The Effects of High Visibility Enforcement on Driver Compliance to Pedestrian Yield Right-of-Way Laws

Submitted by

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Abstract

This study examined the effects of a one-year high visibility pedestrian right-of-way enforcement program on yielding to pedestrians at uncontrolled crosswalks, some of which received enforcement and some of which that did not. The program included four 2-week enforcement waves, supported by education and engineering components that increased the visibility of enforcement. The study produced six results. 1. Enforcement led to a slow and steady increase in the percentage of drivers yielding right-of-way to pedestrians over the year. 2. The program produced a large change in yielding over the course of the year. 3. The program produced higher levels of yielding to natural pedestrian crossings than to staged crossing and the changes in both were highly correlated. 4. The effects of the program generalized to crosswalks that were not targeted for pedestrian right-of-way enforcement. 5. The amount of generalization to unenforced sites was inversely proportional to the distance from sites that received enforcement.
INTRODUCTION

Background

Past research by Hunter, Stutts, Pein, and Cox (1996) indicates that a lack of driver compliance is associated with pedestrian motor vehicle crashes. One way of increasing driver compliance is to use high visibility enforcement of pedestrian right-of-way laws. Research conducted in the U.S. (Levy, Shea, & Asch, 1988; Levy, Asch, & Shea, 1990; Lacey, Jones, & Smith, 1999; Milano, McInturff, & Nichols, 2004) indicates that the use of high visibility enforcement (enforcement coupled with increased publicity about the enforcement program) has been associated with substantial increases in compliance with occupant protection laws as well as a reduction in alcohol related crashes.

General Deterrence

An underlying assumption of general deterrence theory is that sustained high visibility enforcement in conjunction with media attention will increase the public’s perception of the risk of being stopped by the police thereby increasing compliance with traffic laws (Waller, Li Stewart, & Ma, 1984). Therefore, raising the perceived probability of apprehension is an essential element of an effective pedestrian enforcement program. In 1985, Van Houten and Malenfant developed a multifaceted high visibility countermeasure described as a pedestrian decoy operation to increase the efficacy of pedestrian right-of-way enforcement operation (Van Houten, Malenfant, & Rolider, 1985). Typically, decoy operations involve the use of police in plainclothes who step into the roadway at marked or unmarked crosswalks following a carefully defined protocol, which provide ample opportunity for drivers to stop and yield right-of-way. This program also incorporated feedback signs providing weekly information on the percentage of motorists yielding to pedestrians along with the record (best level achieved to date); and outreach materials distributed to members of the community that describe the law, ask for cooperation in making the program a success and provide warning of impending enforcement operations. Subsequent iterations of this program included sandwich board signs that informed motorists that vehicles pulled over were stopped for failing to yield to pedestrians; and the installation of in street signs reminding pedestrians of the law and drivers of the fine for failing to yield to pedestrians to increase public awareness at the start of enforcement.

Van Houten and Malenfant (2004) conducted a study to evaluate enforcement alone in Miami Beach, Florida. The study design called for a periodic publicity and enforcement effort, e.g., high visibility enforcement and publicity 4 times a year, but due to practical limitations, neither increased publicity nor sustained enforcement was achieved. This study was associated with a modest increase in the percentage of drivers yielding to pedestrians and a reduction in crashes.

Britt, Bergman, and Moffet (1995) also reported on the effect of decoy pedestrian right-of-way enforcement operations carried out in Seattle. These were carried out over a period of several years but did not include extensive educational and/or engineering elements to increase the visibility of the operations. The authors concluded “In light of the often contradictory results, expectations of traffic enforcement to improve pedestrian safety should remain modest.” However, they also recommended continued research to determine ways to optimize the effects of pedestrian right-of-way enforcement.
The focus of the present effort was to assess the effects of increased publicity and enforcement on driver compliance with pedestrian right-of-way laws. The proposed study differs from those conducted previously inasmuch as this study involved an increase in visible enforcement over a longer period. In addition, increased emphasis was placed on publicizing the study and providing feedback to citizens in the target jurisdiction.

Participants and Setting

Participants were drivers in the city of Gainesville, FL at crosswalks at uncontrolled locations throughout the city.

Crosswalk Site Selection

The City of Gainesville provided the research team with a database of all marked crosswalks at locations without traffic signal or STOP sign control. The research team then visited the crosswalks located near pedestrian trip generators such as bus stops, hospitals, parks and playgrounds. The research team selected 12 sites that met the above criteria. The team randomly assigned 6 of these sites to receive high visibility enforcement (HVE) and 6 crosswalks to serve as untreated sites to determine whether the effects of HVE pedestrian right-of-way enforcement generalized to uncontrolled sites.

Enforcement sites were:
- NE 16th Street at Saint Patrick’s Middle School (one lane in each direction)
- NW 13th Avenue midblock multilane crosswalk at Gainesville High School (two lanes in each direction)
- SW 2nd Avenue at Shands Hospital (one lane in each direction)
- SW 2nd Avenue at 1st Presbyterian Church (one lane in each direction)
- SE 15th Street at 11th Avenue Lincoln Middle School (one lane in each direction)
- University of Florida crosswalk on Gale Lemerand Drive (two lanes in each direction)

Control sites were:
- University of Florida crosswalk on Museum Road (one lane in each direction)
- NW 41st Street at a shopping center (one lane in each direction)
- NW 16th Avenue at 12th Street WA Metcalfe Elementary School (one lane in each direction)
- SW 2nd Avenue at SW 1st Street at the Courthouse (one lane in each direction)
- NW 6th Street at the Police Station (This was a brick crosswalk with white transverse lines that were not repainted) (two lanes in one direction and one lane in the other direction)
- SW 2nd Avenue at Sweetwater Park (one lane in each direction)

Pre-Baseline Site Preparation

Prior to beginning baseline data collection, the crosswalk markings for all treatment and control sites were refreshed (either repainted or new thermoplastic markings installed), if necessary, and advance yield markings were installed at each crosswalk to decrease the likelihood that drivers would stop too close to the crosswalk blocking the view of pedestrians.
crossing the street. These changes were made prior to baseline data collection to ensure their introduction was not confounded with the introduction of the high visibility enforcement program. The use of advance yield markings are particularly important if a city is to transitions from low to high levels of yielding because intermediate levels of yielding could increase risk if driver yield too close to the crosswalk.

**DATA COLLECTION PROCEDURES**

Data to evaluate changes in motorist yielding behavior were collected using a standard recording sheet at crosswalks with an uncontrolled approach. Data collectors were trained to use an operational definition of yielding behavior that increased the objectivity of data collection. This method included the definition of the dilemma zone, the space on the roadway approaching an intersection or crosswalk where it may be difficult for the driver to decide whether to proceed or brake to be safe. Drivers needed to be outside the dilemma zone when the pedestrian entered the crosswalk in order to be scored. This procedure ensured that motorists traveling at the speed limit had adequate time to yield to a pedestrian.

**Defining the Dilemma Zone**

A cone was used to mark each dilemma zone. The research team employed the formula used by traffic engineers to determine whether a driver could have safely stopped at a traffic signal to determine whether the driver could have stopped for a pedestrian standing with one foot in the crosswalk. Calculating the distance beyond which a motorist can safely stop for a pedestrian is the same as calculating the distance in advance of a traffic signal that a motorist driving the speed limit can stop if the traffic signal changes to yellow. Traffic engineers use the signal-timing formula (Institute of Transportation Engineers, 1985), which takes into account driver reaction time, safe deceleration rate, the posted speed, and the grade of the road to calculate this interval for the amber indication. This formula:

\[ y = t + \frac{v}{2a + 2Gg} \]

was used to determine the distance to the dilemma zone boundary by multiplying the time (y) by the speed limit in feet per second. Motorists who had passed the landmark (cone) when a pedestrian entered the crosswalk were scored as yielding to pedestrians but not as failing to yield, because they passed the point at which there was sufficient time to easily yield right-of-way to pedestrians. Motorists who had not yet crossed the dilemma zone boundary when the pedestrian entered the crosswalk were scored as yielding or not yielding because they had sufficient distance to safely stop given the speed limit.

**Scoring Driver Yielding Right-of-Way to Pedestrians**

Once a pedestrian indicated an intention to cross the street (by standing at the curb between the crosswalk lines facing the roadway or oncoming traffic with one foot in the roadway between the crosswalk lines and the other foot on the curb), the behavior of drivers who had not

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\(^1\) Where \( t = \) the perception/reaction time in seconds, \( v = \) the speed of approaching vehicles in ft/s (we substitute the posted speed limit in ft/s), \( a = \) the deceleration rate, recommended at 10ft/s\(^2\), \( G = \) acceleration due to gravity (32ft/s\(^2\)), and \( g = \) the grade of the approach in percent divided by 100.
yet crossed the dilemma zone boundary was scored as not yielding to pedestrians if they failed to yield.

When the pedestrian first started to cross, only drivers in the first half of the roadway were scored for yielding. Once the pedestrian approached within a half lane of the center of the road, the yielding behaviors of motorists in the remaining lane(s) were scored. This procedure was followed because it conformed to the obligation of motorists specified in most motor vehicle statutes. The observers used a clipboard and data sheets to record their observations of the research assistants who served as decoy pedestrians.

Observers scored motorist-yielding behavior for both staged crossings and any naturally occurring, or unstaged, crossings that took place during each data collection period. These data were disaggregated for analysis purposes. Data were recorded in sets of 20 staged crossings when vehicles were present that could yield or fail to yield right-of-way during each observation session.

Data Collection Schedule

A data sheet consisted of 20 staged crossings, and as many unstaged crossings as occurred during that period of time. Researchers collected three data sheets each week at each site for the duration of the study at 6 enforcement sites and 6 untreated generalization sites. All data were collected during daylight hours in the morning and afternoon at times that coincided with times scheduled for enforcement. Data were not collected when the pavement was wet, or at enforcement sites at times when enforcement was being carried out.

Staged crossing integrity

Occasional measures of crossing procedure integrity were employed as a control for procedural drift (the tendency of decoys to change their crossing behavior over time). Crossing integrity was assessed by video taping crossings and having an observer score the decoy’s crossing behavior from the videotape using a checklist based on the safe crossing procedure.

Inter-observer agreement (IOA)

IOA is a method of determining whether the observers are measuring the conditions reliably. IOA was calculated for 20% of the sheets collected. Each event that was scored the same by both observers was counted as an agreement and each event that was scored differently by each observer was scored as a disagreement. IOA was calculated by dividing the number of agreements during each session by the number of agreements during that session plus the number of disagreements for that session. The percentage of IOA for yielding behavior for staged crossings averaged 96.8% with a range of 70% to 100%. The percentage of IOA for unstaged, or natural, crossings averaged 84% with a range of 50% to 100%.

Data on perceived level of enforcement

The Gainesville Police Explorers (an organization of high school students who worked with the police) conducted a survey (under the direct supervision of a police officer) to determine if general deterrence increased, whether police activity was detected, and if drivers had been exposed to publicity materials. The Explorers were directly trained by the research team. One
A survey was conducted during the baseline condition before the program was initiated. The second survey was conducted several weeks after the first enforcement wave. The third survey was administered after the second enforcement wave and the final survey was administered after the fourth enforcement wave.

The intercept technique involves sampling or “intercepting” respondents who are near the locus of the interventions. Since we are interested in drivers, the intercept points were gas stations, parking lots at supermarkets, or other sites downstream of the data collection locations.

HIGH VISIBILITY PEDESTRIAN RIGHT-OF-WAY ENFORCEMENT

The total program implemented in Gainesville consisted of pedestrian right-of-way enforcement accompanied by the development and deployment of a variety of countermeasures to increase the visibility of the enforcement program.

Enforcement Elements

The enforcement phase consisted of four enforcement wave. Each enforcement wave consisted of 2 weeks of enforcement plus educational and engineering components. Educational and engineering interventions are described separately in subsequent sections. During the enforcement wave, each of the 6 enforcement sites received between 2 and 3 enforcement operations, for a total of 16 enforcement operations per wave. Each enforcement operation lasted from 60 to 90 minutes in durations. Enforcement operations were typically carried out by a 6 officer team, a decoy pedestrian, a spotter and two officers to flag vehicles and warn or cite violators at each side of the crosswalk. The fine for failing to yield to a pedestrian was $154.

Because Gainesville had not conducted previous pedestrian right-of-way enforcement the first two-week enforcement wave involved giving warnings unless the violation was very flagrant. During this period, police gave 1,177 warnings. Warnings were issued during the first phase to generate driver and public support for the program goals and to maximize the number of traffic stops observed by other drivers. The remaining three two-week enforcement operations all involved issuing citations to drivers that violated the pedestrian right-of-way statutes. During the second enforcement wave, police wrote 182 citations for failure to yield right-of-way to pedestrians. During the third wave, they wrote 153 citations and during the fourth wave, they wrote 66 citations.

Preparation for the deployment of the enforcement elements

The research team briefed traffic magistrates and the county prosecutor’s office on the elements of the enforcement program to address the perception of any legal issue such as entrapment related to HVE operations. This was done so traffic magistrates would understand the procedures to operationally define failure to yield if the violators chose to contest their citations.

Officer Training

Officers were trained prior to the start of the first enforcement wave. Considerable emphasis was placed on using the standard crossing protocol because the use of the protocol
helps ensure that citations will be upheld in court and, most importantly, ensures the safety of officers serving as decoy pedestrians.

**The Use of Decoy Pedestrians**

Police officers in plain clothes crossed as decoy pedestrians. This feature of the program provided three important advantages: Officers could maximize the number of stops during an operation; Officers crossed in accordance with the crosswalk statutes to ensure that citations, when they are given, stand up in court; Officers did not cross if the vehicle was inside the dilemma zone.

**The Use of Enforcement Flyers**

Enforcement flyers and asking for driver’s cooperation is a winning combination. Officers used a short standardized script that pointed out how serious the problem is, informs the person they are only getting a warning this time, and to asked them to help make their community a safer place by sharing the information they have received with friends and neighbors. Enforcement flyers were given to all drivers stopped for failing to yield right-of-way to pedestrians whether they were warned or received a written citation.

**The Use of Sandwich Board Signs**

Sandwich board signs were set up in the shoulder area at the flagging sites downstream from enforcement sites. These signs communicated to drivers traveling along the road that police were conducting an enforcement operation that stopped drivers that failed to yield right-of-way to pedestrians. Because pedestrian enforcement has not been conducted as frequently as seatbelt or speed limit enforcement, these signs ensured that motorists passing the enforcement operation were made aware that pedestrian right-of-way enforcement was being conducted.

**Education Elements**

**School Flyers**

School flyers were proactive and had two components. One flyer provided information on pedestrian safety for children and drivers. The second flyer was a notice that warned parents that enforcement was about to begin and asked them to be good community models by yielding to pedestrians. This component went home along with the safety flyer to the parents of all elementary and middle school students in Gainesville.

**Outreach to UF Faculty and Students**

The University of Florida prepared material to appear in the University of Florida newspaper and website “Inside UF.” These articles mentioned the requirement that drivers yield to pedestrians in crosswalks and publicized the ongoing enforcement operations.

**Earned Media**
Earned media refers to stories rather than paid ads. The Gainesville Police Department sent out press releases and was very effective in attracting the attention of printed and electronic new media. The Gainesville Sun newspaper covered pedestrian enforcement in a relatively consistent manner over the year. These stories sometimes appeared on the front page. The program also attracted attention from TV, radio, and the UF news. We documented 11 stories in the Gainesville Sun, 4 TV news stories and a number of radio stories.

Paid Radio Ads

The Gainesville Police Department prepared four radio ads and paid for prime time frequent presentation over a 5-week period. These ads focused on the requirement to yield right-of-way to pedestrians, and the danger of striking a pedestrian in a crosswalk.

Feedback Sign

Feedback signs were erected along busy roads within the City of Gainesville. These signs displayed the percentage of drivers yielding to pedestrians each week along with the highest level of yielding for a week attained to date (the record). The data presented on the signs was based on the data collected by the research assistants, and was changed every Monday based on the average percentage of drivers yielding the previous week.

Engineering Elements

The engineering elements included the use of advance yield markings (installed before data collection began) and in-street signs warning drivers that it was state law to yield to pedestrians at crosswalks. The in-street signs were introduced during the last enforcement wave. These signs were placed in the center of the road or in the median next to crosswalks. They reminded motorists that they were required by state law to yield to pedestrians in crosswalks.

The schedule of enforcement operations, concomitant education and engineering interventions is presented in Figure 1.

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<table>
<thead>
<tr>
<th>HVE Element</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
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<th>Jul</th>
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<th>Oct</th>
<th>Nov</th>
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</table>

Figure 1. Treatment Deployment Schedule

Results

The evaluation included measurements of yielding, an intercept survey of knowledge and awareness, and analyses of crashes.
Yielding Results

Yielding results for enforcement and generalization sites were examined for staged and naturally occurring pedestrians.

Yielding Results at Enforcement Sites

The average percent of drivers yielding for staged crossings during baseline and following each successive enforcement wave averaged across all enforcement sites are presented in Figure 2. It is clear that yielding increased following the initiation of the high visibility pedestrian right-of-way enforcement program at enforcement sites and yielding showed an increasing pattern over the duration of the program.

The individual site data are shown in tabular form in Table 1 for staged and unstaged crossings for the enforcement sites. An examination of Table 2 shows higher yielding for unstaged pedestrians than for staged pedestrians at all but the Gale Lemerand Drive site which had a high baseline level of yielding. Typically natural pedestrians crossings (unstaged crossings) were more assertive then staged crossings at the treatment sites. Natural pedestrians would often take a few steps into the crosswalk making themselves more visible to drivers as well as better convincing drivers of their intention to cross. Yielding for staged crossings averaged 31.5% during baseline and 62.0% by the end of the study. Yielding for unstaged crossing averaged 45.4% during baseline and 82.7% at the end of the study.

Figure 2. The Mean Percent of drivers yielding to pedestrians at enforcement sites during each condition of the experiment.
Table 1. The percentage of drivers yielding right-of-way to staged and unstaged crossings at each enforcement site during each condition of the experiment.

<table>
<thead>
<tr>
<th>Site</th>
<th>Staged</th>
<th>Unstaged</th>
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<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>Enforcement</td>
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<tr>
<td></td>
<td>Baseline</td>
<td>Enforcement</td>
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<tr>
<td>Staged</td>
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<tr>
<td>SE 15th Street at SE 11th Avenue</td>
<td>27.8</td>
<td>34.2</td>
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<tr>
<td>782 SW 2nd Avenue at Shands Hospital</td>
<td>30.9</td>
<td>49.0</td>
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<tr>
<td>University of Florida at Gale Lemerand</td>
<td>86.2</td>
<td>85.6</td>
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<tr>
<td>NE 16th Street at Saint Patrick's School</td>
<td>24.3</td>
<td>34.6</td>
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<td>NW13th Street at Gainesville High School</td>
<td>3.0</td>
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<td>50.8</td>
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<tr>
<td>Unstaged</td>
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<td>SE 15th Street at SE 11th Avenue</td>
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<td>782 SW 2nd Avenue at Shands Hospital</td>
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<td>55.0</td>
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<td>University of Florida at Gale Lemerand</td>
<td>86.3</td>
<td>71.9</td>
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<tr>
<td>MEAN</td>
<td>45.4</td>
<td>64.6</td>
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</table>

Yielding Results at Generalization Sites

The average percent of drivers yielding for staged crossings during baseline and following each successive enforcement wave averaged across all generalization sites are presented in Figure 3. It is clear that yielding also increased at the generalization sites following the initiation of the high visibility pedestrian right-of-way enforcement program at the enforcement sites and yielding also showed an increasing pattern over the duration of the program at these sites.

Figure 3. Mean percent of drivers yielding to pedestrians at the generalization sites during each condition of the experiment.
Data for staged and unstaged crossings are also shown in tabular form for the generalization sites in Table 2. An examination of the Table 3 shows the same pattern of higher yielding for unstaged crossings than for staged crossings. Yielding for staged crossings at generalization sites averaged 36.7% during baseline and 58.5% by the end of the study. Yielding for unstaged crossing at these sites averaged 49.6% during baseline and 72.9% percent at the end of the study.

Table 2. The percentage of drivers yielding right-of-way to staged and unstaged crossing at each generalization site during each condition of the experiment

<table>
<thead>
<tr>
<th>Site</th>
<th>Baseline</th>
<th>Enforcement</th>
<th>Enforcement &amp; Ticketing</th>
<th>Citations &amp; Ads</th>
<th>Enforcement &amp; Signs</th>
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<tr>
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<td>82.9</td>
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<td>70.0</td>
<td>72.7</td>
<td>79.0</td>
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</table>

Statistical Analysis of Yielding Results

The research design provided multiple sources of data that were subjected to formal statistical evaluation. These analyses were carried out to determine: (1) whether the evidence supports the conclusion that there are overall effects of the enforcement interventions at the enforced sites, and if so, the size of these effects; (2) whether the interventions generalize to other sites, and if so, the magnitude of the generalization; (3) whether generalization effects (if present) are associated with a possible measure of intervention diffusion.

Intervention Analysis

Time-series regression models of the general type described by Huitema and McKean (1998, 1999, & 2000) were used to evaluate intervention effects in the enforced and generalization sites. The specific form of the model was determined for the data obtained from each of the 12 sites and for the weekly averaged data that were pooled from these sites. The final models that were applied and contained either three or nine parameters. Data from most of the sites were modeled using a three-parameter model that provided measures of baseline level, level change, and slope change from the baseline phase to the remaining phases. The more complex nine-parameter model was required for several series because they did not exhibit the simple structure that was adequate for the data from most sites. This more complex model provides a measure of baseline level, a measure of level change from each phase to the next, and a measure of slope change from phase to phase. Because the design contains five phases, there are four level change measures and four slope change measures. This complex model was initially applied to the data from each site, but model comparison tests indicated that the three-parameter
model was more satisfactory for most sites. The simpler model is desirable because it provides both higher power and simpler description of the data.

**Intervention Effect Results - Enforced Sites**

Table 3 summarizes the outcome on both the weekly average percentage yielding and the individual site yielding for the enforced sites. The second and third columns indicate the level change and the associated *p*-value, the fourth and fifth columns indicate the slope (trend) change and the associated *p*-value, and the baseline level and the level at the end of the study are in columns six and seven. Level change is the difference between (1) the value of the yield measure that is predicted to occur after intervention in the absence of an effect and (2) the yield that is actually observed after intervention. Slope change refers to the difference between the trend measured during the baseline phase and the trend measured during the subsequent intervention phase. Level change and slope change are both measures of intervention effects.

The difference between the level at the beginning of the study and the level at the end of the study is shown in column 8. With the exception of the site that had very high yielding at the beginning of the study, all other sites have both a statistically significant effect (on either level change or slope change) and a large practical effect, as measured by level change, slope change, or the difference between the baseline level and the level at the end of the study.

**Table 3. Results of the time-series regression analysis for the experimental sites. LC1 = Level change from the baseline phase to the subsequent phase and SC1 = Slope Change from the baseline phase to the subsequent intervention phase.**

<table>
<thead>
<tr>
<th>Site</th>
<th>LC1</th>
<th><em>p</em>-value</th>
<th>SC1</th>
<th><em>p</em>-value</th>
<th>Baseline Level</th>
<th>Level at end of study</th>
<th>End level minus baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average for all six Enforcement sites</td>
<td>11.97</td>
<td>&lt;.001</td>
<td>.484</td>
<td>&lt;.001</td>
<td>30.63</td>
<td>67.3</td>
<td>36.7</td>
</tr>
<tr>
<td>Enforcement Site 1</td>
<td>6.52</td>
<td>.26</td>
<td>1.06</td>
<td>&lt;.001</td>
<td>28.63</td>
<td>84.34</td>
<td>55.71</td>
</tr>
<tr>
<td>Enforcement Site 2</td>
<td>21.41</td>
<td>&lt;.001</td>
<td>.369</td>
<td>&lt;.001</td>
<td>30.18</td>
<td>70.43</td>
<td>40.25</td>
</tr>
<tr>
<td>Enforcement Site 3</td>
<td>-2.49</td>
<td>.46</td>
<td>-.007</td>
<td>.912</td>
<td>85.83</td>
<td>82.98</td>
<td>-2.85</td>
</tr>
<tr>
<td>Enforcement Site 4</td>
<td>9.11</td>
<td>.009</td>
<td>.738</td>
<td>&lt;.001</td>
<td>22.48</td>
<td>69.21</td>
<td>46.73</td>
</tr>
<tr>
<td>Enforcement Site 5</td>
<td>7.10</td>
<td>.042</td>
<td>.500</td>
<td>&lt;.001</td>
<td>3.10</td>
<td>35.76</td>
<td>32.66</td>
</tr>
<tr>
<td>Enforcement Site 6</td>
<td>30.55</td>
<td>&lt;.001</td>
<td>.002</td>
<td>.79</td>
<td>17.52</td>
<td>49.29</td>
<td>31.77</td>
</tr>
</tbody>
</table>
Intervention Effect Results - Generalization Sites

Notice in Table 4 that the difference between the average weekly baseline level and the level at the end of the study is approximately one-half the corresponding difference in the enforcement sites. However, all but one of the individual generalization sites had a statistically significant level or slope change. Hence, both site types increased yielding behavior but the enforcement sites had larger increases. It should be noted that the site that did not show a significant change was the site that did not have a painted crosswalk near the police station (another crosswalk was painted by mistake and the error was not reported until baseline data were collected and the treatment introduced.

Table 4. Results of the time-series regression analysis for the generalization (control) sites.

LC1 = Level change from the baseline phase to the subsequent phase and SC1 = Slope Change from the baseline phase to the subsequent intervention phase.

<table>
<thead>
<tr>
<th>Site</th>
<th>LC1</th>
<th>p-value</th>
<th>SC1</th>
<th>p-value</th>
<th>Baseline Level</th>
<th>Level at end of study</th>
<th>End level minus baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average of all generalization sites</td>
<td>10.80</td>
<td>.010</td>
<td>.158</td>
<td>.044</td>
<td>37.48</td>
<td>56.30</td>
<td>18.82</td>
</tr>
<tr>
<td>Generalization Site 1</td>
<td>-9.74</td>
<td>.002</td>
<td>.243</td>
<td>&lt;.001</td>
<td>85.00</td>
<td>87.64</td>
<td>2.64</td>
</tr>
<tr>
<td>Generalization Site 2</td>
<td>22.33</td>
<td>&lt;.001</td>
<td>.129</td>
<td>.204</td>
<td>12.77</td>
<td>47.69</td>
<td>34.92</td>
</tr>
<tr>
<td>Generalization Site 3</td>
<td>4.94</td>
<td>.011</td>
<td>.095</td>
<td>.017</td>
<td>6.52</td>
<td>16.29</td>
<td>9.77</td>
</tr>
<tr>
<td>Generalization Site 4</td>
<td>23.08</td>
<td>&lt;.001</td>
<td>-2.28</td>
<td>.004</td>
<td>43.06</td>
<td>59.46</td>
<td>12.73</td>
</tr>
<tr>
<td>Generalization Site 5</td>
<td>15.34</td>
<td>.036</td>
<td>-.406</td>
<td>.73</td>
<td>35.04</td>
<td>79.69</td>
<td>44.65</td>
</tr>
<tr>
<td>Generalization Site 6</td>
<td>10.76</td>
<td>.018</td>
<td>.447</td>
<td>&lt;.001</td>
<td>37.03</td>
<td>70.59</td>
<td>33.56</td>
</tr>
</tbody>
</table>

Regression Tests

The enforcement group slope (.484) is approximately three times the value of the generalization group slope (.157). A test on the difference (enforcement versus generalization) between the overall rate of increase in yielding for the two groups of sites is statistically significant (p <.001). The test used is similar to a conventional homogeneity of regression test that is often used in analysis of covariance applications, but it was modified for the time-series context of the present study. It is clear from these analyses that as a whole, there were increases in yielding behavior for both groups of sites, but the enforcement group was associated with much larger increases.

Intervention Diffusion

The statistical results on the generalization sites indicate an obvious increase in yielding across time even without the enforcement interventions. There is variation in yielding behavior, however, within the group of generalization sites. It is relevant to inquire whether the variation in
yielding increase (i.e., the steepness of the individual site slopes) is associated with intervention diffusion. Hence, the distance from each generalization site to the nearest enforcement site was measured. The overall slope for each site was then correlated with the distance measure for the 6 generalization sites. The relationship was, $r = -0.88$ ($p = .02$). Overall, this suggests that as the distance from the enforcement site increases, the slope measuring yielding behavior over time and conditions decreases.

**Effects of Staging**

Although yielding behavior was measured under both staged and unstaged conditions, the focus was on staged data collection. A comparison of results under the two conditions was undertaken to evaluate support for the staged protocol. The average increases in yielding associated with both staged and unstaged approaches used at the enforcement sites were compared. The unstaged (square) regression line is above the staged regression line, but the difference between the means, which is similar during all five conditions, is not statistically significant ($p > .16$). If adjustment is made for the difference present at baseline, there is no evidence of differential responding when a staged intervention is used. Hence, use of staged pedestrians appears to be supported.

**Knowledge, Attitudes, and Awareness**

An inherent part of the intervention in Gainesville was to generate high visibility. The survey conducted by the Gainesville Police Department provides confidence that the program was active, perceived by the public, and conveyed messages about pedestrian right-of-way enforcement. The large changes in yielding behavior provide support for the program’s success. One interesting survey result was the magnitude of recognition of the community feedback signs showing the percentage of drivers yielding to pedestrians. The percentage of the sample saying they had seen a sign jumped from 13.0% at baseline before the signs were erected, to 52.8% in April 2010 and then 75.2% and 77.8% in September 2010 and January 2011, respectively. The overall distribution is significant ($p=.001$), and each of the three post-baseline waves is significantly higher in “Yes” responses (and lower in “No” responses) than the baseline wave ($p < .05$). It is also noteworthy that the September 2010 and January 2011 percentage of “Yes” responses is also significantly higher than the April 2010 level ($p < .05$).

**DISCUSSION**

This study was designed to evaluate the effect of a high visibility pedestrian enforcement operation on driver yielding right-of-way to pedestrians and driver perception of enforcement. A second purpose was to determine whether the effects of the treatment generalize from treated to untreated crosswalk locations. In order to establish a perception of a high level of enforcement, it was essential that the program attract broad attention within the community. This was achieved by implementing frequent prompts or reminders to drivers through a number of measures that help ensure broad media coverage, by sending reminders to parents and other community stakeholders, providing community feedback, paid media, and signs at crosswalks that remind drivers of the legal obligation to yield right-of-way at crosswalks.

This study produced six interesting results.
1. Enforcement led to a slow and steady increase in the percentage of drivers yielding right-of-way to pedestrians over the course of the year.
2. The program produced higher levels of yielding to natural pedestrian crossings than to staged crossing and the changes in both were highly correlated.
3. The effects of the program generalized to crosswalks that were not targeted for pedestrian right-of-way enforcement.
4. The amount of generalization to unenforced sites was inversely proportional to the distance from sites that received enforcement.

The slow but steady increase in yielding behavior over the course of the study provides added evidence that the high visibility elements that were introduced in a stepwise manner contributed to the overall success of the program. The awareness survey also confirmed that different elements of the program each played a role in producing the change in driver behavior. The presence of a high degree of generalization also helps confirm the effect of high visibility enforcement on driver perception of being ticketed for failing to yield right-of-way to pedestrians. The survey contributed by the Gainesville Police Department also provides confidence that the program was active, perceived by the public, and conveyed messages about pedestrian right-of-way enforcement.

It is also interesting that drivers yielded at higher levels to naturally-occurring pedestrian crossings than to staged crossings. These data replicate a finding by Van Houten, Ellis, and Marmolejo (2008). One possible reason for this effect is that naturally occurring pedestrians may cross more assertively than pedestrians following a safety protocol for staged crossing.

Although yielding right-of-way showed a large increase over the course of the program, there were a couple of reasons why it was not possible to conclude that the program reduced pedestrian crashes. First, although the changes observed were in the right direction the sample size was too small to yield data for statistical analysis. Second, crashes in crosswalks related to drivers failing to yield right-of-way to pedestrians are only a subset of all pedestrian crashes. Third, the program did not produce an instantaneous increase in yielding behavior to high levels but instead produced a steady but slow increase over the course of the year.

The results of this study suggest that local agencies can produce a culture shift in the percentage of drivers yielding right-of-way to pedestrians. However, it is clear that the program must employ high visibility elements, and receive consistent focus for a period of at least a year. It is likely that the effort required to produce such a shift is also a function of the size of the city. Large cities would likely require a longer treatment period to produce similar results. It is unclear whether occasional operations need to be continued to sustain an effect once the majority of drivers are yielding to pedestrians. Future research should address this question.
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References


