

*EFFECTS OF A DRIVER ENFORCEMENT PROGRAM ON  
YIELDING TO PEDESTRIANS*

RON VAN HOUTEN

MOUNT SAINT VINCENT UNIVERSITY

AND

J. E. LOUIS MALENFANT

CENTER FOR EDUCATION AND RESEARCH IN SAFETY  
SHEDIAC, NEW BRUNSWICK

A driver-yielding enforcement program that included decoy pedestrians, feedback flyers, written and verbal warnings, and saturation enforcement for a 2-week period was evaluated in the city of Miami Beach using a multiple baseline design. During baseline, data were collected at crosswalks along two major corridors. Treatment was introduced first at selected crosswalks without traffic signals along one corridor. A week later, enforcement was shifted to crosswalks along the second corridor. Results indicated that the percentage of drivers yielding to pedestrians increased following the introduction of the enforcement program in each corridor and that these increases were sustained for a period of a year with minimal additional enforcement. The effects also generalized somewhat to untreated crosswalks in both corridors, as well as to crosswalks with traffic signals.

DESCRIPTORS: generalization, pedestrian safety, police enforcement, punishment

Pedestrian crashes account for 20% of traffic fatalities in the state of Florida. Florida also has vacillated between having the highest and second highest rate of pedestrian fatalities in the country, with a rate that is almost twice the national average. More specifically, the Miami–Dade area, which includes the city of Miami Beach, has been rated first on the Florida Department of Transportation’s FDOT 402 Crash Matrix for Pedestrian Problems for the last 11 years. This matrix rates each county in fatality and injury crashes according to a composite index that is corrected for population.

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Reprints can be obtained from Ron Van Houten, Psychology Department, Mount Saint Vincent University, Halifax, Nova Scotia B3M 2J6, Canada (e-mail: Rvh@cers-safety.com).

Recently, research has examined a variety of procedures to increase driver safety (e.g., Gras, Cunill, Planes, Sullman, & Oliveras, 2003). One way to modify driver behavior is through enforcement programs. Van Houten and Nau (1983) compared the effects of an enforcement program that issued citations with one that issued primarily written and verbal warnings on speeding on urban streets. The results indicated that the effects of a 1-week enforcement program, which relied on citations alone, persisted only while the program was in effect, but that the effects of the warning program persisted for up to a year. These results were later replicated in Israel (Van Houten, Rolider, et al., 1985), and were associated with significant crash reductions (Scherer, Freidmann, Rolider, & Van Houten, 1985).

Van Houten, Malenfant, and Rolider (1985) evaluated a similar program to increase drivers’ yielding to pedestrians in two Canadian cities. The combined use of warnings, decoy pedestrians, information flyers,

community feedback, and operant scheduling techniques produced a marked and sustained increase in yielding to pedestrians on selected streets in both cities. This program was one component of a multifaceted "Courtesy Promotes Safety" program that also included traffic-engineering components; this program was evaluated on a city-wide basis in three Canadian cities (Malenfant & Van Houten, 1989). The engineering components included (a) pavement markings and signs prompting motorists to yield farther back from the crosswalk, (b) signs prompting pedestrians to extend their arm to signal their intention to cross the street, (c) signs prompting pedestrians to thank drivers who yielded, and (d) signs posting the percentage of drivers yielding to pedestrians during the past week. The treatment package produced a large increase in the percentage of drivers yielding to pedestrians in crosswalks and reductions in pedestrian crashes in crosswalks in these three cities.

Although data indicate that the "Courtesy Promotes Safety" program can increase driver yielding to pedestrians and that the use of some of the engineering components can increase yielding when used alone (Van Houten, 1988; Van Houten & Malenfant, 1992), it is not known whether the enforcement component alone can increase the yielding behavior of drivers. It is important to evaluate the effectiveness of enforcement programs per se because police do not always have control over the behavior of traffic engineers. Although cooperation between police traffic-management staff and city traffic engineers is desirable, engineering and police budgets and administration are separate, and police administrators and traffic-engineering administrators may not share the same priorities. However, just as traffic-engineering staff can introduce engineering components of the "Courtesy Promotes Safety" program in isolation, it is also possible for police to introduce the enforcement component alone

when it is not feasible to implement the entire package. Therefore, one purpose of this research was to evaluate the effect of the enforcement component without the engineering components on driver yielding to pedestrians.

Although previous research has indicated that the effects of enforcement at uncontrolled crosswalks may generalize to untreated uncontrolled crosswalks, it is unknown whether enforcement at uncontrolled crosswalks will generalize to crosswalks controlled by traffic signals. Evidence of generalization to crosswalks controlled by traffic signals would be useful because it is more difficult to enforce yielding to pedestrians at traffic signals. Pedestrian right of way is easier to enforce at uncontrolled crosswalks because (a) pedestrians always have the right of way at these locations but have the right of way only when the WALK light is active at crosswalks controlled by traffic signals, (b) there are fewer vehicles on conflicting paths with pedestrians at traffic signals than at uncontrolled crosswalks, and (c) it is often more difficult to pull over vehicles in close proximity to traffic signals in busy areas.

Therefore, the two purposes for conducting this research were (a) to determine whether the enforcement component of the "Courtesy Promotes Safety" program without its engineering components could produce large and sustained increases in yielding to pedestrians, and (b) to determine whether changes in yielding behavior produced by enforcement at uncontrolled crosswalks would generalize to untreated crosswalks controlled by traffic signals.

## METHOD

### *Subjects and Setting*

Subjects were drivers traveling on two high-crash corridors in Miami Beach. South Miami Beach has significantly more crashes than any other area in Miami-Dade County,

averaging over 100 crashes per year, and most of these crashes occur in a small portion of South Miami Beach. A Geographical Information System map of Miami Beach over a 5-year period showing crash locations in the two target corridors is shown in Figure 1. More than one crash occurred at a number of these locations. One corridor was located on the east side of the city near the beach and included three parallel streets: Collins Avenue, Ocean Drive, and Washington Avenue; the other corridor was located on the west side of the city and included two parallel streets: Alton Road and West Street.

Four crosswalks in each corridor, all located at marked crosswalks without traffic signals, were selected to receive the enforcement program. Additional sites selected to test for generalization included seven marked crosswalks at intersections controlled by traffic signals and pedestrian signals, two marked crosswalks at intersections without traffic signals (similar to the treated sites), two unmarked crosswalks (intersection locations) without traffic signals, and one marked crosswalk located at a midblock location that did not have a traffic signal. Only crosswalks with high pedestrian volumes and histories of recent pedestrian crashes were selected for measuring yielding to pedestrians. Overall, data were collected at a total of 20 crosswalks (8 treated, 12 untreated).

#### *Measures at Crosswalks without Traffic Signals*

During each session, data were collected on a sample of 20 pedestrians crossing the street when vehicles were present that could influence crossing behavior. Data were collected on weekdays during daylight hours when it was not raining. Typically, only one data sheet would be filled per day at each site. However, on some occasions it was necessary to collect more than one data sheet to make up for data lost because of rain. Measures were never obtained at any site at times

when police were conducting an enforcement operation.

At crosswalks without traffic signals, observers measured the following four behaviors: the number of drivers who did and did not yield to pedestrians in crosswalks, the number of driver-pedestrian conflicts that involved evasive action taken by a pedestrian or driver, the number of pedestrians trapped at the centerline by drivers who failed to yield to them, and the percentage of drivers who yielded at least 3.26 m (10 ft) in advance of the crosswalk.

*Drivers yielding to pedestrians.* Observers scored the percentage of motorists yielding and not yielding to pedestrians. A motorist was scored as yielding if he or she stopped or slowed and allowed the pedestrian to cross. A motorist was scored as not yielding if he or she passed in front of the pedestrian but would have been able to stop when the pedestrian arrived at the crosswalk. We used a formula used by traffic engineers to determine whether a driver could safely stop. Calculating the distance beyond which a motorist can safely stop for a pedestrian is essentially the same problem as calculating the distance that a motorist driving the speed limit can stop for a traffic signal that changes to red. 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. This formula was used to measure the distance beyond which a driver could safely stop for a pedestrian, and a landmark was placed at this distance on each side of each crosswalk by marking the curb with tape. Motorists who had passed this landmark when the pedestrian started to cross could be scored as yielding to pedestrians but not for failing to yield. Motorists beyond the landmark when the pedestrian entered the crosswalk could be scored as yielding or not yielding because they had sufficient distance

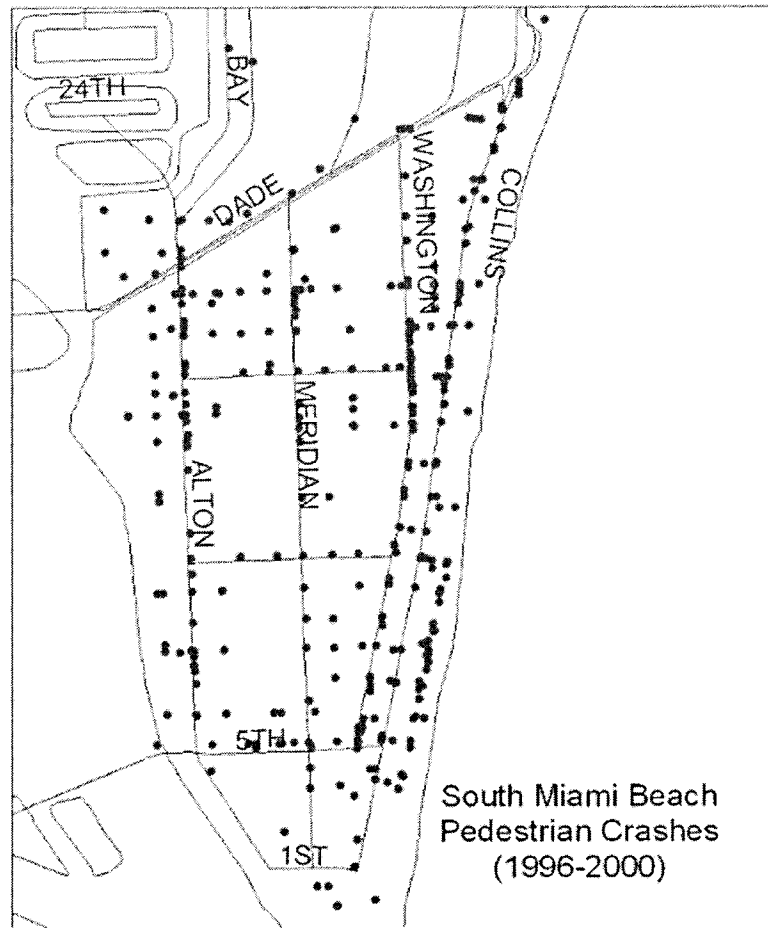


Figure 1. A plot of pedestrian crashes in Miami Beach.

to stop safely. When the pedestrian first started to cross, only drivers in the first half of the roadway were scored for yielding. Once the pedestrian approached the painted median, the yielding behaviors of motorists in the remaining two lanes were scored. This procedure was followed because it conformed to the obligation of motorists specified in the Florida statutes.

*Conflicts between motorists and pedestrians.* A conflict between a motorist and a pedestrian was scored whenever a motorist suddenly stopped or swerved to avoid striking a pedestrian or whenever a pedestrian jumped, ran, or suddenly stepped or lunged backward to avoid being struck by a vehicle.

*Pedestrian trapped at the centerline.* A pe-

destrian was scored as trapped at the center whenever he or she had to wait at the centerline or median for 10 s or more because at least one car in the second half of the roadway did not yield. Increases in yielding reduced wait time because the duration of the wait was dependent on the number of drivers who did not yield and the traffic flow.

*Yielding at least 10 ft in advance of the crosswalk.* Yielding at least 10 ft in advance of the crosswalk was scored by determining whether the yielding motorist was behind a mark 10 ft in advance of the crosswalk when the pedestrian crossed the lane directly in front of the vehicle. This measure provided some indication of whether the driver en-

gaged in observing behavior because motorists who only notice the pedestrian at the last moment would be expected to yield closer to the crosswalk.

#### *Measures at Crosswalks with Traffic Signals*

The observers measured the following two behaviors at crosswalks with traffic signals: the number of drivers of turning vehicles who did or did not yield to pedestrians, and the number of driver–pedestrian conflicts that involved a driver or pedestrian taking evasive action.

*Motorists' yielding behavior.* Motorists' yielding behavior was scored only when the pedestrian had the right of way (i.e., started crossing when the WALK sign was on). Drivers were scored as yielding when they stopped or slowed to allow the pedestrian to clear their path before proceeding. Drivers were scored as not yielding to a pedestrian if they turned within a lane of a pedestrian's path.

*Conflicts between motorists and pedestrians.* A conflict with a turning vehicle was scored whenever a motorist suddenly stopped or swerved to avoid striking the pedestrian or when a pedestrian jumped, ran, or suddenly stepped or lunged backward to avoid being struck by a turning vehicle.

#### *Interobserver Agreement*

Interobserver agreement was assessed by having two observers independently score driver behavior during at least two recording sessions at each site during each experimental condition. During sessions in which agreement data were collected, the two observers stood several meters apart at a location having an unobstructed view of the crosswalk. When more than one pedestrian was crossing at a particular crosswalk, the primary observer identified the pedestrian for whom yielding behavior was scored. Interobserver agreement was computed by di-

viding the number of agreements on the occurrence of each target behavior by agreements plus disagreements and multiplying by 100%. An agreement on yielding was scored only if both observers scored all vehicles the same for each pedestrian. An agreement on yielding more than 10 ft in advance of the crosswalk was scored if both observers scored the driver as yielding at a point more than or less than 10 ft in advance of the crosswalk for each pedestrian. An agreement on the occurrence of conflicts was scored if both observers scored an event as a conflict, and an agreement for a pedestrian being trapped at the centerline was scored if both observers scored the pedestrian as trapped. Agreement at the eight treated sites averaged 91.6% for yielding (range, 80% to 100%), 100% for conflicts, 93% for trapped at the centerline (range, 80% to 100%), and 84% for yielding at least 10 ft in advance of the crosswalk (range, 75% to 95%). Agreement on yielding behavior at the 12 untreated sites averaged 89% (range, 78% to 94%).

#### *Experimental Design*

A multiple baseline across settings design was used. Repeated measures of yielding behavior and driver–pedestrian conflicts were recorded daily at four marked crosswalks in both the west and east corridors (none of these had traffic signals). Following baseline, treatment was introduced sequentially in two corridors. A maintenance condition was then in effect for 1 year.

*Baseline.* No enforcement was implemented during baseline. Police reported that they had never conducted a driver enforcement operation for failing to yield to pedestrians prior to this study and that motorists were stopped for failing to yield to a pedestrian only when a pedestrian had been struck in a crosswalk. Although selective enforcement of speeding, impaired driving, and, to a lesser extent, drivers running red lights is oc-

asionally carried out by police departments, enforcement for failing to yield to pedestrians is rarely carried out. Thus, the baseline condition was typical of what normally occurred.

*Intensive enforcement.* Following baseline, the enforcement program was introduced first at the four crosswalks located in the west corridor. Once changes in driver compliance in the west corridor had been documented, the enforcement operation was introduced in the east corridor. Police enforcement was conducted with teams that included (a) a decoy pedestrian (plainclothes police officer) who crossed when other pedestrians were not present, and (b) a spotter located on the sidewalk who radioed failure to yield violations to (c) other officers who flagged violators and gave them an enforcement flyer and either a verbal warning or a citation (ticket associated with a fine). Most motorists received the flyer and a warning; however, flagrant violators who endangered a pedestrian by passing too close, swerving around the pedestrian, honking the horn at the pedestrian, or traveling above the speed limit were cited. Vehicles were pulled over within a block from the crosswalk and therefore were visible to drivers approaching the crosswalk.

Prior to beginning each enforcement operation, police placed cones at locations on each end of the crosswalk. Because the speed limit in each of the zones was 30 mph, the police placed the cones 140 ft in advance of the crosswalk (this distance was calculated using the signal-timing formula mentioned previously). Officers pulled over drivers who failed to yield only if the drivers had not passed the cones when the pedestrian entered the crosswalk. Motorists who were pulled over were informed that they failed to yield to a pedestrian in a crosswalk and were given a warning flyer, which included information on the number of pedestrians killed or injured in Miami Beach and asked

the driver to help make the community a safer place for themselves and loved ones (see Figure 2). The police officer quickly summarized the content of the flyer, and if the violation was not flagrant, issued a verbal or written warning ticket and asked the violator to help keep pedestrians safe by yielding in the future. If the violation was flagrant, the officer wrote a citation for failing to yield to a pedestrian. Enforcement operations typically lasted from 1.5 to 2 hr.

The decoy pedestrian entered the crosswalk when a vehicle was beyond the cone if a pedestrian was not crossing in the street. If the motorists began to slow, the decoy would begin to cross. If the motorist did not slow, the decoy waited, and the motorist was stopped for failing to yield. No data were collected at a crosswalk while police were conducting an enforcement operation.

Police also issued a press release during the end of the 2nd week of the enforcement program, which generated coverage by electronic and print media. A favorable story was run on the Fox network for an entire day, and a story with pictures appeared in *The Miami Herald*. The Miami Beach police also placed announcements publicizing the program on the community television channel.

*Maintenance.* Data were collected at the eight treated sites for one year following the introduction of treatment at the first corridor to evaluate maintenance of treatment effects over time. During the maintenance condition, observers conducted one observation session at each of the eight sites at the end of each month. During this phase, police conducted one enforcement operation every 6 weeks at the eight treatment sites, and occasional stories appeared in the electronic and print media about police enforcement of pedestrian right-of-way.

*Generalization.* Data were collected at each of the 12 untreated sites during baseline, while the eight experimental sites re-



You have just failed to yield to a pedestrian at a crosswalk in

## MIAMI BEACH

In the past year more than 1643 pedestrians were injured and 81 were killed by drivers in Miami-Dade County. **An average of almost five (5) pedestrians injured or killed every day.** The majority of pedestrians killed or injured were children and senior citizens.

Data gathered at crosswalks in this county indicate that drivers do not pay enough attention to pedestrians at crosswalks, often fail to yield the right of way and are involved in near hits. Unfortunately many people drive with the attitude that they always have the right of way and that pedestrians should only enter a crosswalk when there are no oncoming vehicles.

**The law in Florida is clear, section 316.130 states:**

"When traffic signals are not present or not operational, the driver of a vehicle **must yield the right of way**, slowing or stopping if necessary to pedestrians crossing within a crosswalk upon the half of the roadway upon which the vehicle is traveling or when the pedestrian is approaching too closely from the opposite half of the roadway as to be in danger. Drivers may not overtake other drivers stopped at a **marked or unmarked** crosswalk.

**A note about crosswalks:** Pavement markings are not required for crosswalks at intersections. Imaginary lines connecting the sidewalk on opposite sides of an intersection define an unmarked crosswalk. Pedestrians in unmarked crosswalks have all the rights of pedestrians in marked crosswalks.

**Section 316.075 states:** "The driver of a vehicle making a right turn on red must yield the right of way to all pedestrians crossing the intersection roadway or proceeding as directed by the signal."

The most dangerous threat to pedestrians by drivers occur when they turn at intersections, overtake stopped vehicles at a crosswalk, speed and drive with undue care and control.

Drivers must pay more attention to crosswalks. The fine for failing to yield to a pedestrian at a crosswalk is \$90, however carrying the responsibility of injuring or killing a pedestrian is more difficult to bear than the possible consequences of being charged.

**We are trying to make your streets safer for you and your family. Help us by cooperating and by encouraging others to do the same.**

THE MIAMI BEACH POLICE

Figure 2. The flyer handed out to violators who were stopped for failing to yield to pedestrians.

ceived the enforcement treatment, and for 1 year after treatment was first introduced at the eight experimental sites. Data collection consisted of five observation sessions during each condition.

## RESULTS

### *Data from the Eight Treated Sites*

The police stopped 1,562 motorists for failing to yield to pedestrians over the period of the study (1,218 were stopped during the first 2 weeks of the program). This included

307 citations, 188 of which were given during the first 2 weeks of the program. The percentage of drivers yielding to pedestrians at each of the four sites in the west and east corridors during each weekday session and during monthly maintenance assessments is presented in Figure 3 (top). These data show that 3.3% and 18.2% of drivers yielded to pedestrians in the west corridor and east corridor, respectively, during baseline. Introduction of the enforcement program at the four sites in the west corridor led to an increase in yielding to 27.6% during the 1st week of

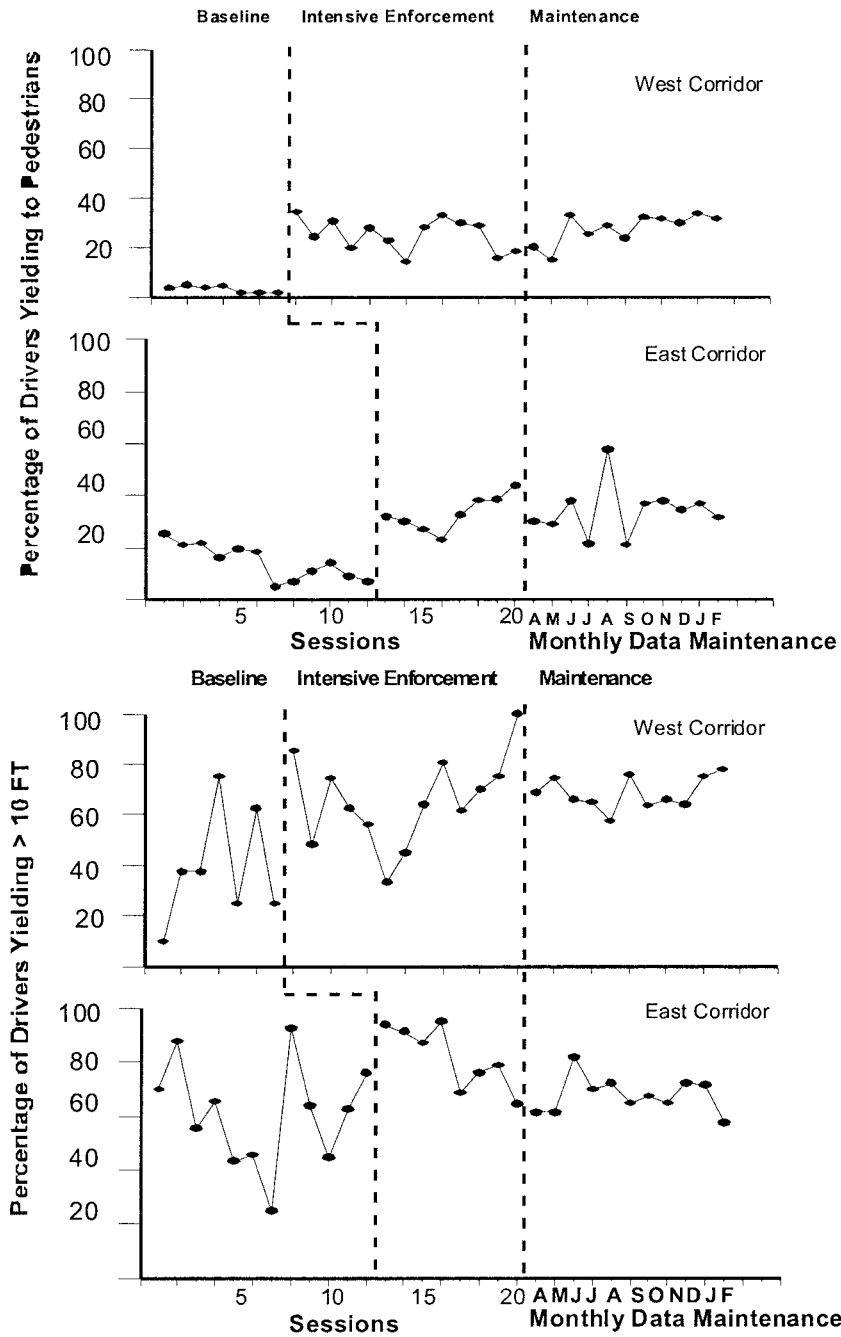


Figure 3. The percentage of drivers yielding to pedestrians at the experimental sites in the west and east crash corridors during baseline, enforcement, and maintenance conditions (top). The percentage of drivers yielding to pedestrians more than 10 ft in front of the crosswalk at the experimental sites in the west and east crash corridors during baseline, enforcement, and maintenance conditions (bottom).



the program, while no increase in yielding occurred at the untreated east corridor. Introduction of the program in the east corridor led to an increase in yielding to 33.1%. Maintenance data indicate that the gains produced by the program were maintained in the absence of high levels of police enforcement (enforcement averaged one operation every 6 weeks), with overall yielding rates of 27.8% in the west corridor and 34.1% in the east corridor during the maintenance condition.

The percentage of drivers yielding more than 10 ft from the crosswalk during each condition of the experiment at both sites is presented in Figure 3 (bottom). These data show that the percentage of drivers yielding at least 10 ft ahead of the crosswalk initially increased from 38.9% to 65.9% in the west corridor and from 61.1% to 82% in the east corridor. Although this increase was sustained in the west corridor, yielding more than 10 ft from the crosswalk gradually decreased to baseline levels during the maintenance condition in the east corridor.

The percentage of conflicts during each session is presented in Figure 4 (top). These data show that the percentage of conflicts decreased following treatment in the west corridor and that this effect was generally sustained during the maintenance condition. The results for the east corridor are more equivocal because the rate of conflicts decreased during the second half of the baseline condition and initially increased before declining when treatment was introduced.

Figure 4 also shows the percentage of pedestrians stranded in the roadway during all conditions of the experiment. These data showed negligible change from baseline to enforcement in the west corridor (17% to 13.3%) but a more noticeable decrease in the east corridor (6.3% to 2.0%). The percentage of pedestrians stranded during maintenance decreased in the west corridor but

increased before decreasing again in the east corridor.

#### *Data from the 12 Untreated Sites*

The data from the 12 generalization sites are presented in Figure 5. Yielding to pedestrians showed only a modest increase at two of the seven sites with traffic signals during the treatment condition but increased at six of these intersections during the maintenance condition. The average percentage of yielding increased from 44.5% during baseline to 58% during the maintenance condition at the intersections with traffic signals.

Data for two uncontrolled marked crosswalks that were not treated showed an increase in yielding from an average of 20.5% during baseline to 32.1% during the treatment condition and 54.8% during the maintenance condition. The increase at one of these crosswalks, on Ocean Drive, was greater than that produced at any of the treated sites.

The data from two unmarked crosswalks showed a decline in yielding from 29.4% in baseline to 11.2% during the treatment condition but an increase to 53.3% and 55% during maintenance conditions. Data from a single multilane midblock marked crosswalk did not show any change associated with the enforcement operations.

## DISCUSSION

Results of the study indicated that a 2-week intensive enforcement program increased yielding to pedestrians at sites where enforcement was implemented and that this increase was sustained over the course of a year even though the level of enforcement was greatly reduced. The intervention was also associated with a change in yielding to pedestrians during the maintenance period at 10 of the 12 generalization sites, which received no enforcement, including yielding by drivers of turning vehicles at crosswalks

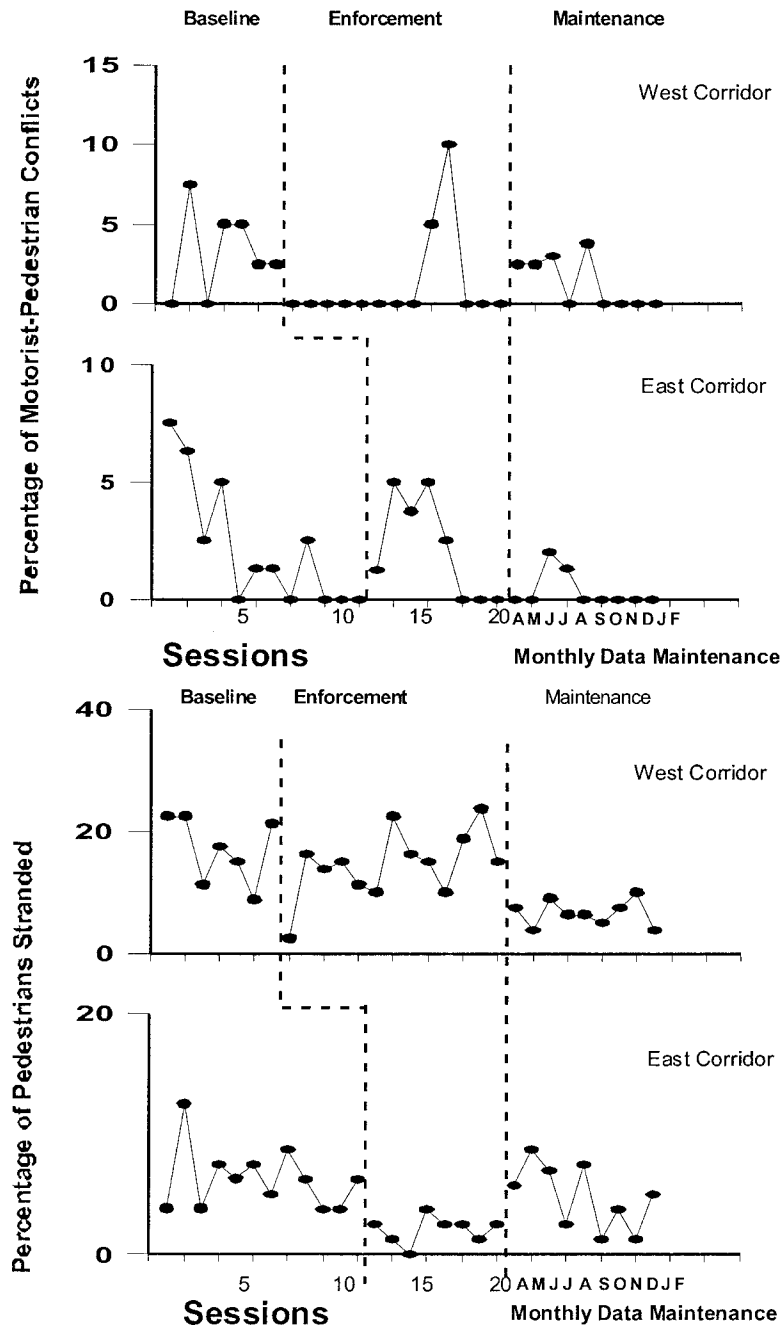


Figure 4. The percentage of conflicts at the experimental sites in the west and east crash corridors during the baseline, enforcement, and maintenance conditions (top). The percentage of pedestrians stranded in the center of the roadway at the experimental sites in the west and east crash corridors during baseline, enforcement, and maintenance conditions (bottom).

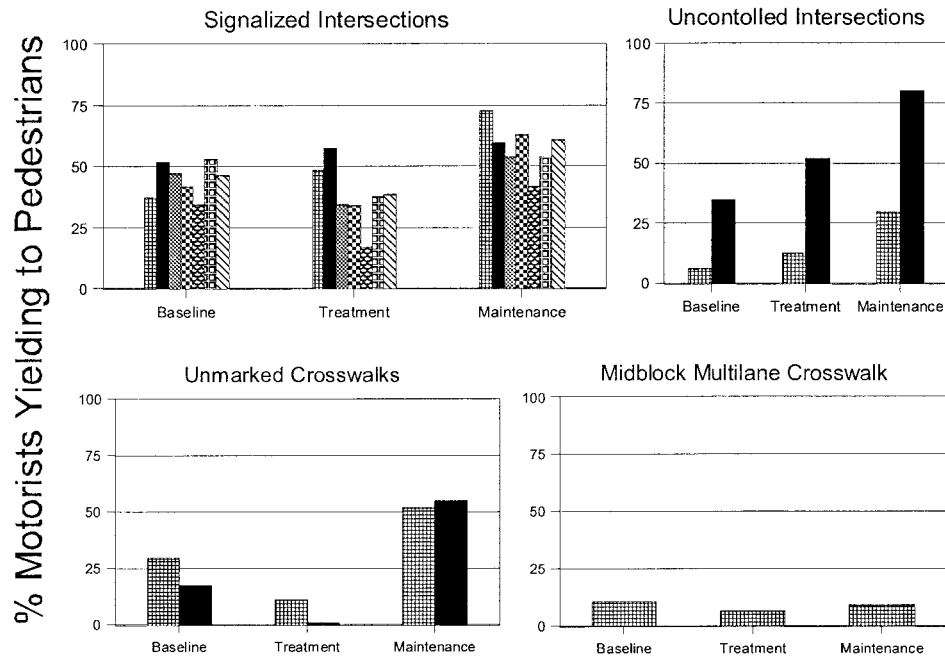


Figure 5. The percentage of motorists yielding to pedestrians at the 12 generalization-test locations during baseline, enforcement, and maintenance conditions.

with traffic signals. It is interesting that the change at generalization sites occurred only during the maintenance condition. The most likely explanation for these results is that publicity for the program occurred at the end of the 2-week enforcement period and continued during the maintenance condition and may have mediated generalization to additional sites because it described the operation as citywide.

These results also show that enforcement alone can increase yielding behavior at crosswalks, although the effects were less than those produced when enforcement was combined with traffic-engineering components. These data are useful because they indicate that action by police agencies can produce some improvement in yielding in circumstances where they cannot influence traffic engineers to install engineering solutions. Although the overall increase in yielding behavior was not particularly large, it would be reasonably discernible to pedestrians because a yield rate of 10% means that a pedestrian

would need to wait for an average of nine drivers to pass before a driver yielded, whereas a yield rate of 33.3% means that a pedestrian would only need to wait for an average of two drivers to pass before a driver yielded.

Although the level of driver-pedestrian conflicts was lower following treatment at both sites, the decreasing trend during baseline in the east corridor makes this finding difficult to interpret. The increase in the percentage of motorists who yielded more than 10 ft from the crosswalk demonstrated that motorists became more vigilant of the presence of pedestrians. It is unclear why this increase returned to baseline levels during maintenance in the east corridor but not the west corridor.

The program included a number of features that would be expected to enhance its efficacy. First, police used an objective behavioral definition of failing to yield to pedestrians, which ensured that a motorist who failed to yield actually had sufficient time to

yield, thereby increasing the likelihood that a conviction would be obtained if the case went to court. Second, police used undercover decoy pedestrians at times when actual pedestrians were not present at the crosswalk, which increased their frequency of contact with motorists by reducing downtime when pedestrians were not present in the crosswalk. Third, the use of warnings allowed police to contact up to 20 times as many noncompliant motorists. Data show that the use of warnings greatly increases the effectiveness of enforcement (Van Houten & Nau, 1983), and a high frequency of stops ensures not only that many people directly make contact with the punishment contingency but also that many drivers witness these stops. It is interesting to note that after a few taxi drivers were cited for failing to yield during the first couple of days of the program, taxi drivers began to yield reliably. This effect was striking and was noticed by the entire research team, and suggests that taxi drivers who were stopped during the first few days communicated with other taxi drivers.

It is likely that the simultaneous deployment of engineering crosswalk enhancements and police enforcement is mutually supportive. Such a synergistic relation may explain why less intensive enforcement produced a larger shift in behavior in the Malenfant and Van Houten (1989) study. Although traffic engineers and traffic officers can occasionally coordinate activities, such coordination is not the rule. Therefore, it was valuable to determine whether enforcement alone could produce some benefit when it is not possible to introduce engi-

neering treatments along with police enforcement.

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*STUDY QUESTIONS*

1. How are the law enforcement and engineering approaches to improving driver yielding different? What is one advantage of the engineering approach over the law enforcement approach?
2. Why was the driver behavior of *not* yielding more difficult to define than was yielding?
3. How were the four dependent variables defined in this study?
4. Briefly describe the intensive enforcement condition.
5. Summarize the immediate results of the enforcement program.
6. How did the authors account for observed increases in yielding at generalization sites that occurred only during the maintenance condition?
7. Given that few motorists were actually issued warnings and citations, what may have accounted for the increases in yielding observed in the current study?
8. Suggest some additional antecedent interventions that might potentially increase the efficacy of the enforcement program described in this study.

Questions prepared by Carrie Dempsey and David Wilson, University of Florida