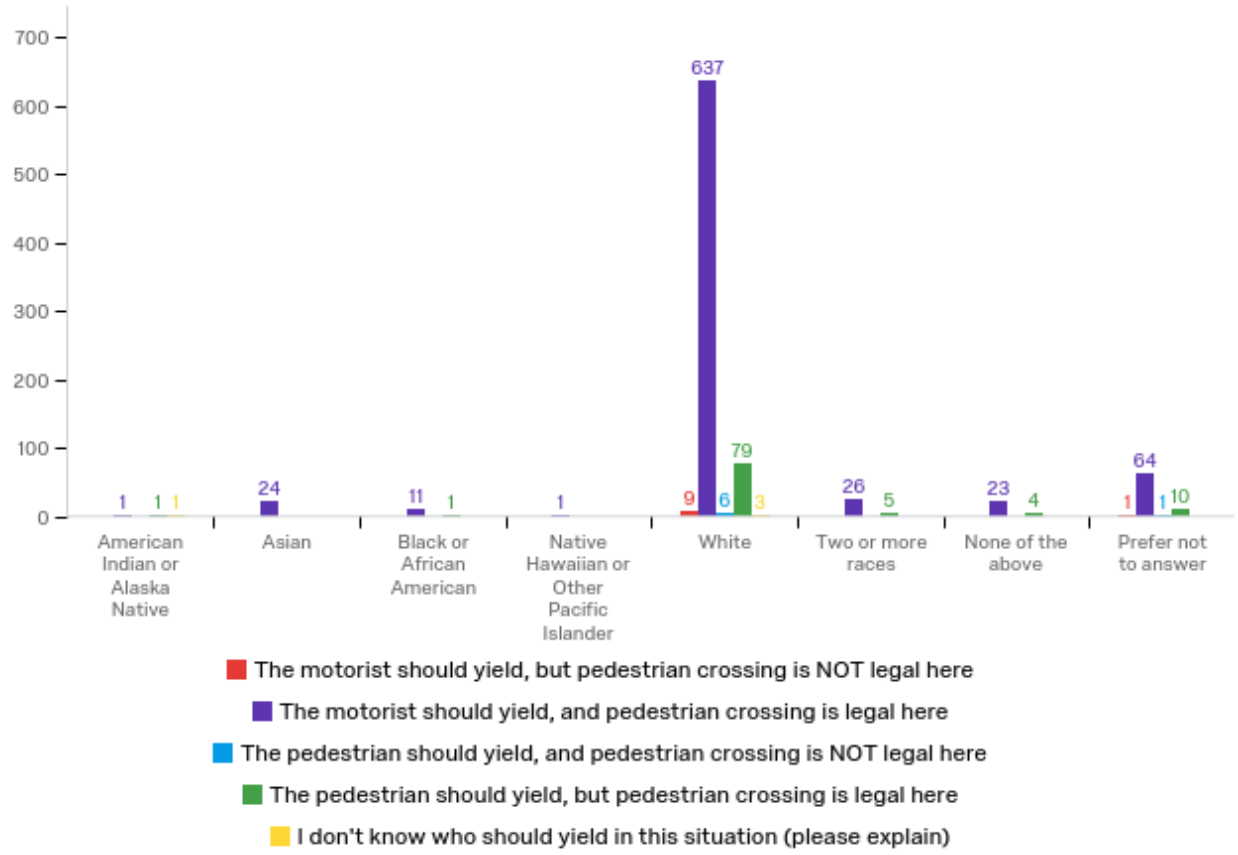


Figure B0.9 Scenario B Response Counts by Race

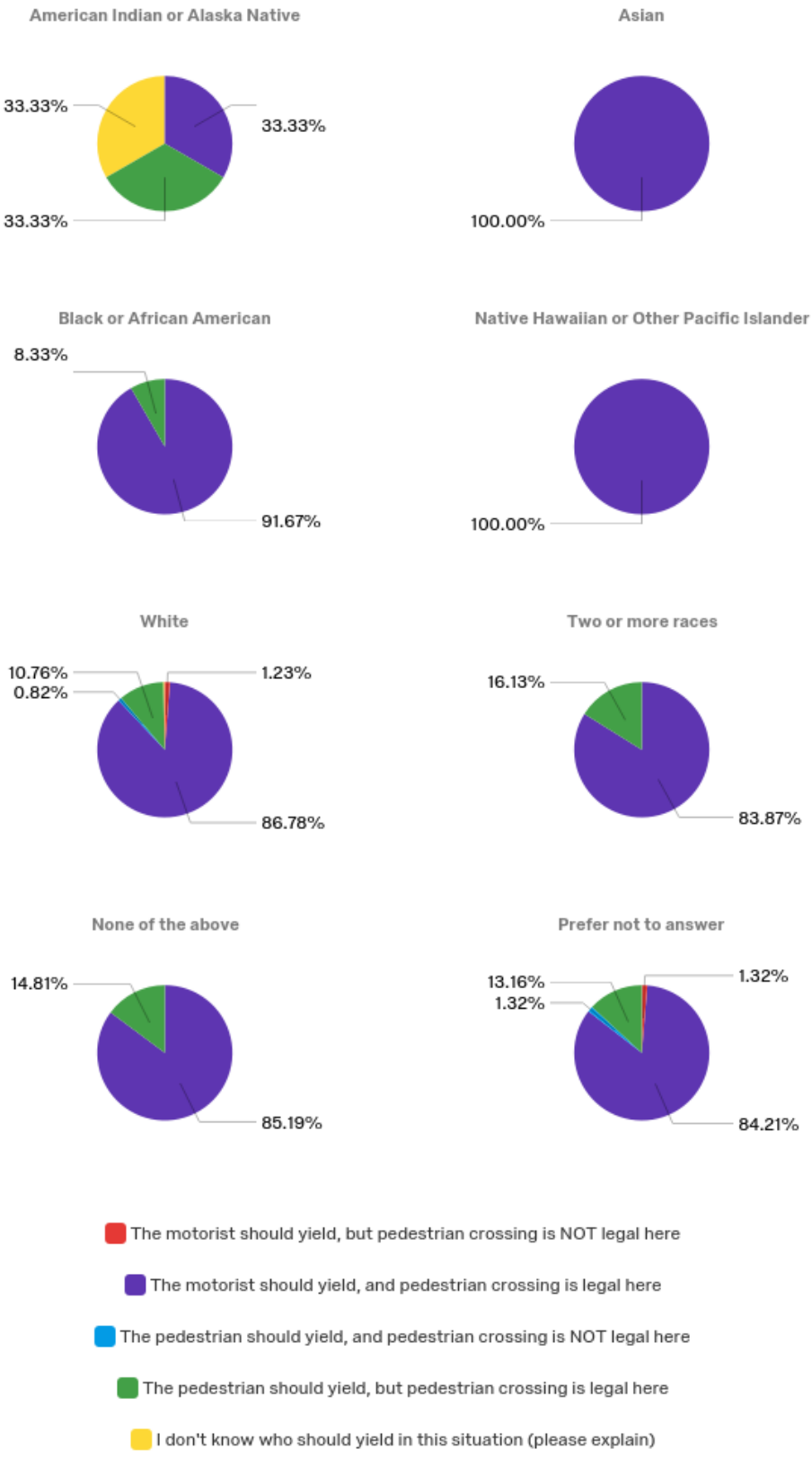


Figure B0.10 Scenario B Response by Race

Table B0.8 Scenario B Response Percentages by Gender

#	Field	The motorist should yield, but pedestrian crossing is NOT legal here	The motorist should yield, and pedestrian crossing is legal here	The pedestrian should yield, and pedestrian crossing is NOT legal here	The pedestrian should yield, but pedestrian crossing is legal here	I don't know who should yield in this situation (please explain)	Total
1	Female	1.45% 8	86.18% 474	0.73% 4	11.27% 62	0.36% 2	550
2	Male	0.57% 2	88.07% 310	0.85% 3	10.23% 36	0.28% 1	352
3	Transgender, non-binary, or another gender	0.00% 0	50.00% 3	0.00% 0	33.33% 2	16.67% 1	6

Showing rows 1 - 3 of 3

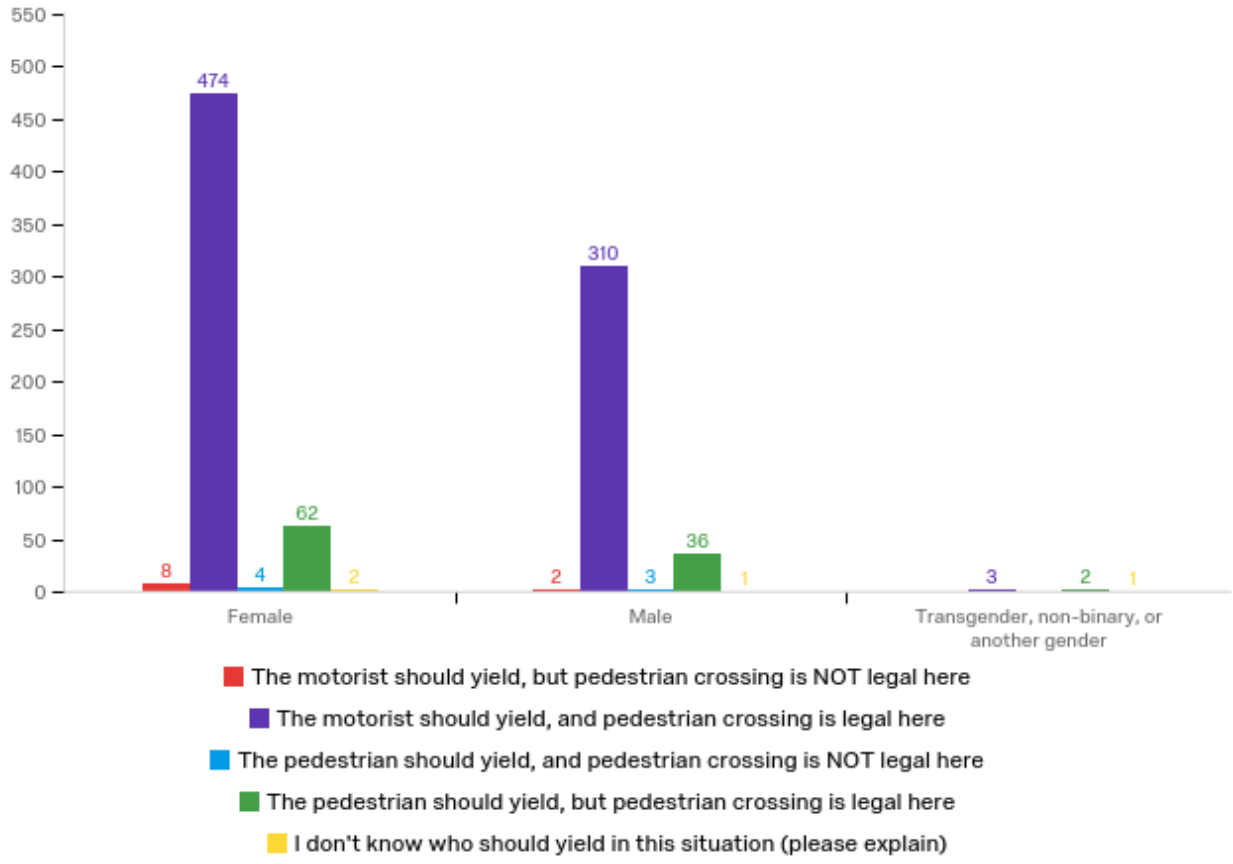


Figure B0.11 Scenario B Response Counts by Gender

Scenario C: Flexpost Island

Table B0.9 Scenario C Response Percentages by Education

Field	The motorist should yield, but pedestrian crossing is NOT legal here	The motorist should yield, and pedestrian crossing is legal here	The pedestrian should yield, and pedestrian crossing is NOT legal here	The pedestrian should yield, but pedestrian crossing is legal here	I don't know who should yield in this situation (please explain)	Total
Some college	0.81% 1	83.87% 104	0.00% 0	15.32% 19	0.00% 0	124
High School or Equivalent	3.85% 1	69.23% 18	7.69% 2	19.23% 5	0.00% 0	26
Graduate Degree	0.00% 0	93.60% 307	0.30% 1	5.79% 19	0.30% 1	328
Grade school or less	0.00% 0	71.43% 5	0.00% 0	14.29% 1	14.29% 1	7
Bachelor's Degree	0.81% 3	92.20% 343	0.00% 0	6.99% 26	0.00% 0	372
Associate's Degree or Trade/Technical	1.96% 1	90.20% 46	0.00% 0	5.88% 3	1.96% 1	51

Showing rows 1 - 6 of 6

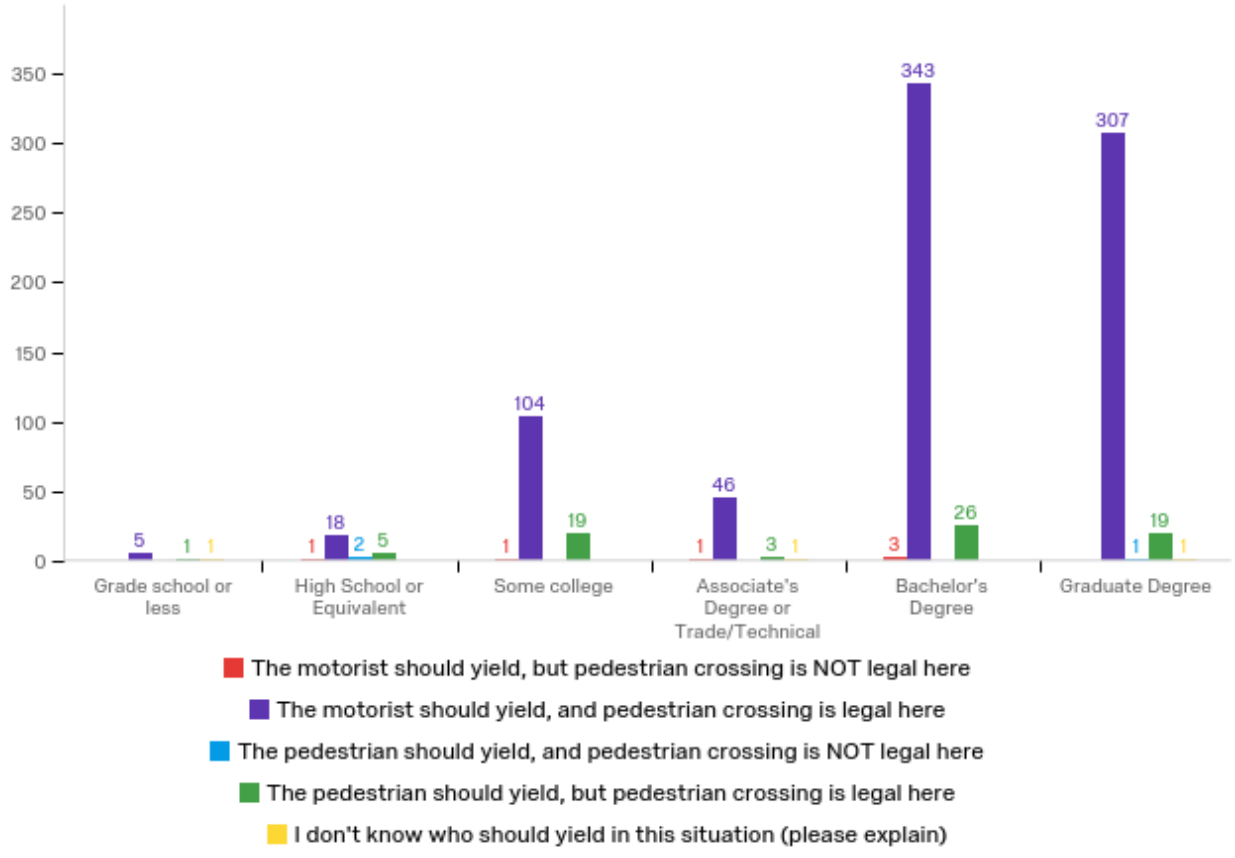


Figure B0.12 Scenario C Response Counts by Education

Table B0.10 Scenario C Response Percentages by Age

#	Field	The motorist should yield, but pedestrian crossing is NOT legal here	The motorist should yield, and pedestrian crossing is legal here	The pedestrian should yield, and pedestrian crossing is NOT legal here	The pedestrian should yield, but pedestrian crossing is legal here	I don't know who should yield in this situation (please explain)	Total
24 and younger	24 and younger	0.00% 0	80.00% 12	6.67% 1	6.67% 1	6.67% 1	15
25 to 34	25 to 34	0.00% 0	96.67% 145	0.00% 0	3.33% 5	0.00% 0	150
35 to 54	35 to 54	0.53% 2	90.91% 340	0.00% 0	8.02% 30	0.53% 2	374
55 to 74	55 to 74	1.22% 4	89.36% 294	0.61% 2	8.81% 29	0.00% 0	329
75 or older	75 or older	0.00% 0	80.00% 32	0.00% 0	20.00% 8	0.00% 0	40

Showing rows 1 - 5 of 5

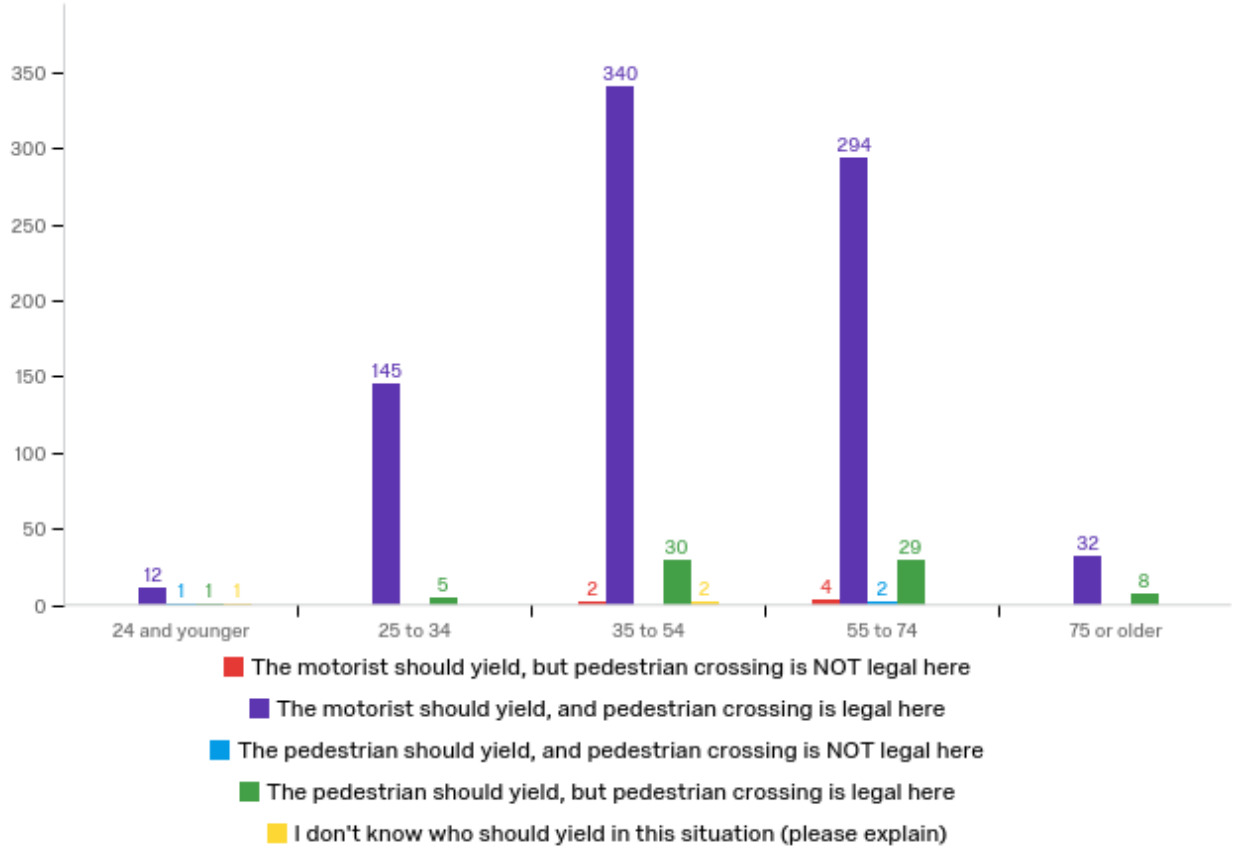


Figure B0.13 Scenario C Response Counts by Age

Table B0.11 Scenario C Response Percentages by Race

#	Field	The motorist should yield, but pedestrian crossing is NOT legal here	The motorist should yield, and pedestrian crossing is legal here	The pedestrian should yield, and pedestrian crossing is NOT legal here	The pedestrian should yield, but pedestrian crossing is legal here	I don't know who should yield in this situation (please explain)	Total
1	American Indian or Alaska Native	0.00% 0	33.33% 1	0.00% 0	33.33% 1	33.33% 1	3
2	Asian	0.00% 0	95.83% 23	0.00% 0	4.17% 1	0.00% 0	24
3	Black or African American	8.33% 1	91.67% 11	0.00% 0	0.00% 0	0.00% 0	12
4	Native Hawaiian or Other Pacific Islander	0.00% 0	100.00% 1	0.00% 0	0.00% 0	0.00% 0	1
5	White	0.54% 4	91.28% 670	0.27% 2	7.77% 57	0.14% 1	734
6	Two or more races	0.00% 0	80.65% 25	3.23% 1	12.90% 4	3.23% 1	31
7	None of the above	3.70% 1	81.48% 22	0.00% 0	14.81% 4	0.00% 0	27
8	Prefer not to answer	0.00% 0	92.11% 70	0.00% 0	7.89% 6	0.00% 0	76

Showing rows 1 - 8 of 8

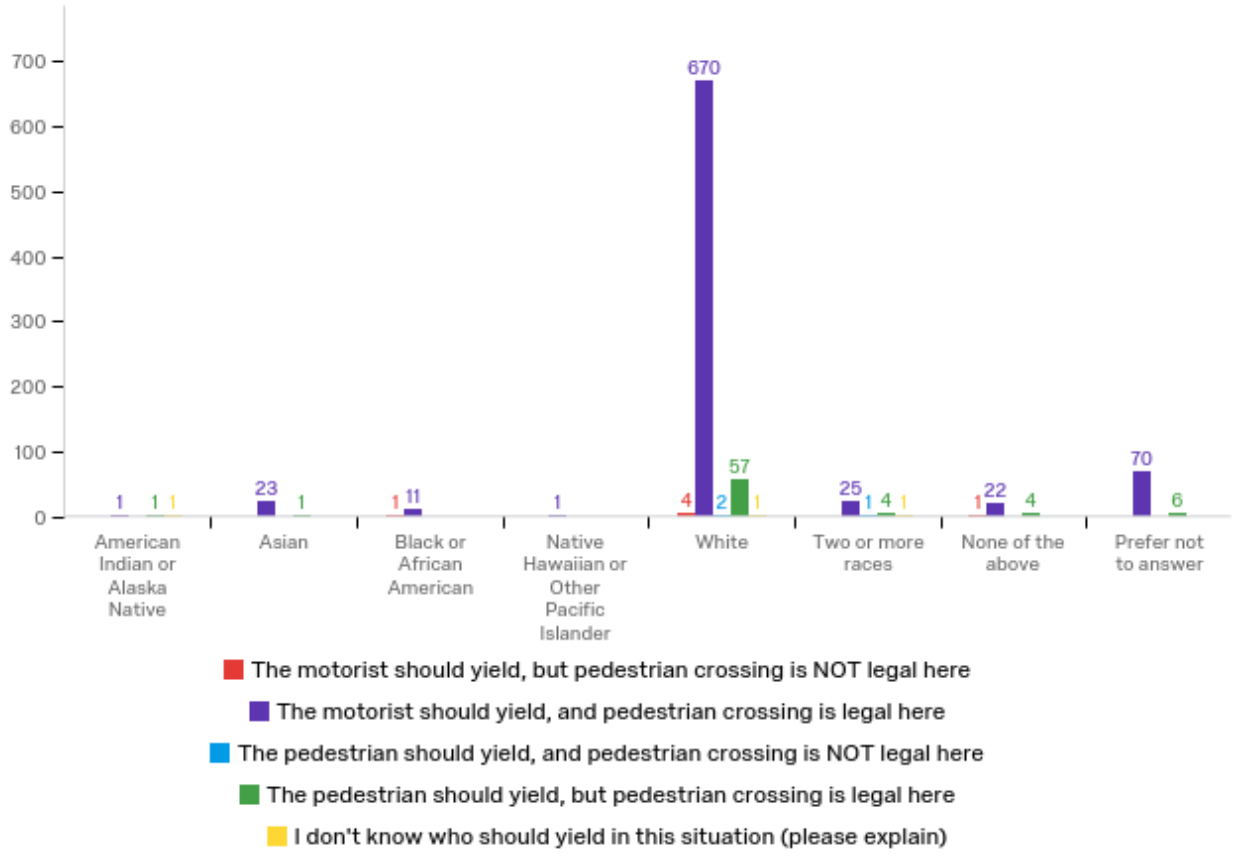


Figure B0.14 Scenario C Response Counts by Race

Table B0.12 Scenario C Response Percentages by Gender

#	Field	The motorist should yield, but pedestrian crossing is NOT legal here	The motorist should yield, and pedestrian crossing is legal here	The pedestrian should yield, and pedestrian crossing is NOT legal here	The pedestrian should yield, but pedestrian crossing is legal here	I don't know who should yield in this situation (please explain)	Total
1	Female	0.91% 5	90.00% 495	0.36% 2	8.36% 46	0.36% 2	550
2	Male	0.28% 1	92.33% 325	0.28% 1	6.82% 24	0.28% 1	352
3	Transgender, non-binary, or another gender	0.00% 0	50.00% 3	0.00% 0	50.00% 3	0.00% 0	6

Showing rows 1 - 3 of 3

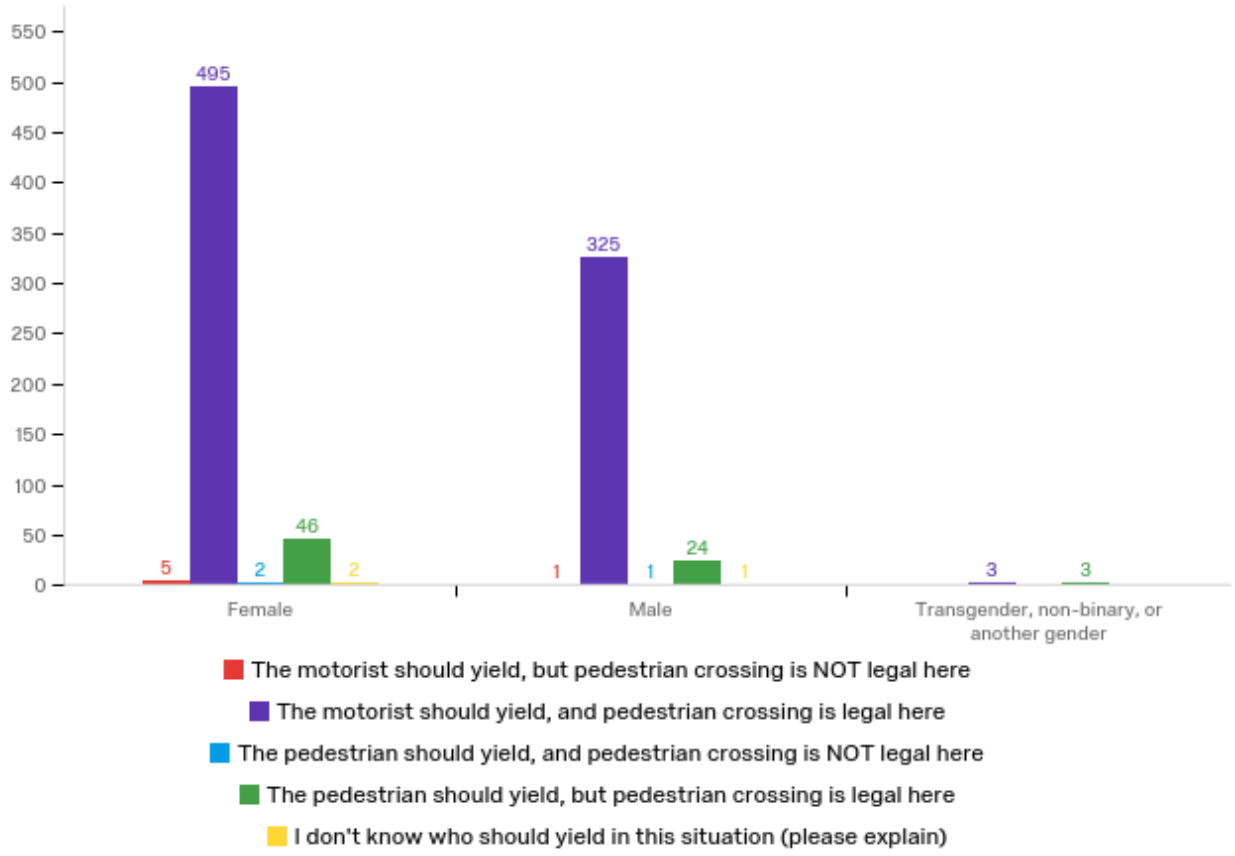


Figure B0.15 Scenario C Response Counts by Gender

Scenario D: Concrete Refuge Island

Table B0.13 Scenario D Response Percentages by Education

Field	The motorist should yield, but pedestrian crossing is NOT legal here	The motorist should yield, and pedestrian crossing is legal here	The pedestrian should yield, and pedestrian crossing is NOT legal here	The pedestrian should yield, but pedestrian crossing is legal here	I don't know who should yield in this situation (please explain)	Total
Grade school or less	0.00% 0	71.43% 5	0.00% 0	14.29% 1	14.29% 1	7
High School or Equivalent	3.85% 1	73.08% 19	7.69% 2	15.38% 4	0.00% 0	26
Some college	0.81% 1	87.10% 108	0.00% 0	12.10% 15	0.00% 0	124
Associate's Degree or Trade/Technical	3.92% 2	90.20% 46	0.00% 0	5.88% 3	0.00% 0	51
Bachelor's Degree	0.27% 1	90.32% 336	0.27% 1	7.80% 29	1.34% 5	372
Graduate Degree	0.00% 0	92.99% 305	0.00% 0	6.71% 22	0.30% 1	328

Showing rows 1 - 6 of 6

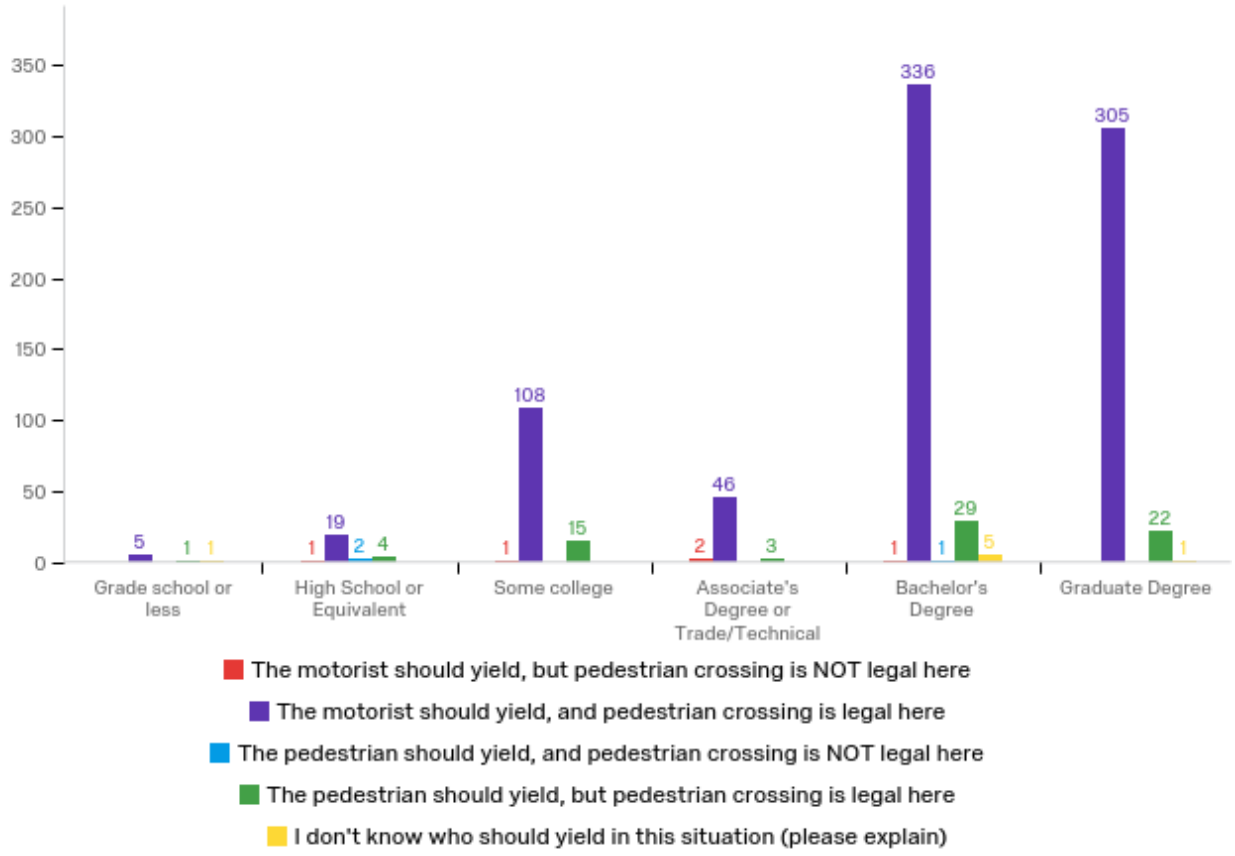


Figure B0.16 Scenario D Response Counts by Education

Table B0.14 Scenario D Response Percentages by Age

Field	The motorist should yield, but pedestrian crossing is NOT legal here	The motorist should yield, and pedestrian crossing is legal here	The pedestrian should yield, and pedestrian crossing is NOT legal here	The pedestrian should yield, but pedestrian crossing is legal here	I don't know who should yield in this situation (please explain)	Total
55 to 74	0.91% 3	87.84% 289	0.61% 2	9.73% 32	0.91% 3	329
35 to 54	0.53% 2	92.51% 346	0.00% 0	6.42% 24	0.53% 2	374
25 to 34	0.00% 0	93.33% 140	0.00% 0	6.00% 9	0.67% 1	150
75 or older	0.00% 0	80.00% 32	0.00% 0	20.00% 8	0.00% 0	40
24 and younger	0.00% 0	80.00% 12	6.67% 1	6.67% 1	6.67% 1	15

Showing rows 1 - 5 of 5

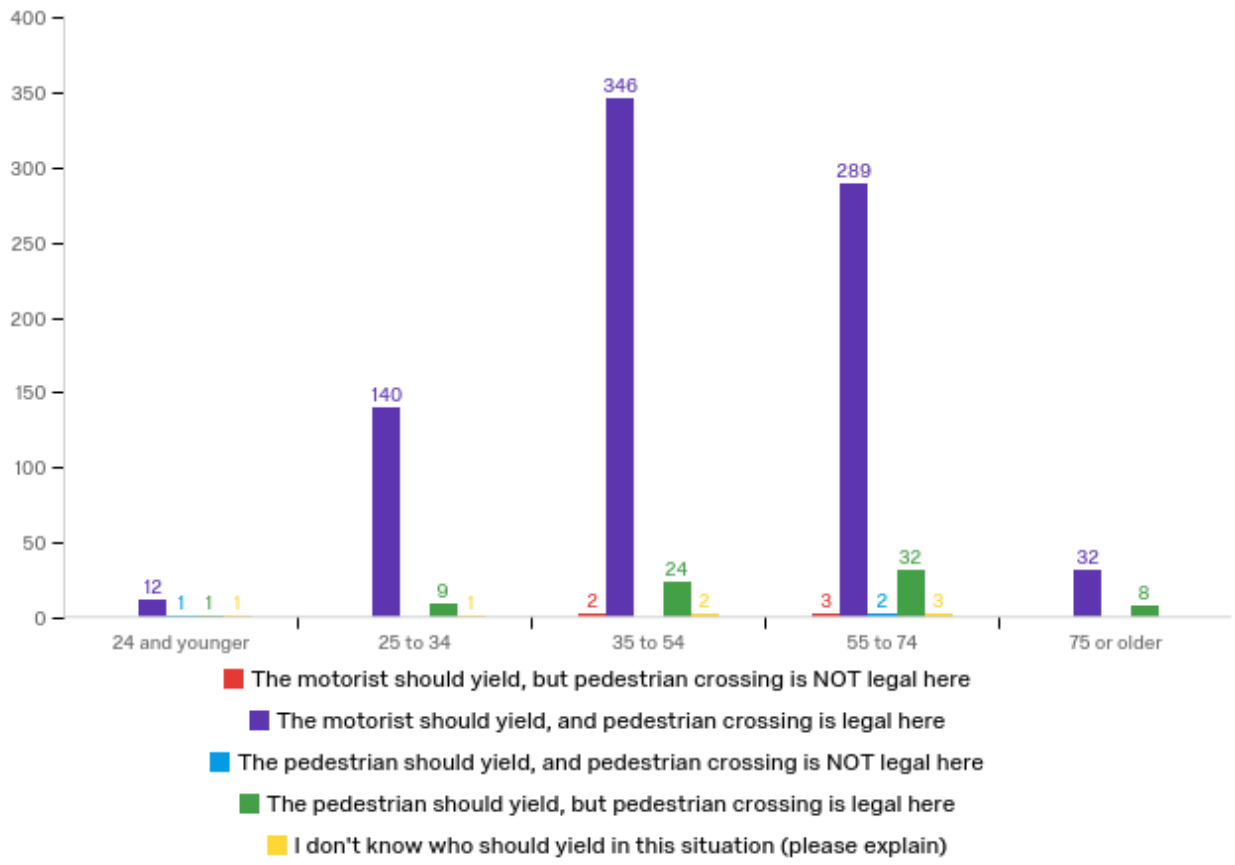


Figure B0.17 Scenario D Response Counts by Age

Table B0.15 Scenario D Response Percentages by Race

#	Field	The motorist should yield, but pedestrian crossing is NOT legal here	The motorist should yield, and pedestrian crossing is legal here	The pedestrian should yield, and pedestrian crossing is NOT legal here	The pedestrian should yield, but pedestrian crossing is legal here	I don't know who should yield in this situation (please explain)	Total
5	White	0.54% 4	90.60% 665	0.27% 2	7.90% 58	0.68% 5	734
6	Two or more races	0.00% 0	90.32% 28	3.23% 1	6.45% 2	0.00% 0	31
8	Prefer not to answer	1.32% 1	85.53% 65	0.00% 0	11.84% 9	1.32% 1	76
7	None of the above	0.00% 0	88.89% 24	0.00% 0	11.11% 3	0.00% 0	27
4	Native Hawaiian or Other Pacific Islander	0.00% 0	100.00% 1	0.00% 0	0.00% 0	0.00% 0	1
3	Black or African American	0.00% 0	100.00% 12	0.00% 0	0.00% 0	0.00% 0	12
2	Asian	0.00% 0	91.67% 22	0.00% 0	8.33% 2	0.00% 0	24
1	American Indian or Alaska Native	0.00% 0	66.67% 2	0.00% 0	0.00% 0	33.33% 1	3

Showing rows 1 - 8 of 8

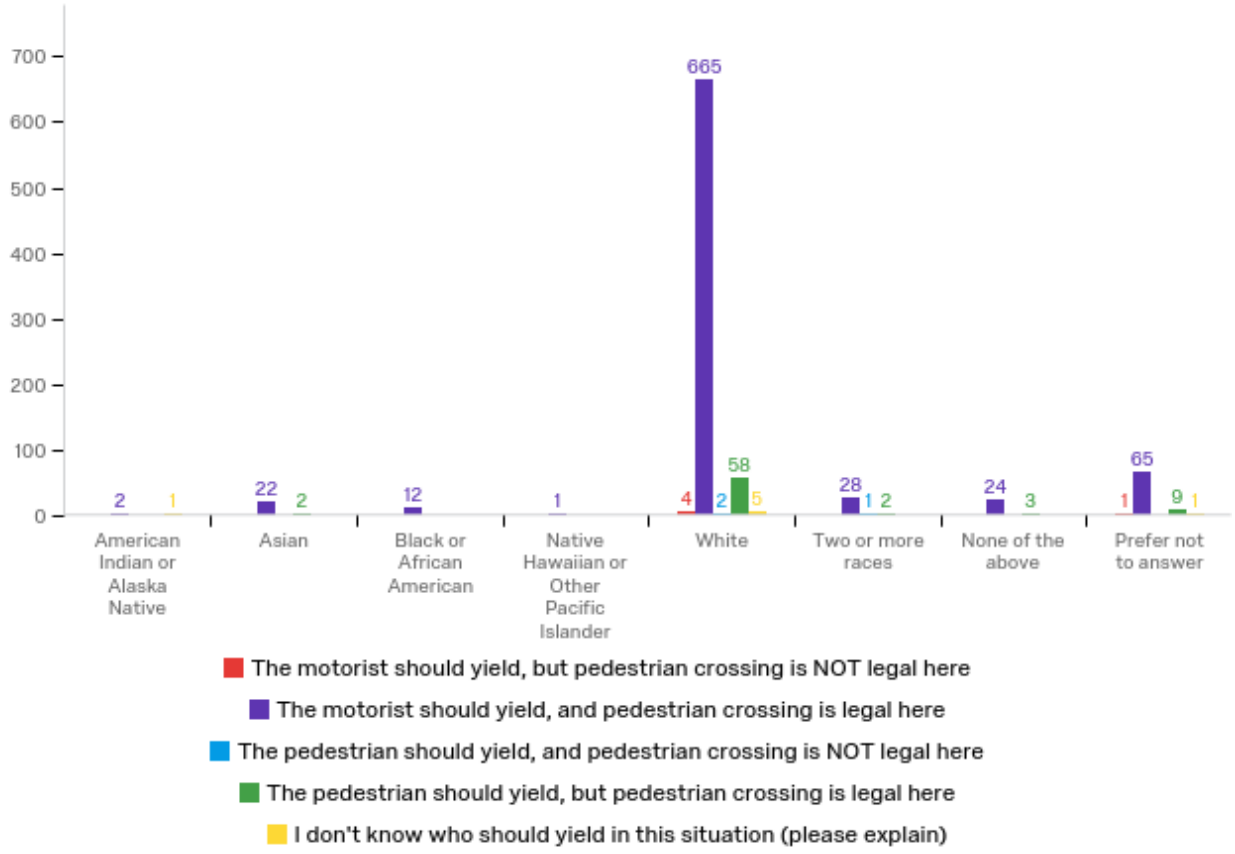
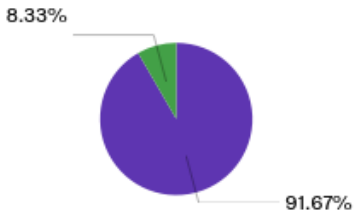


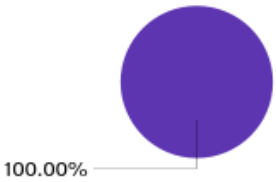
Figure B0.18 Scenario D Response Counts by Race

American Indian or Alaska Native

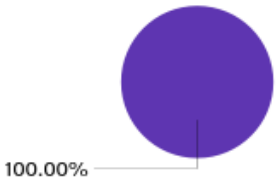
Asian



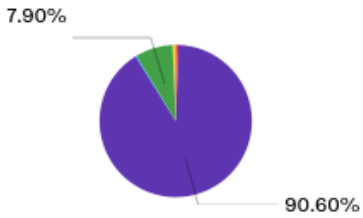
Black or African American



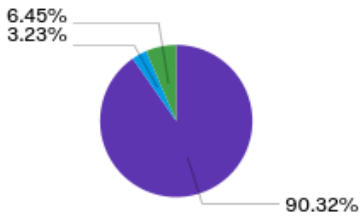
Native Hawaiian or Other Pacific Islander



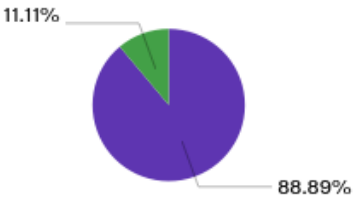
White



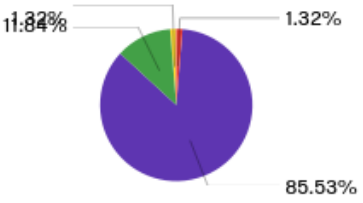
Two or more races



None of the above



Prefer not to answer



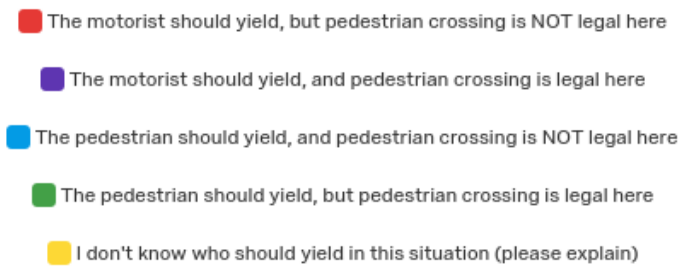


Figure B0.19 Scenario D Response by Race

Table B0.16 Scenario D Response Percentages by Gender

#	Field	The motorist should yield, but pedestrian crossing is NOT legal here	The motorist should yield, and pedestrian crossing is legal here	The pedestrian should yield, and pedestrian crossing is NOT legal here	The pedestrian should yield, but pedestrian crossing is legal here	I don't know who should yield in this situation (please explain)	Total
1	Female	0.55% 3	90.36% 497	0.36% 2	8.18% 45	0.55% 3	550
2	Male	0.57% 2	90.34% 318	0.28% 1	7.67% 27	1.14% 4	352
3	Transgender, non-binary, or another gender	0.00% 0	66.67% 4	0.00% 0	33.33% 2	0.00% 0	6

Showing rows 1 - 3 of 3

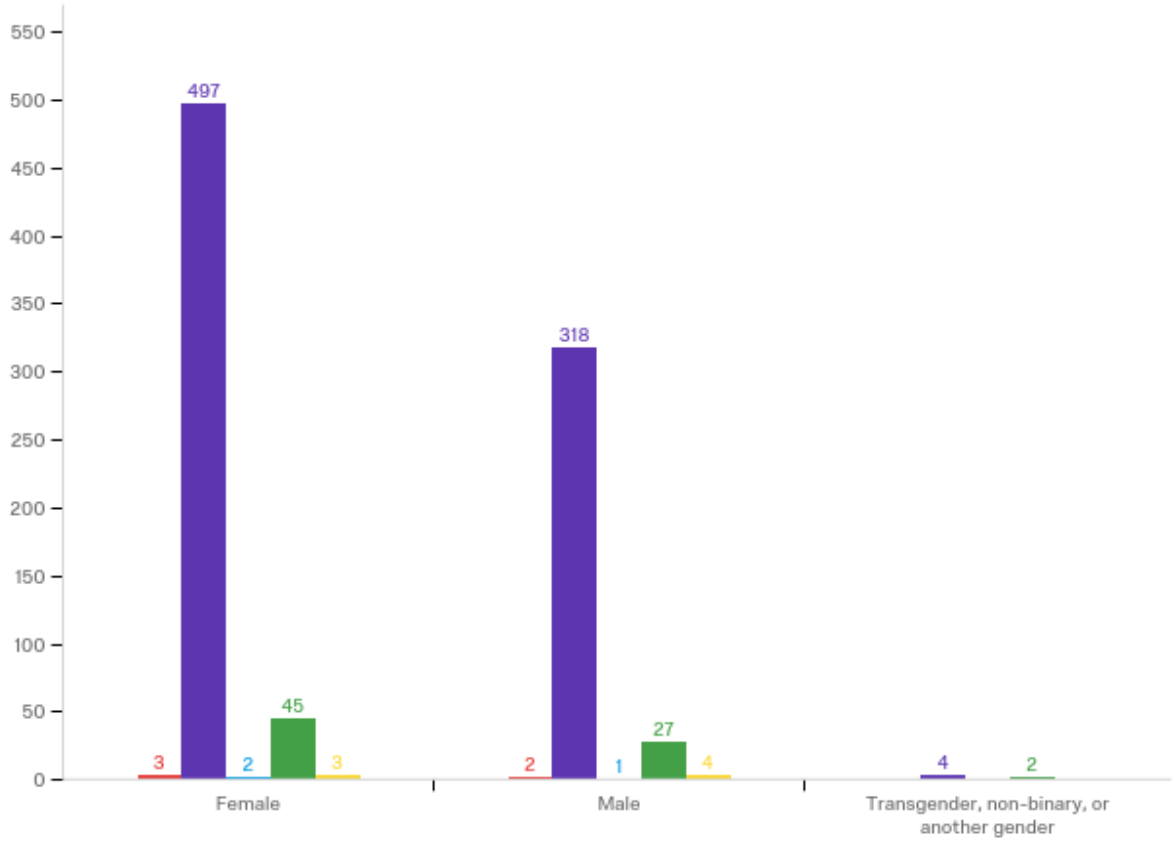


Figure B0.20 Scenario D Response Counts by Gender

Figure B0.21 Scenario D Response by Gender

Scenario E: Legal Mid-block Crossing

Table B0.17 Scenario E Response Percentages by Education

Field	The motorist should yield, but pedestrian crossing is NOT legal here	The motorist should yield, and pedestrian crossing is legal here	The pedestrian should yield, and pedestrian crossing is NOT legal here	The pedestrian should yield, but pedestrian crossing is legal here	I don't know who should yield in this situation (please explain)	Total
Associate's Degree or Trade/Technical	31.37% 16	7.84% 4	60.78% 31	0.00% 0	0.00% 0	51
Bachelor's Degree	36.02% 134	2.69% 10	59.95% 223	1.08% 4	0.27% 1	372
Grade school or less	28.57% 2	0.00% 0	57.14% 4	0.00% 0	14.29% 1	7
Graduate Degree	36.59% 120	2.13% 7	59.45% 195	1.52% 5	0.30% 1	328
High School or Equivalent	42.31% 11	7.69% 2	50.00% 13	0.00% 0	0.00% 0	26
Some college	44.35% 55	1.61% 2	50.81% 63	2.42% 3	0.81% 1	124

Showing rows 1 - 6 of 6

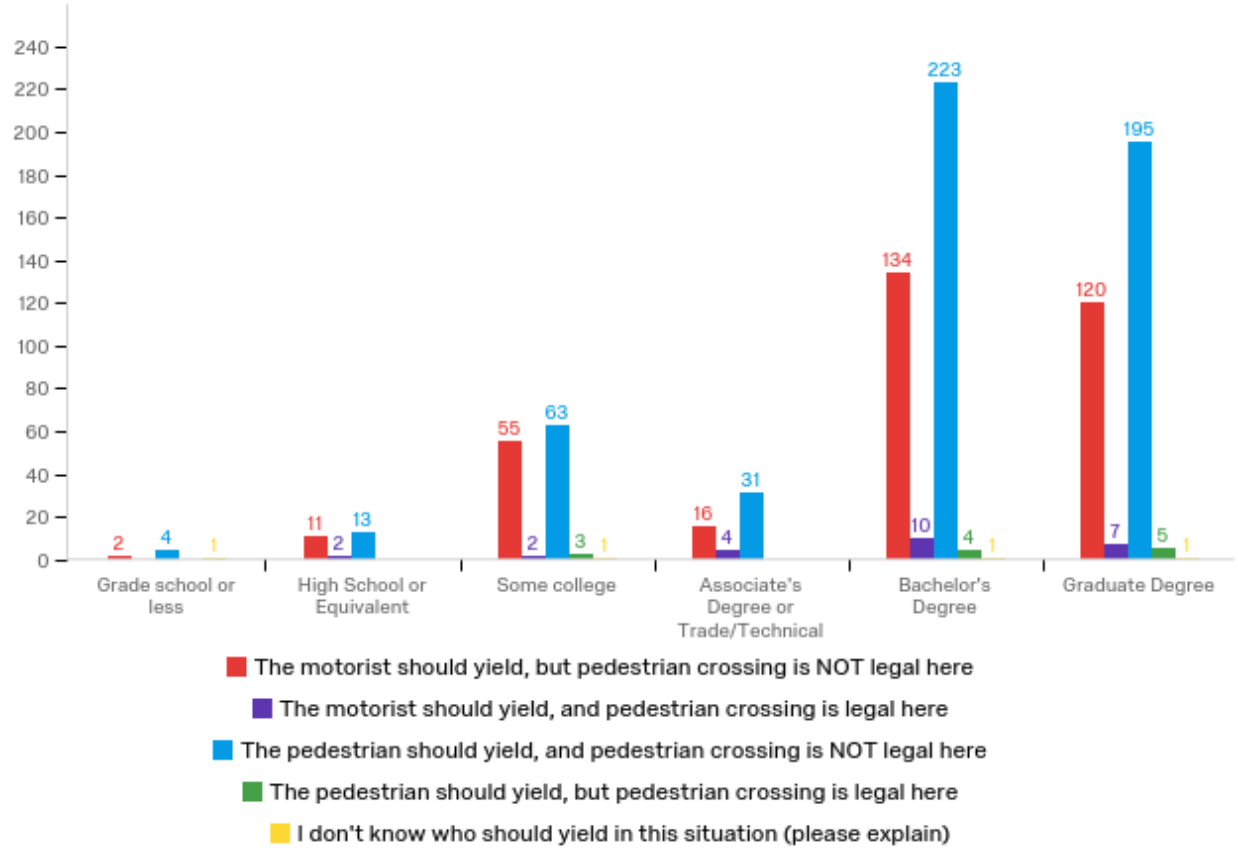


Figure B0.22 Scenario E Response Counts by Education

Table B0.18 Scenario E Response Percentages by Age

Field	The motorist should yield, but pedestrian crossing is NOT legal here	The motorist should yield, and pedestrian crossing is legal here	The pedestrian should yield, and pedestrian crossing is NOT legal here	The pedestrian should yield, but pedestrian crossing is legal here	I don't know who should yield in this situation (please explain)	Total
55 to 74	39.21% 129	2.74% 9	56.84% 187	0.91% 3	0.30% 1	329
35 to 54	36.10% 135	1.87% 7	60.43% 226	1.34% 5	0.27% 1	374
25 to 34	34.00% 51	2.67% 4	63.33% 95	0.00% 0	0.00% 0	150
75 or older	40.00% 16	7.50% 3	40.00% 16	10.00% 4	2.50% 1	40
24 and younger	46.67% 7	13.33% 2	33.33% 5	0.00% 0	6.67% 1	15

Showing rows 1 - 5 of 5

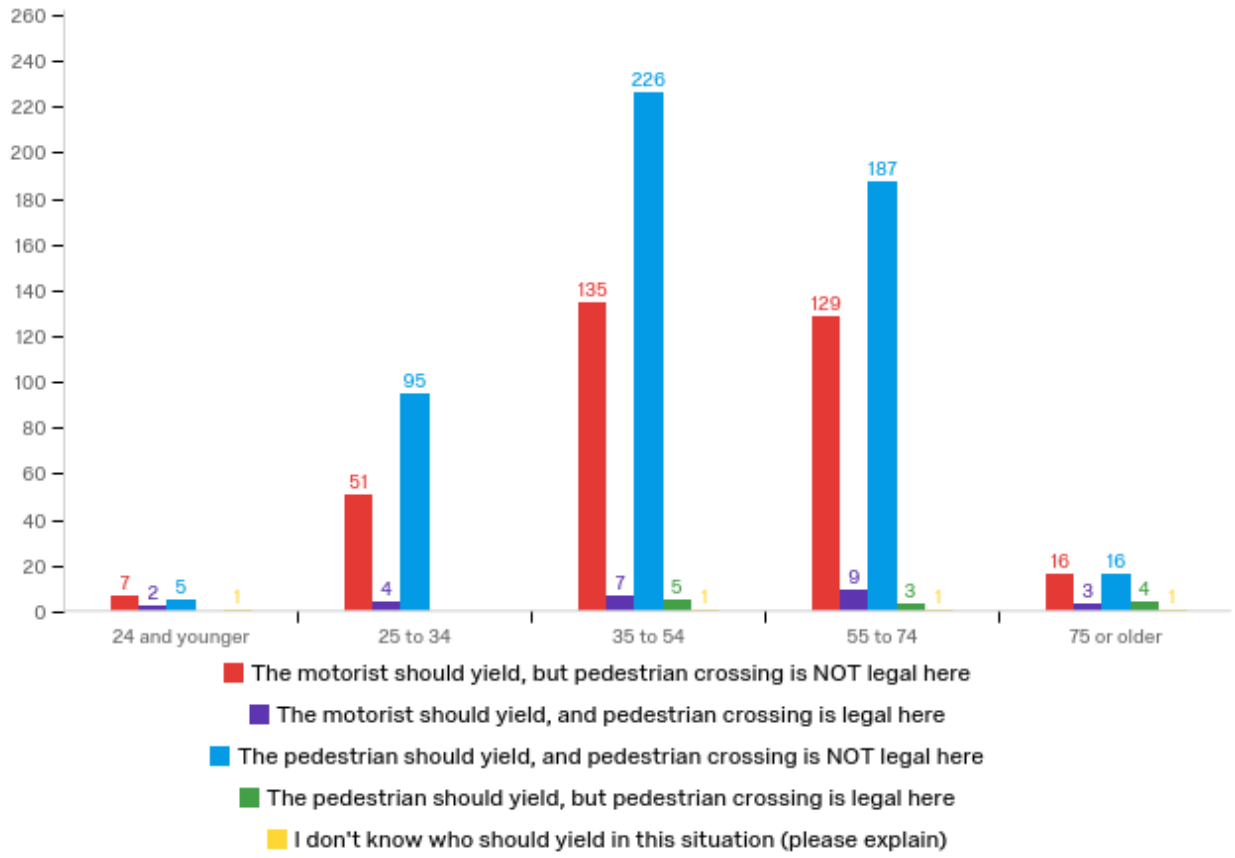


Figure B0.23 Scenario E Response Counts by Age

Table B0.19 Scenario E Response Percentages by Race

#	Field	The motorist should yield, but pedestrian crossing is NOT legal here	The motorist should yield, and pedestrian crossing is legal here	The pedestrian should yield, and pedestrian crossing is NOT legal here	The pedestrian should yield, but pedestrian crossing is legal here	I don't know who should yield in this situation (please explain)	Total
1	American Indian or Alaska Native	0.00% 0	33.33% 1	33.33% 1	0.00% 0	33.33% 1	3
2	Asian	16.67% 4	4.17% 1	79.17% 19	0.00% 0	0.00% 0	24
3	Black or African American	25.00% 3	8.33% 1	66.67% 8	0.00% 0	0.00% 0	12
4	Native Hawaiian or Other Pacific Islander	0.00% 0	0.00% 0	100.00% 1	0.00% 0	0.00% 0	1
5	White	38.83% 285	2.72% 20	56.81% 417	1.36% 10	0.27% 2	734
6	Two or more races	41.94% 13	0.00% 0	58.06% 18	0.00% 0	0.00% 0	31
7	None of the above	14.81% 4	0.00% 0	81.48% 22	3.70% 1	0.00% 0	27
8	Prefer not to answer	38.16% 29	2.63% 2	56.58% 43	1.32% 1	1.32% 1	76

Showing rows 1 - 8 of 8

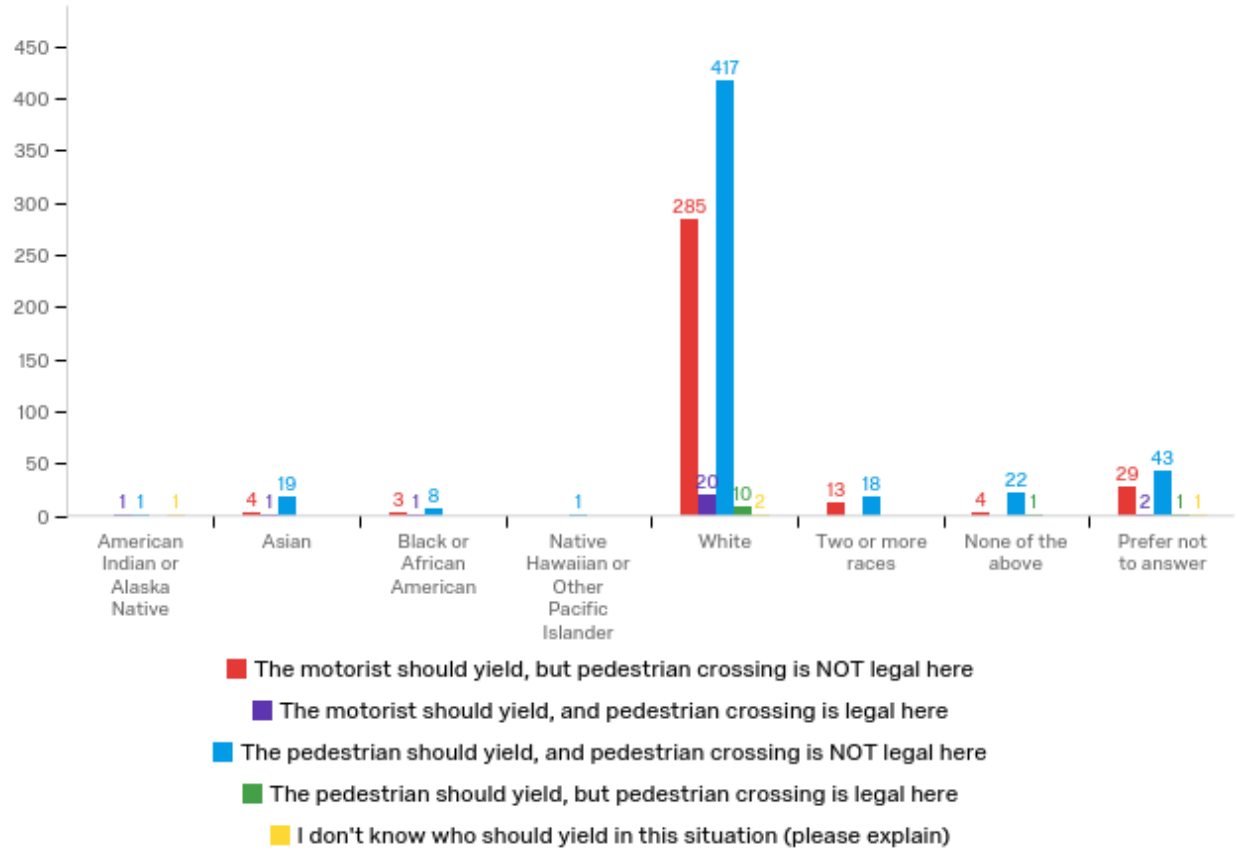


Figure B0.24 Scenario E Response Counts by Race

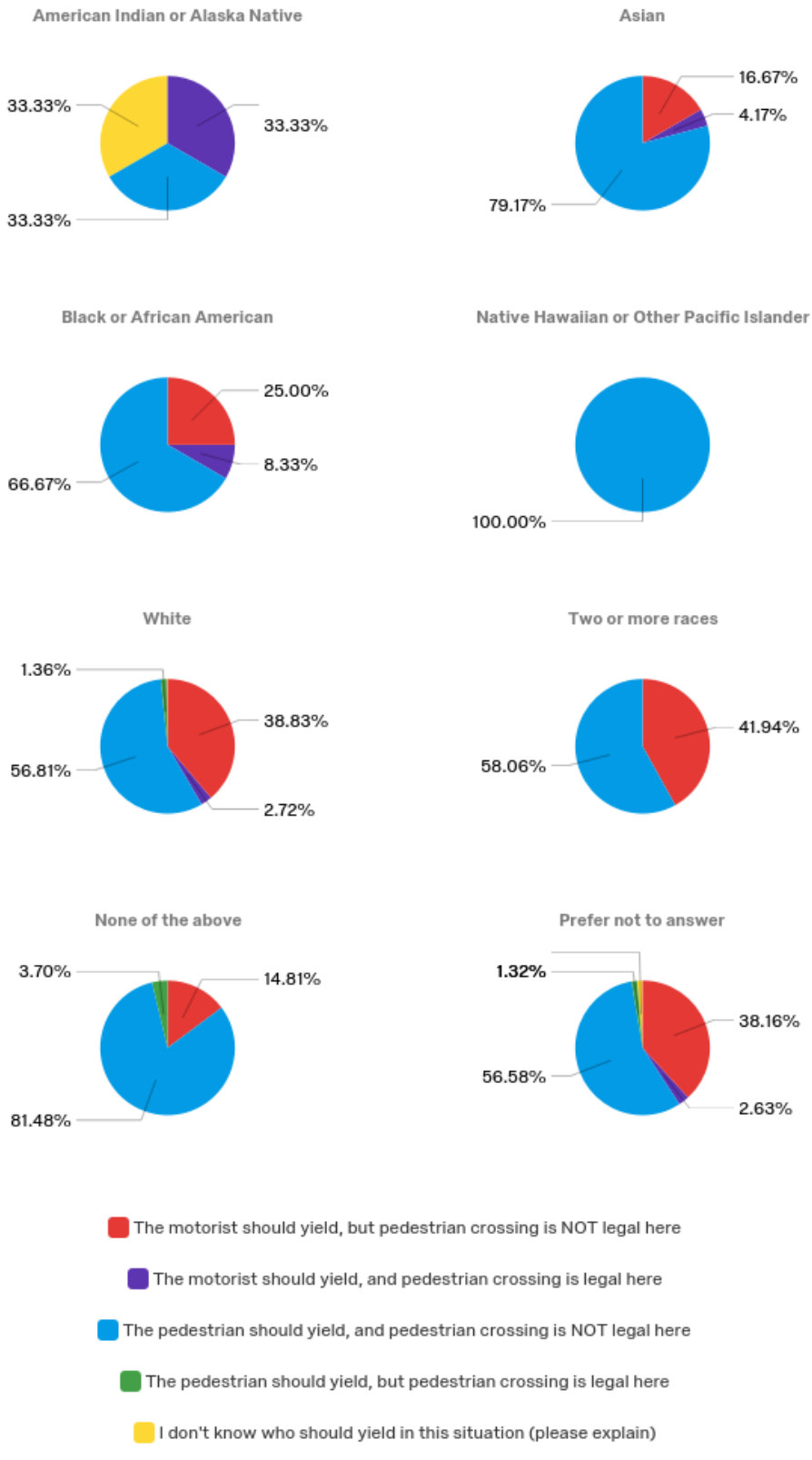


Figure B0.25 Scenario E Response by Race

Table B0.20 Scenario E Response Percentages by Gender

#	Field	The motorist should yield, but pedestrian crossing is NOT legal here	The motorist should yield, and pedestrian crossing is legal here	The pedestrian should yield, and pedestrian crossing is NOT legal here	The pedestrian should yield, but pedestrian crossing is legal here	I don't know who should yield in this situation (please explain)	Total
2	Male	38.92% 137	3.41% 12	55.40% 195	1.99% 7	0.28% 1	352
1	Female	36.55% 201	2.36% 13	59.82% 329	0.73% 4	0.55% 3	550
3	Transgender, non-binary, or another gender	0.00% 0	0.00% 0	83.33% 5	16.67% 1	0.00% 0	6

Showing rows 1 - 3 of 3

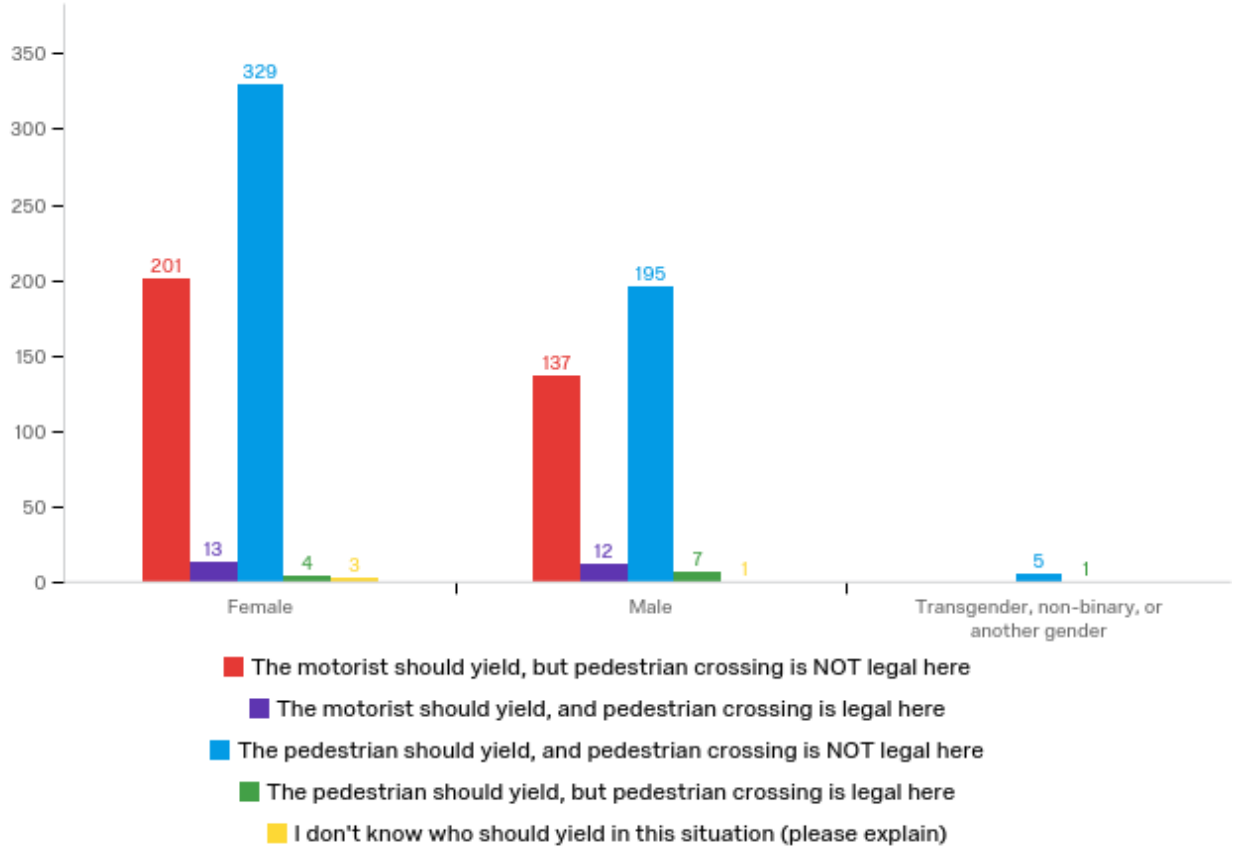


Figure B0.26 Scenario E Response Counts by Gender

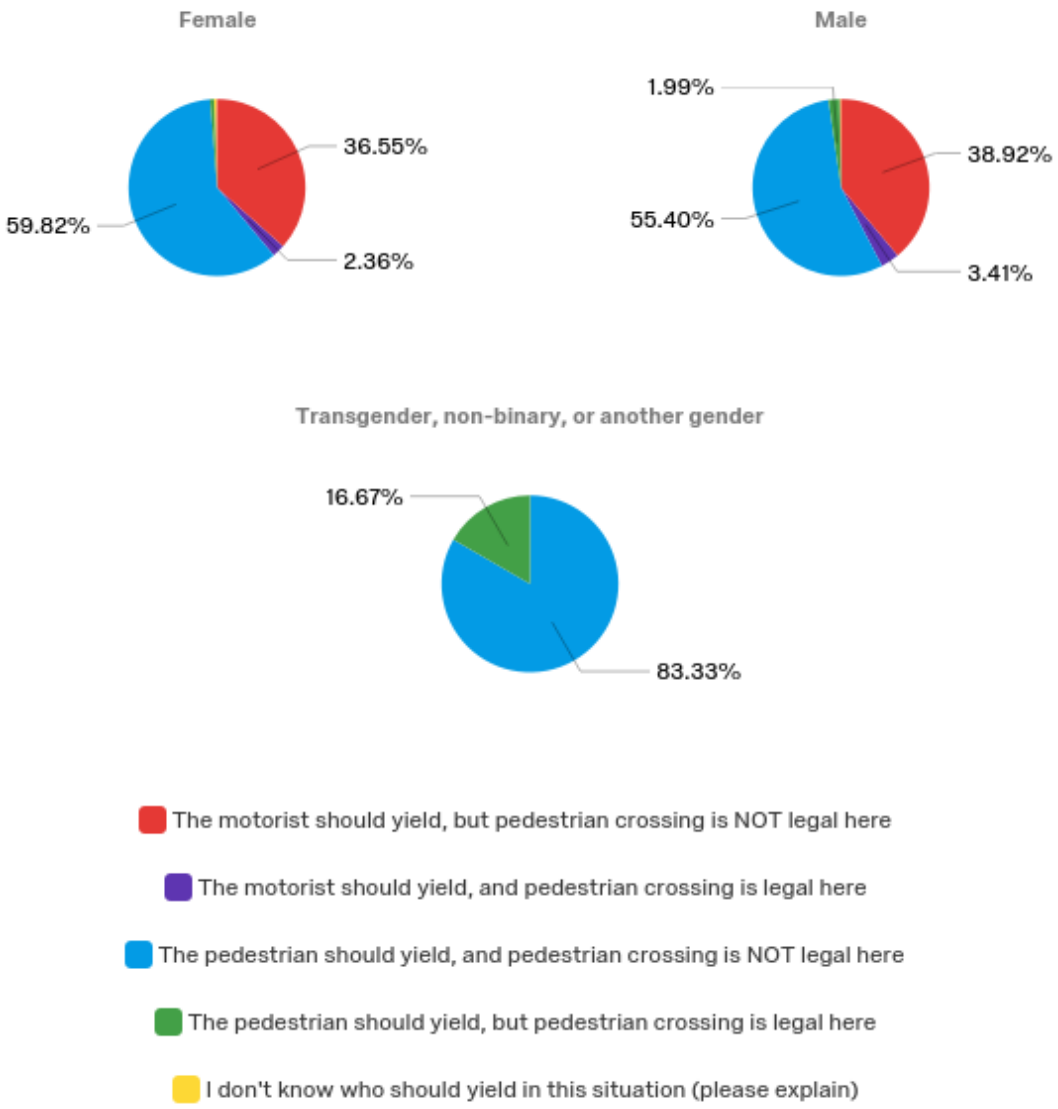


Figure B0.27 Scenario E Response by Gender

Scenario F: Illegal Mid-block Crossing

Table B0.21 Scenario F Response Percentages by Education

Field	The motorist should yield, but pedestrian crossing is NOT legal here	The motorist should yield, and pedestrian crossing is legal here	The pedestrian should yield, and pedestrian crossing is NOT legal here	The pedestrian should yield, and pedestrian crossing is legal here	I don't know who should yield in this situation (please explain)	Total
Some college	46.77% 58	3.23% 4	46.77% 58	2.42% 3	0.81% 1	124
High School or Equivalent	34.62% 9	3.85% 1	57.69% 15	3.85% 1	0.00% 0	26
Graduate Degree	34.45% 113	3.35% 11	57.93% 190	3.05% 10	1.22% 4	328
Grade school or less	28.57% 2	0.00% 0	57.14% 4	0.00% 0	14.29% 1	7
Bachelor's Degree	34.14% 127	3.76% 14	59.41% 221	2.42% 9	0.27% 1	372
Associate's Degree or Trade/Technical	33.33% 17	7.84% 4	54.90% 28	1.96% 1	1.96% 1	51

Showing rows 1 - 6 of 6

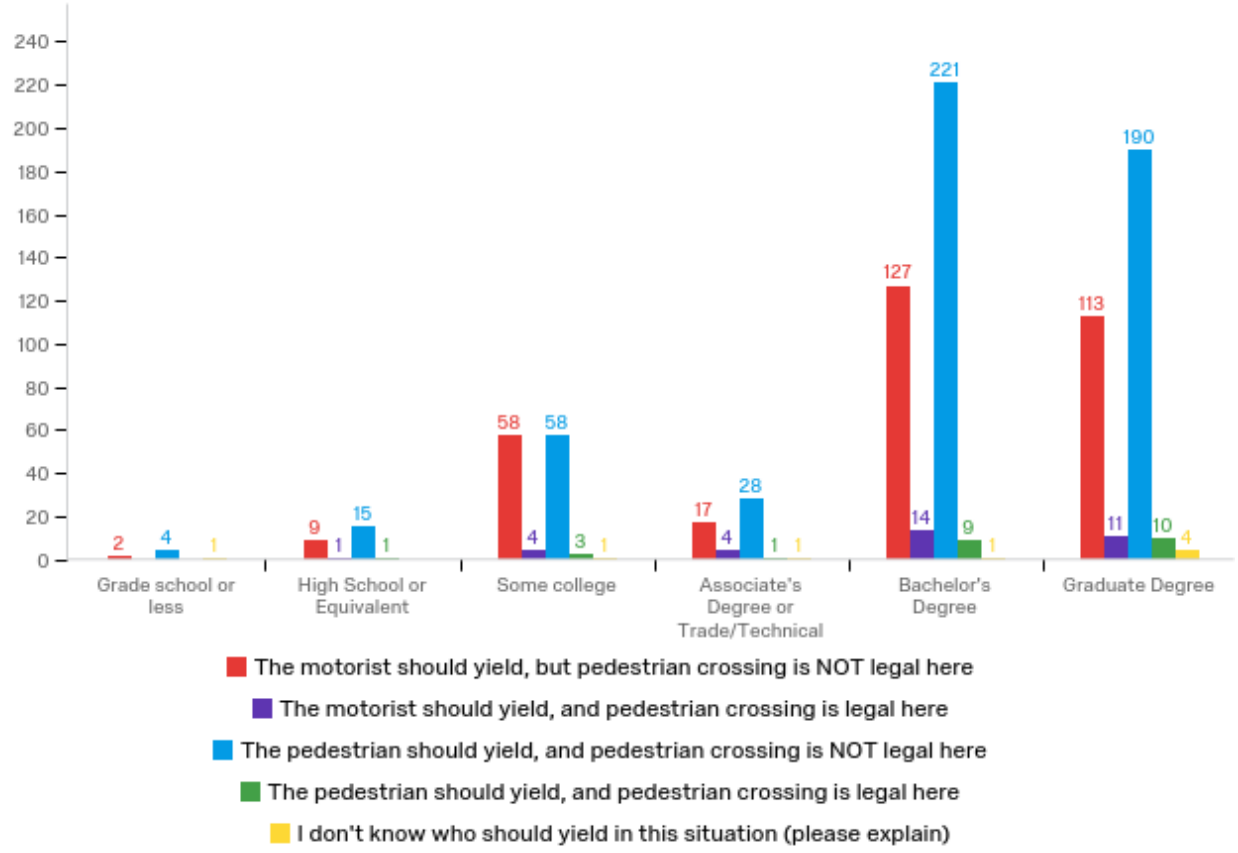


Figure B0.28 Scenario F Response Counts by Education

Table B0.22 Scenario F Response Percentages by Age

Field	The motorist should yield, but pedestrian crossing is NOT legal here	The motorist should yield, and pedestrian crossing is legal here	The pedestrian should yield, and pedestrian crossing is NOT legal here	The pedestrian should yield, and pedestrian crossing is legal here	I don't know who should yield in this situation (please explain)	Total
55 to 74	38.91% 128	2.13% 7	55.93% 184	2.43% 8	0.61% 2	329
35 to 54	34.49% 129	4.01% 15	56.95% 213	3.74% 14	0.80% 3	374
25 to 34	34.00% 51	4.67% 7	60.67% 91	0.00% 0	0.67% 1	150
75 or older	35.00% 14	7.50% 3	50.00% 20	5.00% 2	2.50% 1	40
24 and younger	26.67% 4	13.33% 2	53.33% 8	0.00% 0	6.67% 1	15

Showing rows 1 - 5 of 5

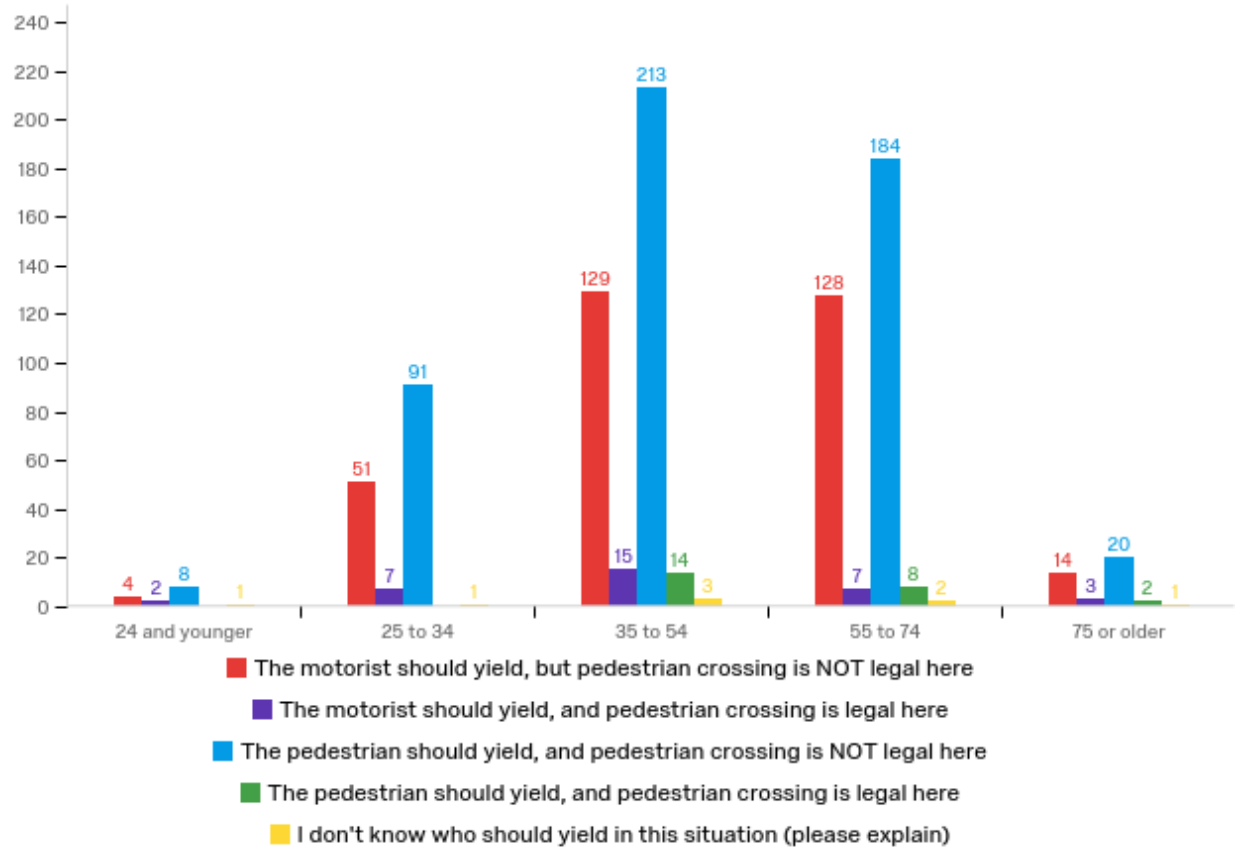


Figure B0.29 Scenario F Response Counts by Age

Table B0.23 Scenario F Response Percentages by Race

#	Field	The motorist should yield, but pedestrian crossing is NOT legal here	The motorist should yield, and pedestrian crossing is legal here	The pedestrian should yield, and pedestrian crossing is NOT legal here	The pedestrian should yield, and pedestrian crossing is legal here	I don't know who should yield in this situation (please explain)	Total
1	American Indian or Alaska Native	0.00% 0	0.00% 0	33.33% 1	33.33% 1	33.33% 1	3
2	Asian	16.67% 4	0.00% 0	79.17% 19	4.17% 1	0.00% 0	24
3	Black or African American	16.67% 2	8.33% 1	75.00% 9	0.00% 0	0.00% 0	12
4	Native Hawaiian or Other Pacific Islander	0.00% 0	0.00% 0	100.00% 1	0.00% 0	0.00% 0	1
5	White	37.33% 274	3.95% 29	55.45% 407	2.45% 18	0.82% 6	734
6	Two or more races	35.48% 11	6.45% 2	51.61% 16	6.45% 2	0.00% 0	31
7	None of the above	18.52% 5	0.00% 0	81.48% 22	0.00% 0	0.00% 0	27
8	Prefer not to answer	39.47% 30	2.63% 2	53.95% 41	2.63% 2	1.32% 1	76

Showing rows 1 - 8 of 8

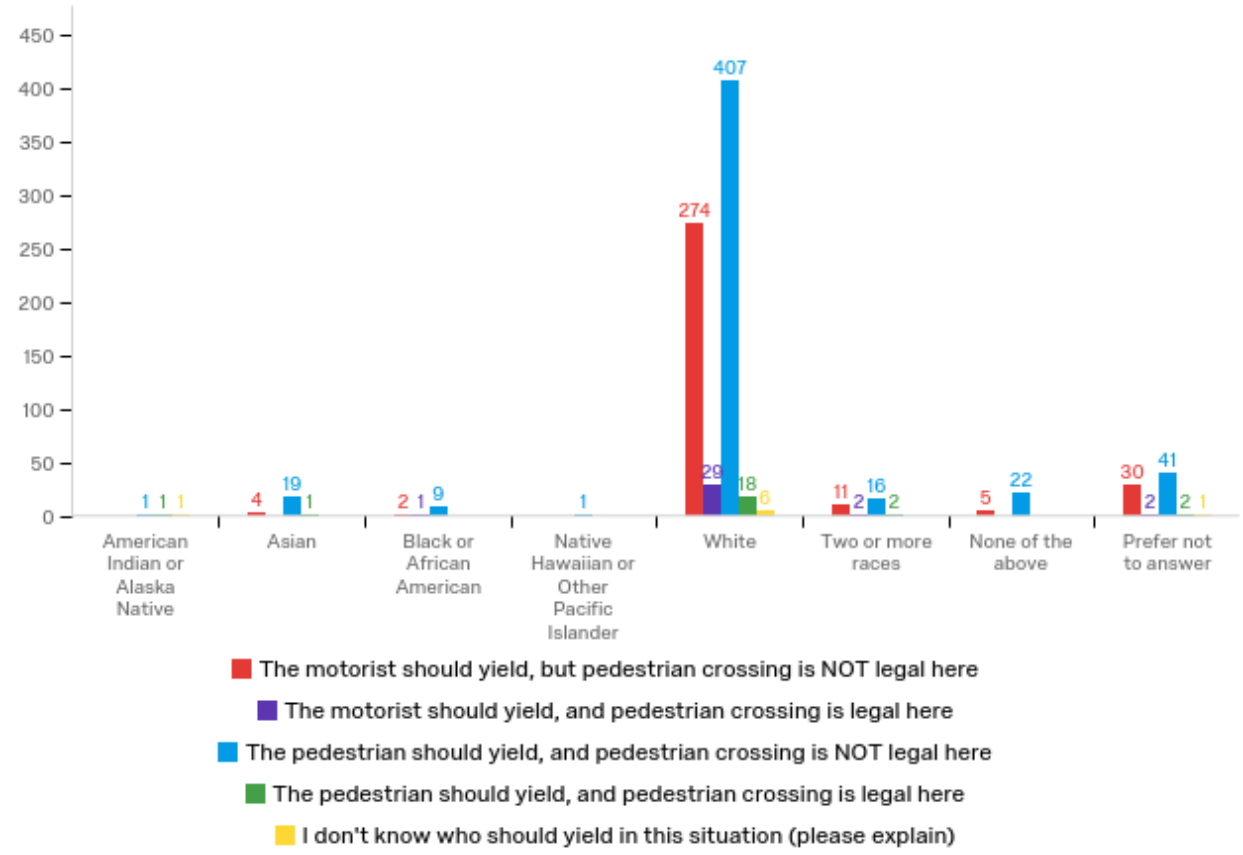


Figure B0.30 Scenario F Response Counts by Race

Table B0.24 Scenario F Response Percentages by Gender

#	Field	The motorist should yield, but pedestrian crossing is NOT legal here	The motorist should yield, and pedestrian crossing is legal here	The pedestrian should yield, and pedestrian crossing is NOT legal here	The pedestrian should yield, and pedestrian crossing is legal here	I don't know who should yield in this situation (please explain)	Total
1	Female	35.27% 194	3.45% 19	58.36% 321	2.00% 11	0.91% 5	550
2	Male	37.50% 132	4.26% 15	53.98% 190	3.41% 12	0.85% 3	352
3	Transgender, non-binary, or another gender	0.00% 0	0.00% 0	83.33% 5	16.67% 1	0.00% 0	6

Showing rows 1 - 3 of 3

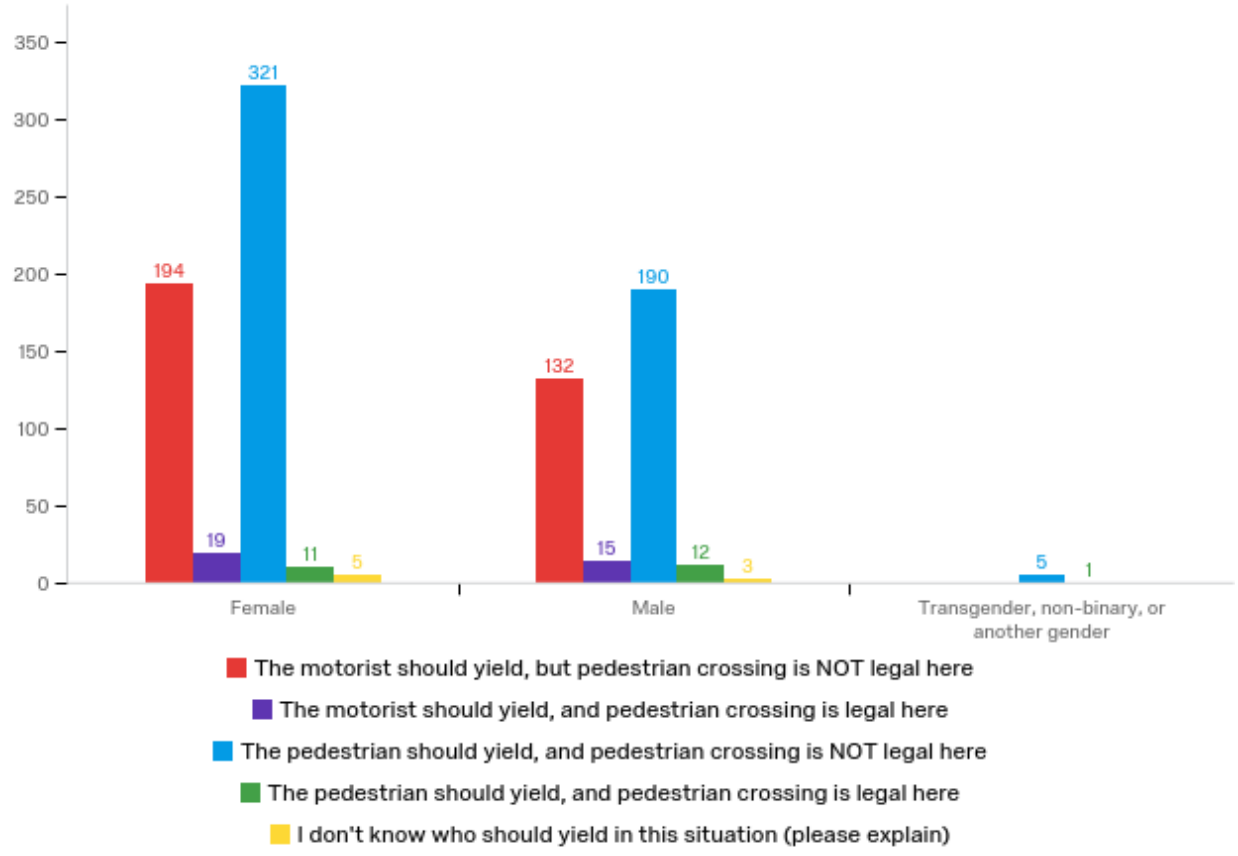


Figure B0.31 Scenario F Response Counts by Gender

Scenario G: Multiple Threat

Table B0.25 Scenario F Response Percentages by Gender

Field	The pedestrian	Motorist A	Motorist B	Both motorists A and B	I don't know who should yield in this situation (please explain)	Total
Some college	9.68% 12	4.03% 5	0.00% 0	86.29% 107	0.00% 0	124
High School or Equivalent	11.54% 3	3.85% 1	0.00% 0	84.62% 22	0.00% 0	26
Graduate Degree	9.45% 31	2.44% 8	0.00% 0	86.59% 284	1.52% 5	328
Grade school or less	42.86% 3	0.00% 0	0.00% 0	42.86% 3	14.29% 1	7
Bachelor's Degree	9.41% 35	2.15% 8	0.27% 1	86.83% 323	1.34% 5	372
Associate's Degree or Trade/Technical	17.65% 9	0.00% 0	0.00% 0	82.35% 42	0.00% 0	51

Showing rows 1 - 6 of 6

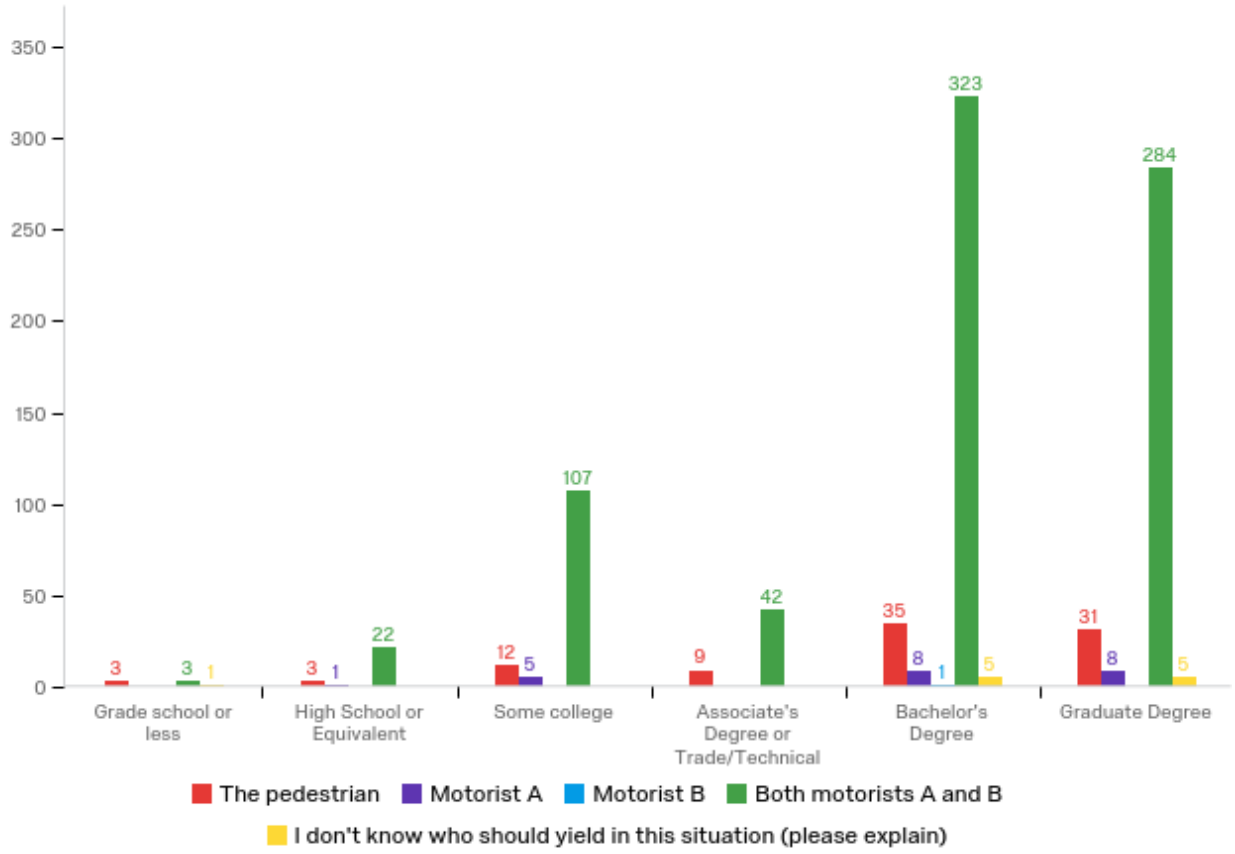


Figure B0.32 Scenario G Response Counts by Education

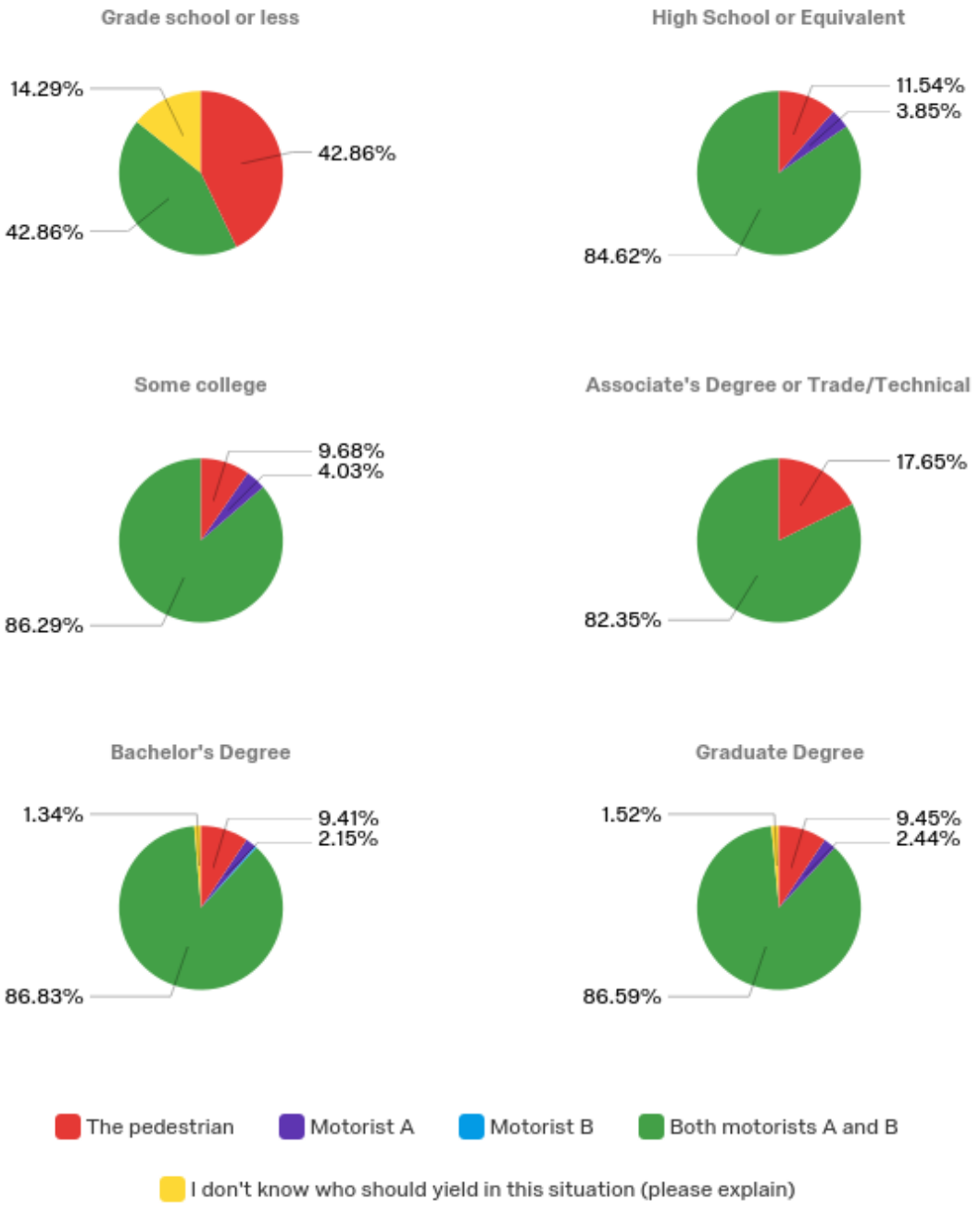


Figure B0.33 Scenario G Response by Education

Table B0.26 Scenario G Response Percentages by Age

Field	The pedestrian	Motorist A	Motorist B	Both motorists A and B	I don't know who should yield in this situation (please explain)	Total
55 to 74	10.03% 33	2.74% 9	0.00% 0	86.63% 285	0.61% 2	329
35 to 54	10.16% 38	2.41% 9	0.27% 1	85.03% 318	2.14% 8	374
25 to 34	7.33% 11	1.33% 2	0.00% 0	91.33% 137	0.00% 0	150
75 or older	17.50% 7	5.00% 2	0.00% 0	77.50% 31	0.00% 0	40
24 and younger	26.67% 4	0.00% 0	0.00% 0	66.67% 10	6.67% 1	15

Showing rows 1 - 5 of 5

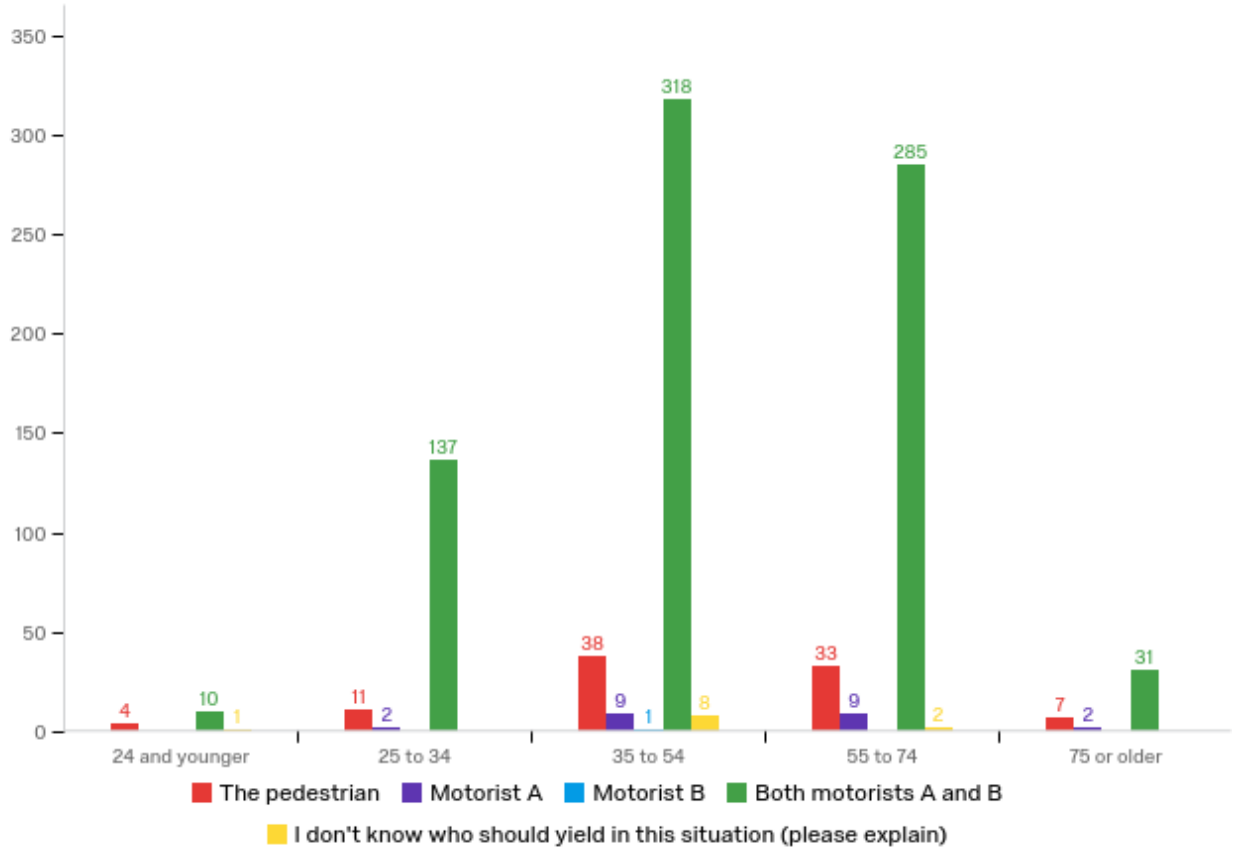


Figure B0.34 Scenario G Response Counts by Age

Table B0.27 Scenario G Response Percentages by Race

#	Field	The pedestrian	Motorist A	Motorist B	Both motorists A and B	I don't know who should yield in this situation (please explain)	Total
5	White	10.22% 75	2.32% 17	0.00% 0	86.38% 634	1.09% 8	734
6	Two or more races	6.45% 2	6.45% 2	0.00% 0	87.10% 27	0.00% 0	31
8	Prefer not to answer	13.16% 10	2.63% 2	1.32% 1	80.26% 61	2.63% 2	76
7	None of the above	14.81% 4	0.00% 0	0.00% 0	85.19% 23	0.00% 0	27
4	Native Hawaiian or Other Pacific Islander	0.00% 0	100.00% 1	0.00% 0	0.00% 0	0.00% 0	1
3	Black or African American	0.00% 0	0.00% 0	0.00% 0	100.00% 12	0.00% 0	12
2	Asian	4.17% 1	0.00% 0	0.00% 0	95.83% 23	0.00% 0	24
1	American Indian or Alaska Native	33.33% 1	0.00% 0	0.00% 0	33.33% 1	33.33% 1	3

Showing rows 1 - 8 of 8

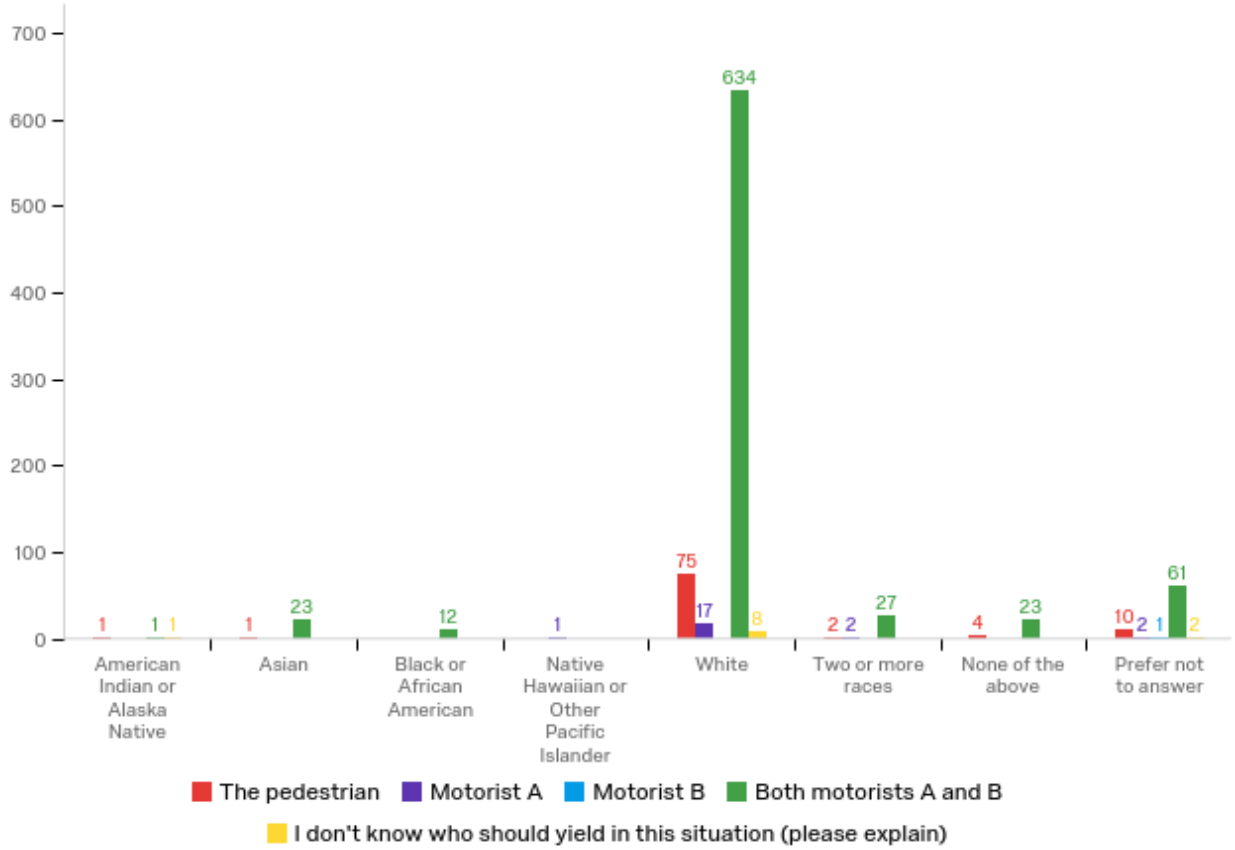


Figure B0.35 Scenario G Response Counts by Race

Figure B0.36 Scenario G Response by Race

Table B0.28 Scenario G Response Percentages by Gender

#	Field	The pedestrian	Motorist A	Motorist B	Both motorists A and B	I don't know who should yield in this situation (please explain)	Total
1	Female	9.45% 52	2.36% 13	0.18% 1	86.55% 476	1.45% 8	550
2	Male	11.08% 39	2.56% 9	0.00% 0	85.80% 302	0.57% 2	352
3	Transgender, non-binary, or another gender	33.33% 2	0.00% 0	0.00% 0	50.00% 3	16.67% 1	6

Showing rows 1 - 3 of 3

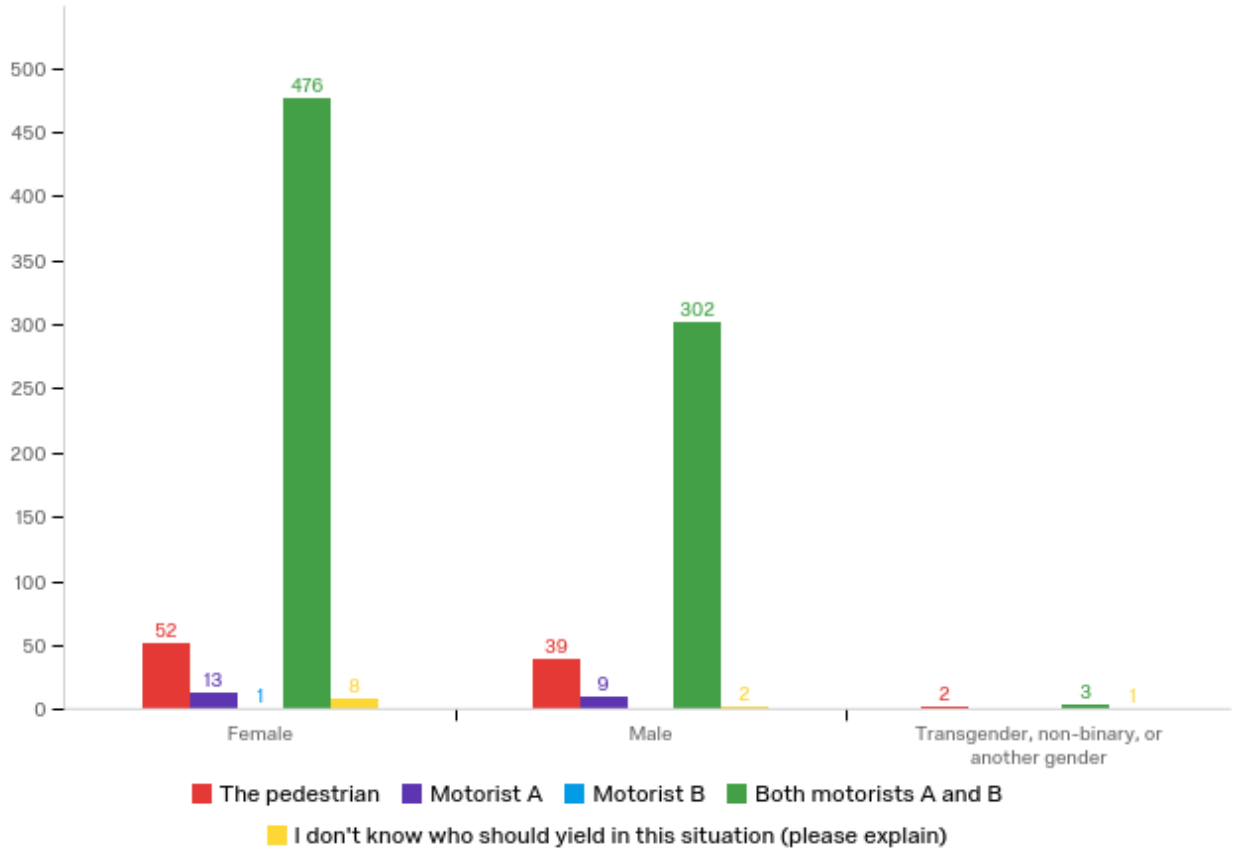


Figure B0.37 Scenario G Response Counts by Gender