EVALUATION OF THE FALSE SENSE OF SECURITY FOR PEDESTRIANS AT VARIED CROSSWALK TREATMENTS

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ABSTRACT

Each year, approximately 12 percent of all traffic-related deaths in the United States involve a pedestrian, which underscores the need for immediate attention. At the forefront of initiatives to improve pedestrian safety has been a continued focus on enhancement of the crosswalk itself. More specifically, newer pedestrian crosswalk treatments have been implemented with the primary goals of improving crosswalk and pedestrian visibility along with increasing drivers' yield compliance rates. However, increased levels of safety enhancements may be accompanied by unintended consequences that are related to the degradation of pedestrian vigilance resulting from an increased perception of safety. This research sought to quantify the false sense of security exhibited by pedestrians' crossing behavior as a function of various crosswalk treatments. A specific hypothesis being evaluated is that as the level of crosswalk treatment increases (i.e., higher visibility), the pedestrian vigilance decreases. This research had two primary objectives: 1) to ascertain if varied pedestrian crosswalk treatments influence specific crossing behaviors, and 2) to quantify the existing sense of security for pedestrians as a function of the crosswalk treatment. Two methodological approaches were employed to collect data on pedestrians' crossing behaviors, including both direct field and video observations. The naturalistic observations yielded several interesting findings regarding differences in pedestrian behavior (i.e., look/no look, talking on the phone, etc.) as a function of crosswalk treatment. The overall results expand upon current literature and provide specific guidance that is useful in designing appropriate countermeasures aimed towards improving pedestrian safety.

1. INTRODUCTION

Each year, approximately 12 percent of all traffic-related deaths in the United States involve a pedestrian (NHTSA, 2013). Walking, generally recognized as the oldest form of transportation, poses a life-threatening risk to many around the world (GRSP, 2014). According to the European Commission's report on the health of the European Union's (EU) roadways, twenty-two percent of all those who died on EU roads in 2013 were pedestrians (European Commission, 2015). In developing countries, pedestrians represent the group of road users with the largest number of fatalities (Mohan et al., 2006).

Pedestrians are the most vulnerable road users and are at a greater risk of being injured in a traffic crash than vehicle occupants. Seventy-eight percent of all pedestrian deaths occur at non-intersections (da Silva et al., 2003). Although many initiatives have targeted pedestrian safety, pedestrian fatalities continue to be a pressing issue across the world (GSRP, 2014). At the forefront of initiatives to improve pedestrian safety has been a continued focus on enhancement of the marked crosswalk – the most commonly utilized method for getting pedestrians from one side of a roadway to the other.

Road crossings are one of the most dangerous locations for pedestrians (Gómez et al., 2011). Differences in speed between vehicles and pedestrians can cause serious and sometimes fatal injuries. At non-intersections, mid-block crosswalks are generally used to accommodate pedestrian crossings. Various traffic control devices are employed at a typical midblock crosswalk, including pavement markings, advance warnings, and traffic signals (Lu & Noyce, 2009).

While there are many variations in crosswalk patterns, two longitudinal lines running perpendicular to the motorist's direction of travel, are generally recognized as a marked crosswalk (MUTCD, 2009). Crossing design is site-specific; one solution may work well in one instance and fail to serve all users in another location. Particular care must be taken to protect the least mobile user, often this means designing for the elderly or children. Key aspects to safe crossings include minimized crossing distances, slower vehicle speeds, enhanced visibility for both pedestrians and cars, and the appropriate form of traffic control.

Marked crosswalks are typically placed at controlled (i.e., signalized intersections) and uncontrolled locations typically referred to as "mid-block crosswalks", for their frequent use for accommodating pedestrians between two signalized intersections. Uncontrolled mid-block crosswalks at multilane streets are associated with a type of pedestrian-vehicle conflict defined as a *multiple-threat* crash scenario (Snyder, 1972).

While crosswalks provide a guided path to safely traverse a roadway, pedestrian behavior while negotiating these crosswalks has evolved. It has become commonplace for pedestrians to cross the street while engaging in other activities such as carrying on a conversation with other crossers while simultaneously using a mobile device. As a result, various countermeasures have been deployed to enhance the safety of pedestrians while crossing. These countermeasures aim to provide a higher level of visibility of the pedestrian, by alerting the driver and ideally increase the yielding/stopping behavior on approach to the crosswalk. Unfortunately, increased levels of safety enhancements may be accompanied by unintended consequences that are related to the degradation of pedestrian vigilance resulting from an increased perception of safety, resulting in a *false sense of security*.

The false sense of security in road users occurs when pedestrians and motorists' alike underestimate the risks involved in many situations (Elvik, 2000). In the case of pedestrians, the demarcation of a crossing may increase the feeling of safety, thus motivating the pedestrian to not look for approaching vehicles as often. The goal of this research is to quantify this false sense of security exhibited by pedestrians' crossing behavior as a function of various crosswalk treatments.

2. METHODOLOGY

In order to evaluate pedestrians' sense of security at various crosswalk treatments, 1386 physical pedestrian crossings (observation) were observed across nine different crosswalk locations. For each observation, the following measures were recorded:

- Pedestrian demographics: age (young or old) and sex (male, female).
- Size of pedestrian group crossing (1, 2, 3+).
- Distraction of pedestrian (talking in person, talking on phone, reading, texting, wearing headphones)
- Presence of vehicles (present, not present) and vehicle behavior (stopped for pedestrian, didn't stop)
- Pedestrian vehicle acuity - Whether or not the pedestrian looked for traffic before crossing (looked, didn't look, not sure if looked)

In order to ensure legitimacy in observation of pedestrian vehicle acuity, teams of two were employed to conduct observations. By using two observers, the confidence among responses increased and overall accuracy of observations improved.

2.1 Crosswalk Treatments

Seven different crosswalk treatments were studied across the nine locations on a rural university campus. The locations varied in vehicular volumes and speeds and crosswalk length but had a consistent pedestrian demographic. Due to the locations being near UMass Amherst and Amherst College, over 90% of pedestrians were college-aged. Pictures of each crosswalk, along with a short description, are shown in Figure 1.

Raised Crosswalk (2 sites)

Overhead Flash Signal

Flashing Push Button Bollards

Standard Crosswalk at T-Intersection

Flashing Signs, Advanced Yield Markings, Rumble Stripes, 1-way Traffic

Countdown Signal at Signalized Intersection (2 sites)

Traditional Crosswalk on 2-way Road

Figure 1 Photos of the seven crosswalk treatments at which observations took place.

2.2 Focus Group

A focus group was conducted to gain insight into how pedestrians made their crossing decisions. Ten college-aged participants provided individual feedback when shown photos of various crosswalk treatments. Participants were asked to discuss whether they would feel safe, or not safe, at the given crosswalk and what improvements, if any, would help increase their level of comfort when crossing. The results of the focus group are presented in the discussion section of this paper.

3. RESULTS AND DISCUSSION

The results presented in this section represent the findings from the 1386 pedestrian crossing observations across nine different locations with seven different crosswalk treatments. Statistical analysis represented by error bars in figures represent 95% confidence intervals and significance achieved at $p<0.05$.

3.1 Pedestrian Behavior

The pedestrian crossing zone leaves non-motorized users particularly vulnerable at this roadway conflict point. While motorists are required to be cognizant of all road users and often times yield right of way at crossing locations, awareness on behalf of the pedestrian remains equally important. As part of the naturalistic observations, pedestrian vehicle acuity observations were recorded. Often times, crosswalk users actively glance in each direction of travel, providing a clear indication of acknowledging the zone of conflict. Not so clear in other instances, a pedestrian may use their peripheral vision or listen for incoming vehicles. While this type of crossing behavior may still result in safe passage through a crosswalk, it is safest to actively look both ways before crossing. The findings presented below represent active glances in each direction of travel. In Figure 2 the effect of a crossers' distraction compared to pedestrian vehicle acuity reveals most pedestrians who remain distraction-less look before crossing. Talking on a cell phone, wearing headphones and talking to a person walking with you would all be classified as a cognitive distraction while texting would be classified as a cognitive and visual distraction. This additional form of attention diversion showed that pedestrians who were texting looked significantly less often than pedestrians who were not distracted. The cognitive distractions did not have the same effect on pedestrian behavior. However, with a large sample size statistically lower look rates may occur.

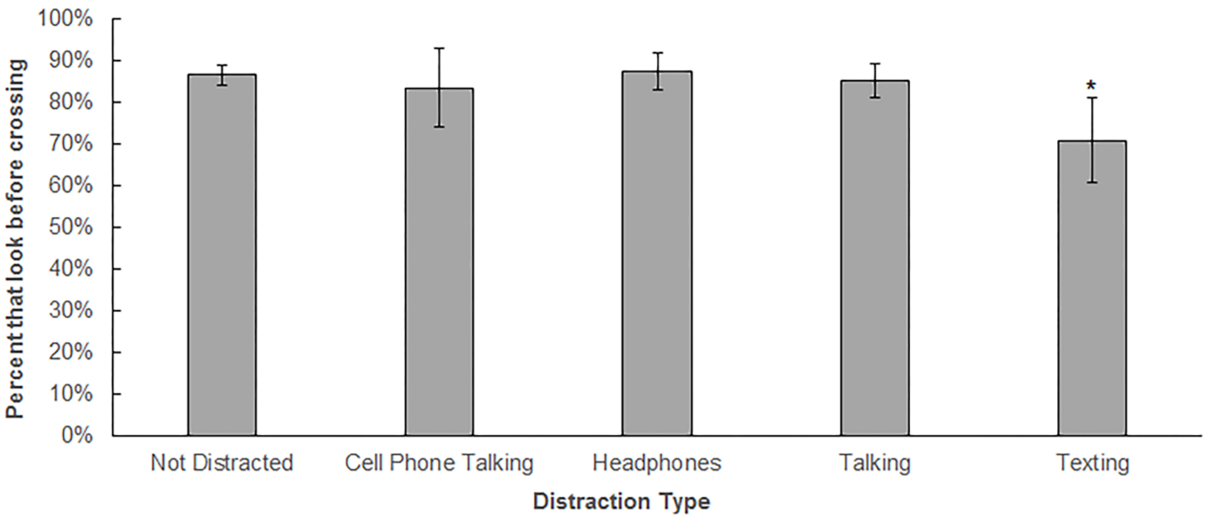

Figure 2 Rate that pedestrians look before crossing versus distraction type. (*) indicates statistically significant difference from 'Not Distracted'.

Pedestrian behavior was also analyzed with respect to the specific crosswalk treatment. As mentioned in the methodology, it was not possible to control for differences in traffic volumes, speeds and crosswalk length. This makes it challenging to directly compare two crosswalk treatments. However, the naturalistic observations provide some insight into a pedestrian's sense of safety at a crosswalk. In Figure 3 the look before crossing rates are presented for each of the seven crosswalk treatments. The traditional crosswalk was used as the baseline for statistical tests. Two treatments types had statistically higher look before crossing rates, those at traffic signals with pedestrian countdown signal heads and those with overhead flashing beacons with bollards. For the signalized intersection, the pedestrian vehicle acuity rate could be due to the higher activity associated with increased traffic volumes and the necessary waiting time before granted right of way to begin crossing. With the overhead flash beacon treatment, pedestrians had similar right of way and traffic volumes were comparable to the traditional crosswalk suggesting a more equitable comparison. The bollards and overhead flashing beacons are intended to bring attention to the crosswalk and alert motorists of the potential hazard. Pedestrians may look at a higher rate because these elements remind them as well that crossing a street can be dangerous. The T-intersection treatment exhibited a statistically lower pedestrian vehicle acuity rate than the traditional crosswalk. While difficult to compare these differing roadway geometries, often times drivers were observed to roll through stop control on the minor approach. Additionally, while it is possible that vehicles from the major roadway could pose a hazard, turning movements onto the minor leg were infrequent so pedestrians effectively only needed to look one way before crossing. This behavior could result in pedestrians building reliance on peripheral vision or listening for conflicts. Furthermore, crossing users may have assumed that the vehicle would stop because of the stop sign.

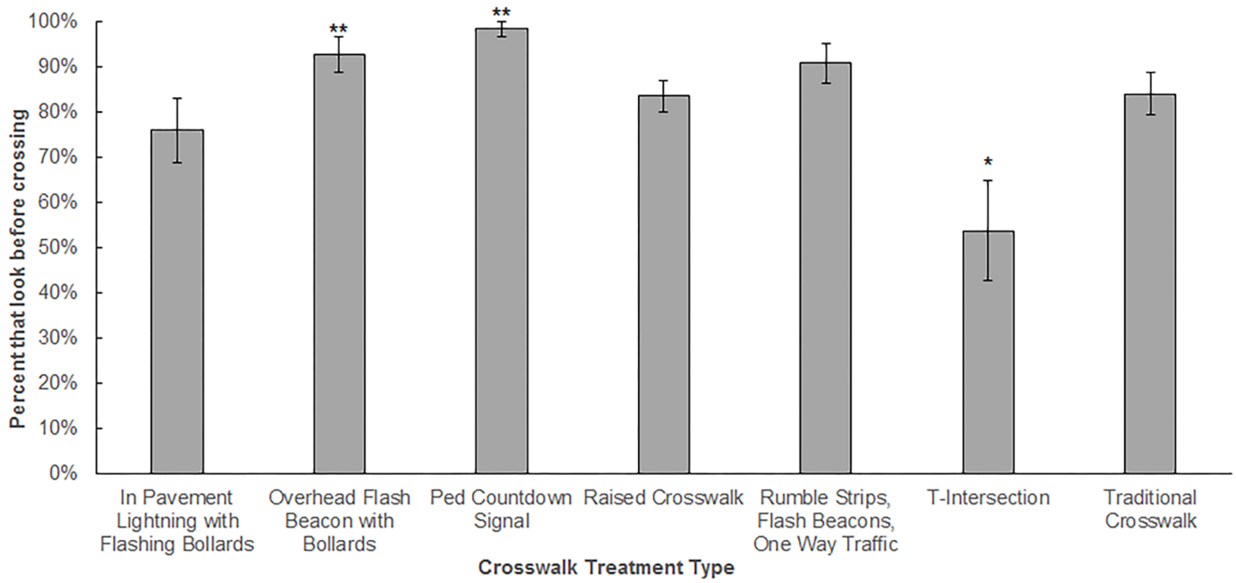

Figure 3 Rate that pedestrians look before crossing versus crosswalk treatment type. (*) indicates statistically significantly lower than traditional crosswalk and (**) indicates statistically significantly higher.

3.2 Vehicle Behavior

Vehicle behavior was observed during each of the 1386 pedestrian crossings. When a vehicle was present during the crossing, the observers noted if the oncoming vehicle slowed for the pedestrian, stopped for the pedestrian or did not stop/slow and proceeded through the crosswalk. For the purpose of analyses stop and slow were combined as both represent the driver yielding to the pedestrian(s) trying to cross. Figure 4 displays yield rates across all treatment types versus the number of pedestrians trying to cross. Due to smaller sample sizes of two and 3+ person groups, there were no statistically significant differences. However, a seemingly direct relationship was observed between the number of pedestrians trying to cross and the likelihood that the motorist would yield. This may be due to the increased visibility of multiple pedestrians.

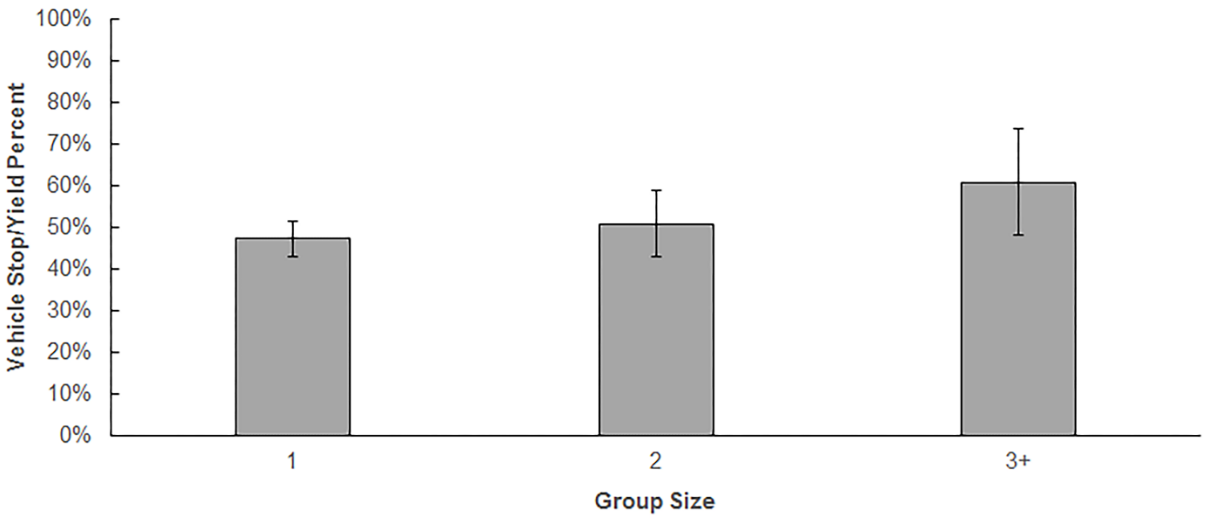

Figure 4 Vehicle stop/yield for pedestrian rate versus size of the group of pedestrians crossing.

Motorists' yielding behavior was also analyzed at each of the crosswalk treatment types. Figure 5 shows each of the seven treatments and the rate at which drivers yielded for both distracted and non-distracted pedestrians. While there were no statistically significant differences due to the small sample of distracted pedestrians, almost every crosswalk had a higher percentage stop for distracted pedestrians than for non-distracted pedestrians. This is notable because it shows that motorists are driving defensively and when they recognize that a pedestrian may be distracted, they are more likely to stop in fear that the pedestrian may not notice them.

Across the treatment types, the pedestrian countdown signal had the lowest yield rate which is unsurprising given that vehicles have the right of way and should not be stopping for pedestrians. The two treatments with the most visibility, the rumble strips/flash beacon and the in-pavement lighting had the highest yield rates suggesting that motorists respond to the increased stimuli. Compared with other types of warning devices, the effectiveness of the in-pavement flashing light system seem to be highly acceptable (Gadiel, 2014).

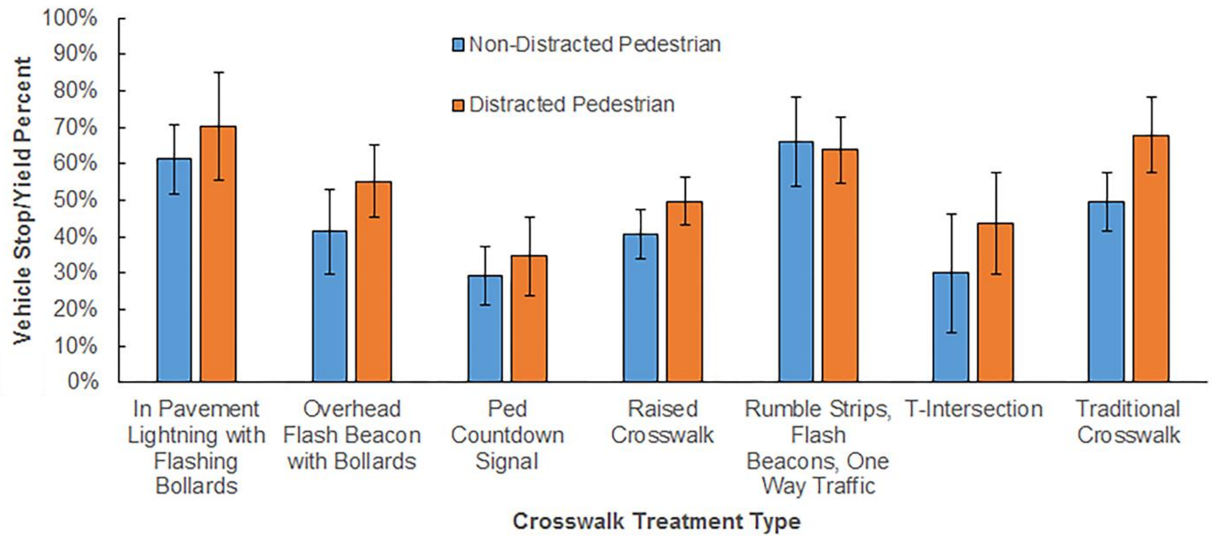

Figure 5: Vehicle stop/yield for pedestrian rate versus crosswalk treatment type for both distracted and non-distracted pedestrians.

3.3 Focus Group

A focus group was conducted in order to gain insight into the thought process of pedestrians and drivers with respect to crosswalks. When asked about each crosswalk treatment, the majority of participants decided upon the safety of the crosswalk based upon the visibility of the crosswalk to the driver. The participants rated the most visible, in-pavement lighting, as the safest; and the least visible traditional crosswalk as the least safe. Participants did not feel an increased sense of safety as a result of the raised crosswalk although they did acknowledge that it may slow drivers down.

The group suggested passive forms of signaling intention to cross a road is not enough. Accessible push buttons on signalized intersections, hawk, or rectangular-rapid flashing beacons provide comfort and visibility of the pedestrian. However, participants noted active and passive solutions should be implemented due to low predicted activation compliance. Long delays at signals may also exasperate some users into crossing out of order, putting themselves at risk and violating typical driver expectancy. Recommendations included passive systems to detect and activate upon activity; particularly in-pavement lighting systems. All participants agreed a strong education program would benefit the public's comprehension of crosswalks and the dangers of using portable electronics while crossing the road.

4. CONCLUSIONS

Pedestrian activity at different crossing treatments was examined in this observational study. Nearly 1400 observations of primarily students were collected on and around two university campuses. Campus environments provide a unique insight into student pedestrian activity due to their range in human behavior in groups, random actions and large sample sizes. Observations for pedestrian-vehicle acuity showed a statistically significant difference when a pedestrian was distracted by texting. Additionally, two crosswalk treatments elicited higher look-before-crossing rates and one treatment elicited a lower look rate. Observations of driver yielding behavior did not result in any statistically significant differences. However, a clear trend emerged at all crosswalk treatments where drivers yielded/stopped for pedestrians at a higher rate when they were distracted versus when they were not, suggesting that drivers anticipate the distracted pedestrians as more of a hazard than the non-distracted pedestrians. Active lighting and physical-attention strategies elicited the most productive reaction for drivers and pedestrians alike. These treatments should be implemented wherever possible to aid in the safety of all road users.

With increased levels of distraction, it is important to focus on the road user behavior when creating policies that target road user safety. Engineering countermeasures alone cannot guarantee safe roadways.

5. REFERENCES

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