

Advance Yield Markings Reduce Motor Vehicle/Pedestrian
Conflicts at Multilane Crosswalks with an Uncontrolled Approach

by

Ron Van Houten

Mount Saint Vincent University

J.E. Louis Malenfant

Center for Education and Research in Safety

Dave McCusker

Halifax Regional Municipality

Abstract

Motorists yielding to a pedestrian at the crosswalk line can screen the view of the pedestrian crossing in front of them. This places the pedestrian at risk from vehicles approaching in adjacent lanes of travel. The purpose of this experiment was to evaluate the effects of advance yield markings and a symbol sign prompting motorists to yield to pedestrians at the markings on pedestrian safety at multilane crosswalks with pedestrian-activated yellow flashing beacons. Motorist and pedestrian behaviors measured throughout the experiment included the occurrence of motor vehicle/pedestrian conflicts that included evasive action; the distance motorists stopped before the crosswalk when yielding to pedestrians; and the percentage of motorists yielding to pedestrians. The introduction of the markings and sign 10 m before the crosswalk increased the distance in advance of the crosswalk that motorists yielded to pedestrians and markedly reduced the percentage of motor vehicle/pedestrian conflicts. Placing markings 15 m and 25 m in advance of the crosswalk produced similar benefits, demonstrating that treatment effects can be produced over a wide range of values.

Crosswalks on streets with multilane uncontrolled approaches are often associated with a type of high energy pedestrian crash termed a multiple threat crash (Snyder, 1972). A major factor contributing to this kind of crash is vehicles that stop for the pedestrian too close to the crosswalk, screening the view of motorists approaching in the pedestrians next lane of travel. Although buses and trucks have traditionally been vehicles that produce complete screening, the popularity of sport utility vehicles and minivans has increased the percentage of vehicles on the road that can completely screen the view of pedestrians crossing the street. Children and persons of short stature can be completely screened by relatively small passenger vehicles.

Prior research (Van Houten, 1988; Van Houten & Malenfant, 1992) has demonstrated that advance stop lines used in conjunction with signs directing motorists to yield at an advance stop line produce a marked reduction in motor vehicle/pedestrian conflicts at multilane crosswalks with an uncontrolled approach. These results have been documented at crosswalks with and without yellow flashing beacons. Van Houten and Malenfant (1992) also demonstrated that the markings and sign together were more effective than the sign alone.

The underlying principle behind advance stop lines is that they increase the safety of pedestrians by reducing the screening effect of vehicles yielding to pedestrians. One problem that can limit the application of this solution is that the reluctance to use stop lines in what is a 'yield' rather than 'stop' situation. Another problem is the use of a text rather than symbol sign to support the markings. The purpose of this experiment is to address both of these problems by evaluating the use of yield markings along with a symbol sign.

Method

Setting

This study was conducted at three multilane crosswalks each with an uncontrolled approach in Halifax Regional Municipality, Nova Scotia. Each of these sites were equipped with pedestrian activated flashing yellow beacons to alert motorists that a pedestrian(s) is crossing. One site, Wyse Rd. at midblock, was a midblock crosswalk with three lanes of traffic in each direction divided by a refuge island, which connected a community sporting facility with a convention center, and office tower. The second crosswalk on South Park crossed 2 lanes of traffic in each direction. South Park formed a T intersection with Brenton a minor road controlled by a stop sign. The third site, Young St. formed a T intersection with Monaghan Dr. a minor road controlled by a stop sign. Each of these sites had a crash history with two of the sites having a fatal crash during the past year. In both cases the crashes involved a multiple threat situation.

Data Collection

Three observers scored motorist and pedestrian behaviors on weekdays between the hours of 8:30 a.m. and 4:30 p.m. Each session included the collection of data from 20 pedestrians crossing while vehicles were present. A pedestrian/motor vehicle conflict was scored if the driver of a vehicle had to engage in abrupt braking, had to swerve to avoid striking a pedestrian, or if a pedestrian had to take sudden evasive action to avoid being struck. This type of conflict has been shown to be highly correlated with crash frequency (Lord, 1996). Observers also recorded how far in advance of the crosswalk motorists stopped for pedestrians. Marks were placed on the curb at 3 m intervals. Observers recorded the distance of the furthest mark the motorists stopped or slowed behind.

Motorist distance was scored only at the moment the pedestrian crossed in front of the target vehicle because this is the critical point for visual screening. Observers also scored the percentage of motorists yielding to pedestrians. A motorist was scored as not yielding if they passed in front of the pedestrian and would have been able to stop if they were driving the speed limit. Marks were placed using the signal timing formula to assist observers in making this determination. Motorists were scored as yielding to pedestrians if they stopped or slowed to allow the pedestrian to pass ahead of them.

Inter-observer Agreement. Two observers independently scored conflicts, stopping distance, and yielding behavior on three sessions during each experimental condition. A measure of inter-observer agreement was computed by dividing the number of agreements on the occurrence of each target behavior by agreements on the occurrence of the target behavior plus disagreements. An agreement on stopping distance was only scored when both observers scored the driver as stopping at the same distance for each driver yielding for each pedestrian. An agreement on the occurrence of conflicts was scored when both observers scored an event as a conflict and an agreement on yielding was scored only if both observers scored all vehicles the same for each pedestrian. Inter-observer agreement always averaged 100 percent for conflicts. Inter-observer agreement on yielding for pedestrians averaged 96% with a range of 85% to 100%. Inter-observer agreement on yielding distance averaged 90% with a range of 70% to 100%.

Apparatus

The yield markings were 16 inches wide at the base of each triangle and 24 inches long. Triangles were separated by 9 inches. Markings were initially placed down with reflective temporary marking material so the placement could be moved. The signs

measured 60 cm wide by 75 cm high. The Yield symbol was 30 cm and red in color. The text “HERE” and “TO” were written in 3 in. (7.7 cm) D black letters. The pedestrian symbol and R10-6 arrow were black. At the Wyse Rd. crosswalk signs with a left handed arrow were placed on the right of the roadway and signs with a right handed arrow were placed on the median strip for a total of two signs on each approach (one on each side of the yield markings). At the remaining two sites only one sign was used on each approach. A photo showing the sign and markings at each of the three sites is shown in Figure 1.

Experimental Design



Figure 3a. Wyse Road



Figure 1 b. South Park St.



Figure 2 c. Young St.

A multiple baseline design was employed in this experiment. Following a baseline condition where no advance markings were used, the advance yield marking and signs were placed 10 m before both approaches to the midblock crosswalk on Wyse Road, while the crosswalks at South Park and Brenton and Young St. remained in the baseline condition. After the effects of the intervention had been assessed at the first site, the advance markings and signs were moved to 15 m in advance of the crosswalk on Wyse Rd. and the advance yield markings and signs were introduced at 10 m in advance of the

crosswalk on South Park St. The crosswalk on Young St. remained in baseline to serve as a control for other extraneous factors that could effect crosswalk safety. Next the markings on Wyse Rd. were moved to 10 m. at one approach and kept at 15 m at the second approach, the advance yield markings and signs were placed at 15 m on both approaches to the South Park Crosswalk, and advance yield markings and signs were placed at 15m on one approach to the crosswalk on Young St. and 25m on the other approach to Young St because of the T intersection with Monaghan Dr.

Results

The number of conflicts per session observed at each of three locations are presented in Figure 2. During baseline, conflicts averaged 16.8% at the crosswalk on Wyse Rd. The introduction of the advance yield markings and sign at 10 m decreased conflicts to 4.3% a reduction of 74%. Moving the markings to 15 m was not associated with further reductions in conflicts, with conflicts averaging 3.3% during this condition. Moving the line back to 10 m on the slower approach had little effect on the frequency of conflicts. The introduction of the treatment at 10 m on South Park reduced conflicts from 12.6% to 1.6%, a reduction of 87%. Moving the lines back to 15 m was not associated with further reductions in conflicts. Introducing the treatment at the crosswalk at Young Street and Monaghan Dr. was associated with a reduction in the percentage of conflicts, with conflicts decreasing from 14.3% during baseline to 6.1% during the treatment condition, a reduction of 57.3%.

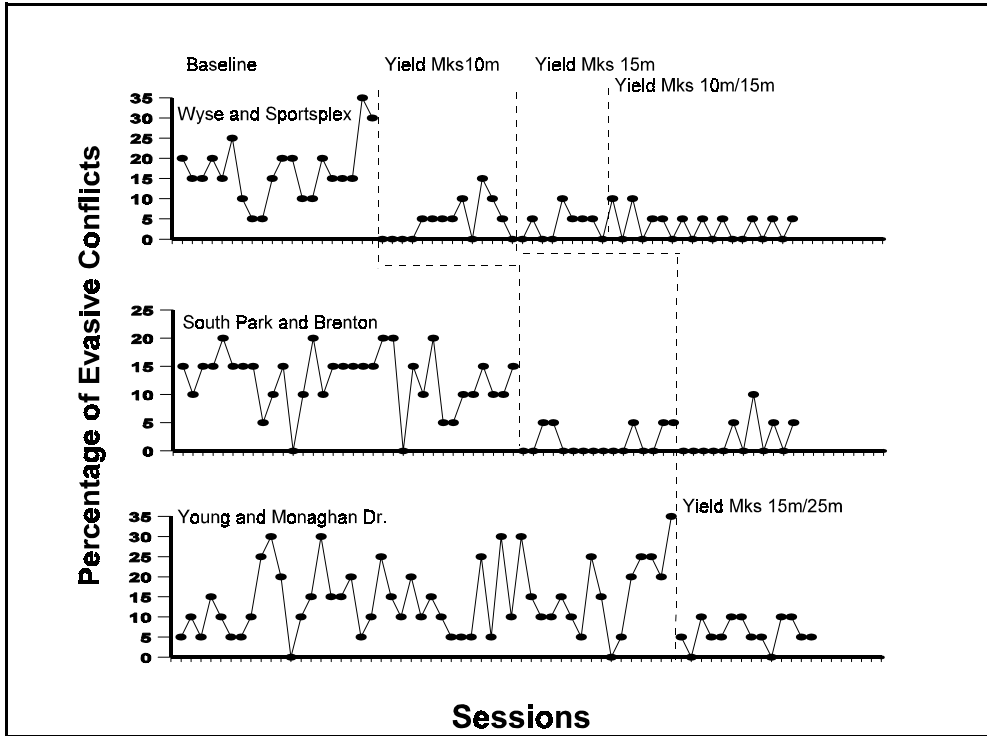


Figure 2. Percentage of evasive manoeuver conflicts.

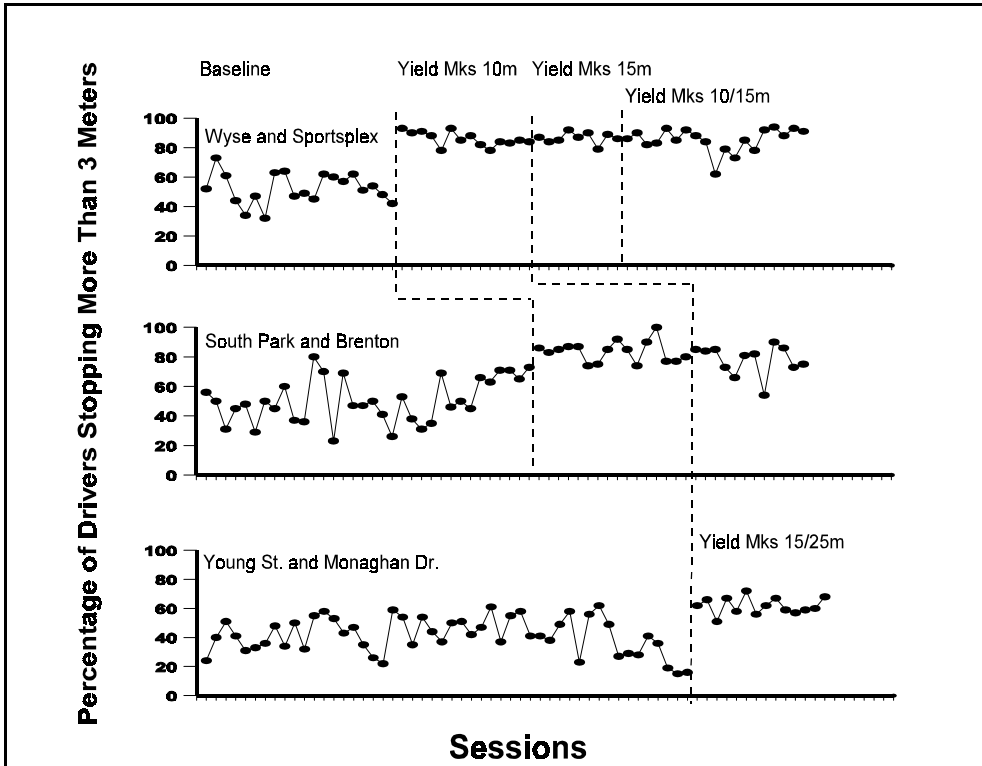


Figure 3. The percentage of drivers yielding more than 3 m. in advance of the crosswalk.

Figure 3 shows the percentage of motorists yielding more than 3 m from the crosswalk. The introduction of the advance yield markings increased the percentage yielding at least 3 m behind the crosswalks from 52.4% to 85.9% at Wyse Rd., from 50.5% to 83.6% at South Park St., and from 41.4% to 61.7% at Young St. There was little difference in the percentage yielding more than 3 m before the crosswalk when the markings were moved to 15 m at Wyse Rd. or South Park St.

The data presented in Figure 4 shows the percentage of motorists yielding at least 6 m in advance of the crosswalk. The introduction of the advance yield markings increased the percentage yielding at least 6 m before the crosswalk from 16.4% to 60% at Wyse Road, from 18.9% to 53.1% on Brenton St., and from 11.2% to 30.1% on Young St. Moving the markings and signs from 10 m to 15 m did not produced little difference in the percentage yielding at least 6 m in front of the crosswalk.

Figure 5 shows the percentage of vehicles yielding at least 9 m in advance of the crosswalk. The data shows that very few people stopped 9 m or more in advance of the crosswalk during the baseline condition. The introduction of the advance yield markings at 10 m increased the percentage of motorists yielding at least 9 m in advance of the crosswalk from 5.7% to 31% at Wyse Rd. and from 8.6% to 29.5% at South Park St. Moving the advance lines to 15 m produced a small increase in the percentage yielding at least 9 m ahead of the crosswalk at Wyse Rd. but had little effect at South Park St. The introduction of the advance yield markings at Young St. was associated with an increase in the percentage yielding at least 9 m before the crosswalk from 3.9% to 14.8%.

The data in Figure 6 show the percentage of motorists yielding to pedestrians at all three sites throughout the experiment. Yielding was consistently high at all three sites

throughout the experiment. Baseline yielding averaged 83.7% at Wyse Rd., 84.7% at South Park St. and 86.2% at Young St. The introduction of the advance yield markings and signs were associated with slightly higher levels of yielding at each of the sites 89.6%, 93.7%, and 93.6% respectively.

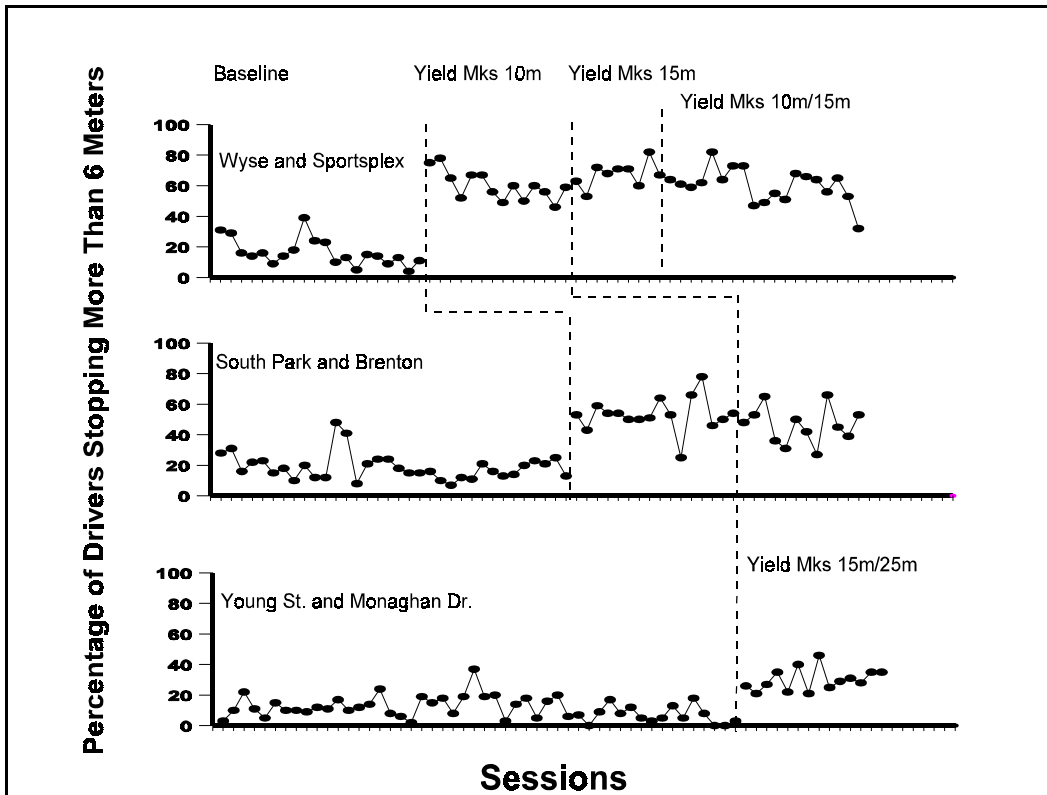


Figure 4. Percentage of motorists yielding more than 6 m. in advance of the crosswalk.

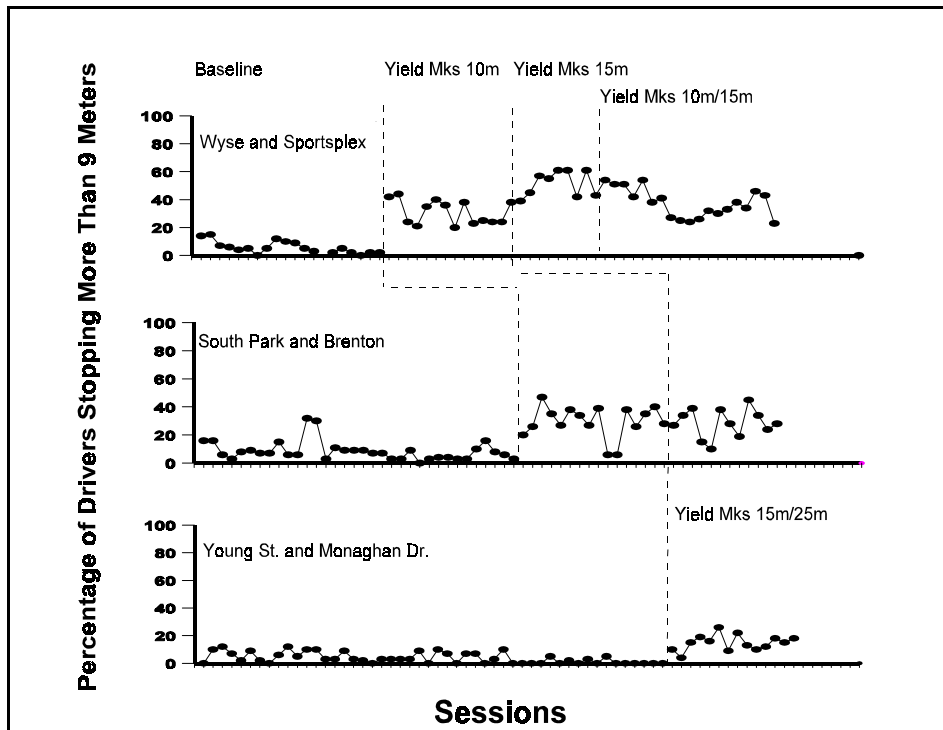


Figure 5. The percentage of motorists yielding more than 9 m. in advance of the crosswalk.

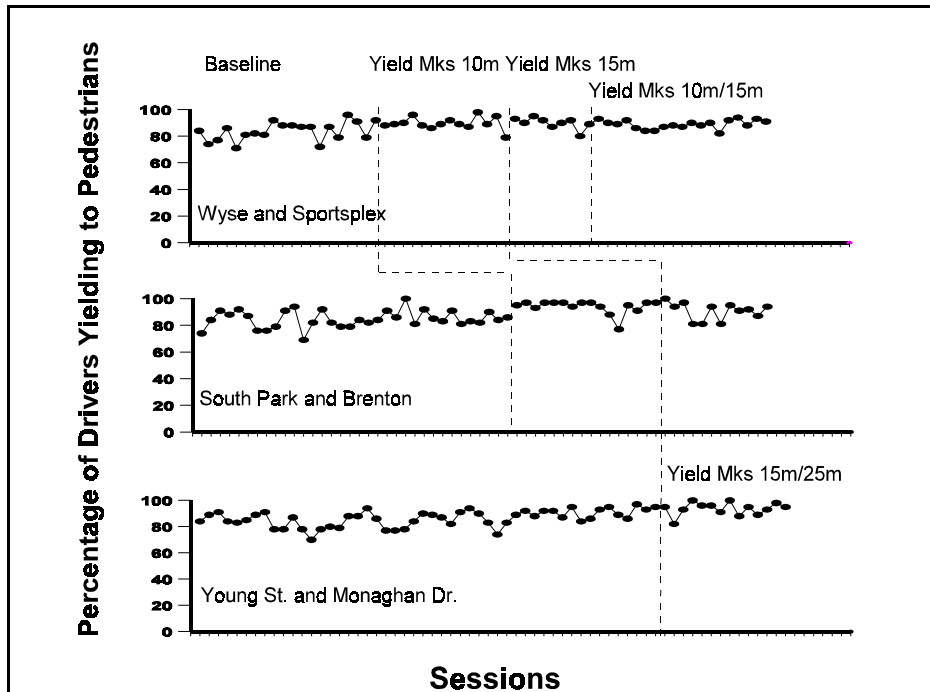


Figure 6. The percentage of motorists yielding to ped

Discussion

These results confirm the findings of earlier studies showing that prompting motorists to yield further back from the crosswalk can increase pedestrian safety at multilane streets with an uncontrolled approach. These data also show that placing the advance yield markings and signs as close as 10 m before the crosswalk and as far back as 15 or even 25 m in advance of the crosswalk can be effective. This is an important finding because it is not always possible to place markings at the same locations at all sites because of driveways and intersections with minor streets with low traffic volumes.

Although not all vehicles stopped at or near the yield lines, many motorists stopped 9 or more meters before the crosswalk. The observers noted that motorists tended to stop closer to the crosswalk during the treatment condition when traffic was heavy and vehicles were travelling slowly. Under these circumstances motorists were often able to yield when they were at the advance yield markings when the pedestrian started to cross. At these times risk was reduced because of the slower speeds.

The small increase in yielding behavior was consistent with earlier findings with the use of advance stop lines. Much of the improved yielding is likely the result of improved visibility of pedestrians crossing in front of vehicles stopped in advance of the crosswalk. In general, conflict reduction seemed to be related to the efficacy of the yield markings, with the site with the smallest increase in stopping distance, Young St., showing the smallest reduction in conflicts.

References

Lord, D. (1996). Analysis of pedestrian conflicts with left-turning traffic. *Transportation Research Record No. 1538*, p 61-67.

Snyder, M.B. (1972). Traffic engineering for pedestrian safety: Some new data and solutions. *Highway Research Record*, 406, 21-27.

U.S. Department of Transportation. (1988) *Manual on Uniform Traffic Control Devices* (Federal Highway Administration SA-89-006). Washington, DC:U.S. Department of Transportation.

Van Houten, R. & Malenfant, L. (1992). The Influence of signs prompting motorists to yield 50 feet (15.5 m) before marked crosswalks on motor vehicle-pedestrian conflicts at crosswalks with pedestrian activated flashing lights. *Accident Analysis and Prevention*, 24, 217-225.

Van Houten, R. (1988). The effects of advance stop lines and sign prompts on pedestrian safety in crosswalk on a multilane highway. *Journal of Applied Behavior Analysis*. 21, 245-251.

Acknowledgements

The authors thank: the city of Halifax Department of Transportation for funding this research; members of the Nova Scotia Road Safety Advisory Committee Pedestrian Sub Committee for helpful suggestions and support; and Richard Moeur, John LaPlante, and Dan Centa for their helpful advice.