JOURNAL OF APPLIED BEHAVIOR ANALYSIS 1988, 21, 245–251 NUMBER 3 (FALL 1988)

THE EFFECTS OF ADVANCE STOP LINES AND SIGN PROMPTS ON PEDESTRIAN SAFETY IN A CROSSWALK ON A MULTILANE HIGHWAY

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The effects of specific signs and stop line bars designed to influence motorists to stop further back from the crosswalk when yielding right of way to pedestrians were evaluated using a reversal design. The introduction of the prompt and stop line reduced motor vehicle–pedestrian conflicts (near collisions) by almost 80%. This finding was replicated in a second experiment the following year on two streets using a multiple baseline design. The use of the advance stop line is now being incorporated by the Provincial Department of Transportation for marking crosswalks on multilane streets.

DESCRIPTORS: pedestrian safety, prompts, safety, transportation safety, conflicts

Each year in the United States, approximately 400,000 pedestrians are struck by vehicles resulting in about 10,000 deaths and many serious injuries (Fruin, 1973; Snyder, 1972). In Canada, pedestrians account for about 15% of traffic deaths (Wolfe & O'Day, 1981). Children are particularly vulnerable to this type of collision (Ross & Seefeldt, 1978). One type of motor vehicle–pedestrian collision, termed a multiple threat, accounts for at least 12,000 pedestrian injuries and 300 deaths in the United States per year (Snyder, 1972). It involves a pedestrian being struck in a crosswalk on a multilane highway by a vehicle after another vehicle has yielded to the pedestrian, thereby blocking the vision of the motorist approaching in the outside lane.

Although actual data on injuries and deaths are essential in traffic safety research, such data must be collected over extended periods. Therefore, in the evaluation of pilot programs more sensitive and immediately available measures are necessary. This is certainly true of the multiple-threat situation. One way to circumvent this problem is to collect data at the location where road users are in conflict. Research has demonstrated that conflicts or near collisions correlate very highly with known long-term accident data (Baker, 1972; Older & Spicer, 1976).

Accordingly, the purpose of this experiment was to reduce the occurrence of multiple-threat conflicts in a six-lane crosswalk through the use of prompts designed to encourage motorists to yield right of way at a point further back from the crosswalk, thereby giving motorists approaching in other lanes a better view of the pedestrian in the crosswalk.

EXPERIMENT 1

Method

Subjects and setting. Subjects were motorists and pedestrians using a marked crosswalk on Wyse Road in Dartmouth, Nova Scotia, during daylight hours on weekdays. The crosswalk traversed a six-lane urban street connecting two shopping malls. The speed limit on the street was 50 km per hour. There were no traffic control devices at the crosswalk. The crosswalk lines and advance markings were painted approximately 1 month before the start of the experiment. Advance markings indicating a crosswalk ahead (consisting of an "X") were painted 50 m on each side of the crosswalk. All data were collected before the first snowstorm of the season.

Apparatus. Two signs were constructed to prompt motorists to stop at a specific location for

The author thanks Paul Connors, Traffic Co-ordinator for the City of Dartmouth, Nova Scotia, for his assistance in carrying out this research. This research was supported by Grant 410-85-0078-R2 from the Social Sciences and Humanities Research Council of Canada.

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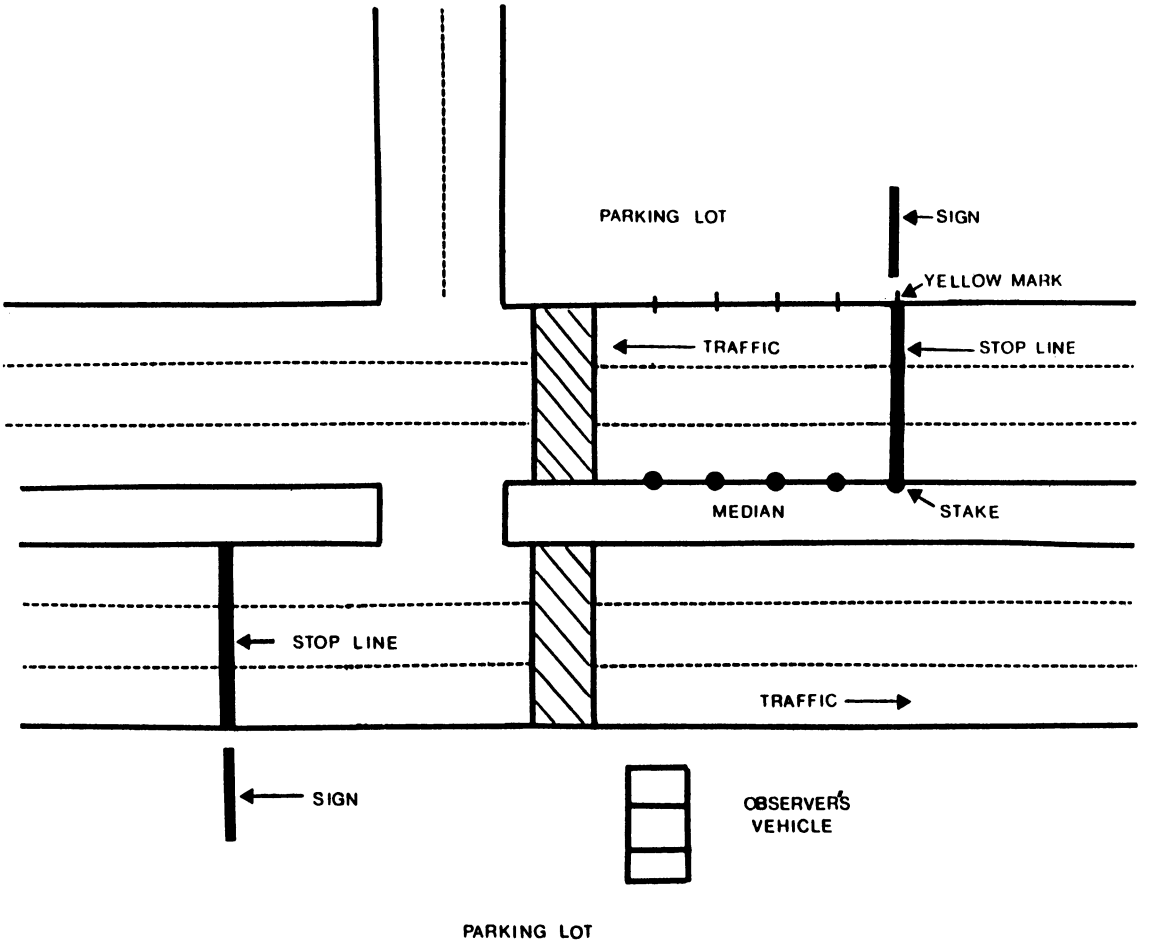

Figure 1. A diagram of the street showing the position of the sign, stop lines, and observer relative to the crosswalk.

pedestrians. These signs read "STOP HERE FOR PEDESTRIANS" and had an arrow pointing down toward the road at an angle of 45° below the horizontal. These signs were constructed from plywood covered with white scotchlite reflective material using 4 in. (10.1 cm) high black lettering. The signs were 1.1 m wide by 0.61 m high and were erected 0.5 m from the side of the highway at a height of 2 m above the street. A 20.3-cm-wide line constructed from two strips of 10.15-cm-wide removable line markings (3M Company) placed side by side was extended across the three lanes beginning at the side of each sign. The purpose of the signs and lines was to prompt motorists to yield further back from the crosswalk to allow overtaking vehicles a better view of pedestrians crossing the street. The arrangement of the signs and the line is illustrated in Figure 1.

Measures. Two trained observers scored the behavior of motorists and pedestrians each weekday. Data were not collected on days with inclement weather (such as heavy rain) that would reduce pedestrian traffic. Data were collected for the first 30 pedestrians crossing the street beginning at 9:00 a.m. each day. It usually took from 1.5 to 2 hr to score data for 30 pedestrians.

The observers sat in a car parked in a parking lot with a clear view of the crosswalk. When a pedestrian approached a crosswalk and was positioned within approximately 30 cm of the curb facing the crosswalk, the observers scored the behavior of the motorists. Motorist behavior contin-

ued to be scored until the pedestrian had cleared the crosswalk.

Three types of motor vehicle–pedestrian conflicts were scored by the observers. A Type 1 conflict was scored whenever a motorist had to engage in abrupt audible braking, had to change lanes abruptly to avoid striking a pedestrian, or a pedestrian had to jump to avoid being struck by a vehicle. A Type 2 conflict was scored whenever a motorist who failed to yield to a pedestrian passed within less than one lane's distance from the pedestrian but did not qualify as a Type 3 conflict. A Type 3 conflict was scored whenever a vehicle passed in the immediately adjacent lane to the left of a vehicle that had yielded to a pedestrian who was crossing the street.

Motorists were scored as yielding to pedestrian(s) if they stopped before the crosswalk or slowed after passing the advanced markings allowing the pedestrian to cross. They were recorded as not yielding to pedestrians if they proceeded through the crosswalk, provided they had not passed the advance marking (an "X" painted on the road 50 m before the crosswalk) before the pedestrian was positioned within 30 cm of the curb facing the crosswalk. Because the Nova Scotia Motor Vehicle Act requires drivers in all lanes facing pedestrians to yield right of way, motorists traveling in both directions were scored as yielding or not yielding to pedestrians.

Observers also noted the distance motorists stopped behind the crosswalk during three baseline and three intervention conditions. Yellow marks were painted on the curb every 10 ft and stakes were placed in the grass in the median at these intervals opposite the lines to facilitate scoring by the observers. Stopping distance was scored only on the side of the street opposite the observers, because there was less of a problem with parallax on this side of the street. The observers scored whether motorists stopped less than 10 ft from the crosswalk, between 10 to 20 ft, 20 to 30 ft, 30 to 40 ft, 40 to 50 ft, or more than 50 ft from the crosswalk. The percentage of motorists stopping more than 10, 20, 30, 40, or 50 ft from the crosswalk was then calculated by dividing the number of motorists that stopped more than each of the abovementioned distances by the total number of cars that stopped.

Measures of interobserver agreement were obtained during at least two sessions during each condition by a second independent observer seated in a car parked beside that of the primary observer. An agreement was scored for a conflict if both observers scored a conflict for a particular pedestrian exactly the same way (i.e., Type 1, 2, or 3). An agreement was scored for yielding whenever both observers scored the same vehicle as yielding. An agreement was scored for stopping distance only if both observers recorded the same distance category. Interobserver agreements for conflicts, yielding behaviors, and distance stopped behind the crosswalk were computed by dividing agreements by agreements plus disagreements. Interobserver agreement averaged 100% on the occurrence of conflicts, 93% (range, 89% to 98%) on yielding, and 93% (range, 89% to 98%) on distance stopped.

Experimental design. A reversal design was used. After baseline data were collected, the "STOP HERE FOR PEDESTRIANS" sign plus advance stop line condition was introduced, removed, and reintroduced. Next, this condition was removed and reintroduced for the third time.

Baseline 1. During the baseline condition, the "STOP HERE FOR PEDESTRIANS" signs and stop lines were absent.

Sign plus stop line 1. During this condition the "STOP HERE FOR PEDESTRIANS" signs were each erected 50 ft before the crosswalk. In addition, the advance stop line was laid down across the three lanes adjacent to each sign, even with the sign.

Baseline 2. During this condition the signs and the lines were removed.

Sign plus stop line 2. This condition was carried out in the same manner as the preceding sign plus stop line condition.

Baseline 3. This condition was carried out in the same manner as Baselines 1 and 2.

Sign plus stop line 3. This condition was carried out in the same manner as the preceding sign plus stop line conditions.

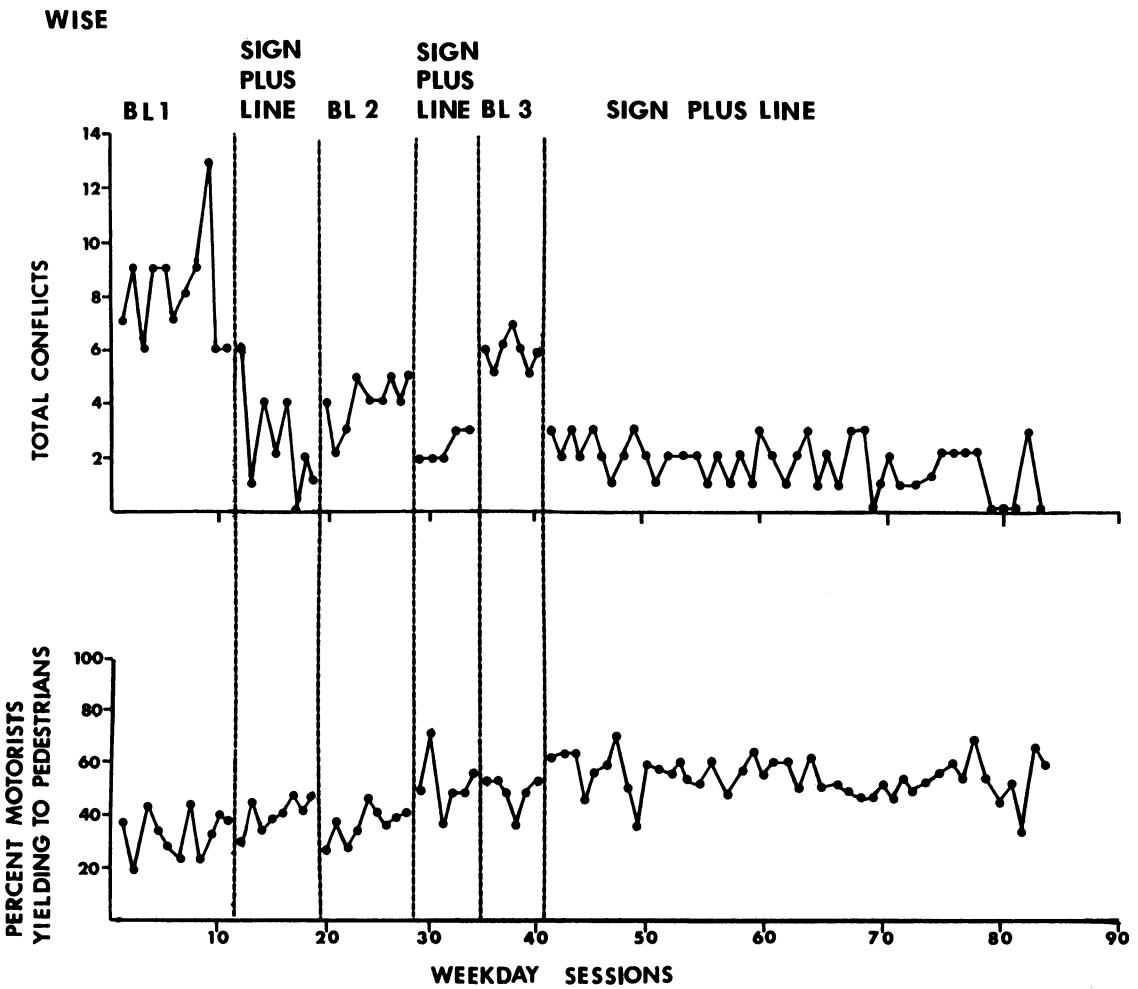

Figure 2. The total number of motor vehicle–pedestrian conflicts and the percentage of motorists yielding right of way to pedestrians during each condition of the experiment.

Results and Discussion

Motorist–pedestrian conflicts. The total number of motorist–pedestrian conflicts recorded during each condition of the experiment is presented in the upper panel of Figure 2. During Baseline 1, the total number of conflicts averaged 8.1 per day. The introduction of the first sign plus stop line condition reduced the number of conflicts to an average of 2.5. This represented a reduction of 69% in the number of conflicts per 30 pedestrian crossings. The removal, reintroduction, second removal, and second reintroduction of the sign plus stop line condition led to 4, 2.5, 5.8, and 1.7 conflicts per 30 crossings, respectively. Original baseline levels did not completely recover during the Baseline 2 and Baseline 3 conditions.

The data for each of the three types of conflicts followed the same trend as the total conflict data. During the Baseline 1 condition, Type 1, 2, and 3 conflicts averaged 0.5, 6.0, and 1.6, respectively, per 30 pedestrian crossings. During the first sign plus stop line condition these frequencies declined to 0.25, 2.0, and 0.25. During the Baseline 2 condition they remained about the same for Type 1 conflicts (0.22) and increased for Type 2 and 3 conflicts to 3.1 and 0.67, respectively. During the

second sign plus stop line condition the percentage of all three conflicts declined to 0.17, 1.83, and 0.5. Type 1 conflicts remained the same during the Baseline 3 condition, whereas the percentage of Type 2 and 3 conflicts increased to 4.33 and 1.33. During the final sign plus stop line condition the number of all three conflicts declined to 0.05, 1.1, and 0.44.

Yielding right of way to pedestrians. The percentage of motorists yielding right of way to pedestrians during each condition of the experiment is presented in the lower panel of Figure 2. Although the introduction of the sign plus stop line conditions was associated with increased yielding, the increases were small.

The data collected on those motorists who did stop behind the line is presented in Figure 3. During the baseline conditions motorists tended to stop close to the crosswalk. The introduction of the sign plus stop line condition resulted in a large increase in the percentage of motorists stopping at least 10 ft from the crosswalk (from 50% to 95%). Although the data indicate that the intervention was effective, the generality of the findings are somewhat limited because the treatment was applied on only one street. The purpose of the second experiment was to extend the generality of these findings through replication.

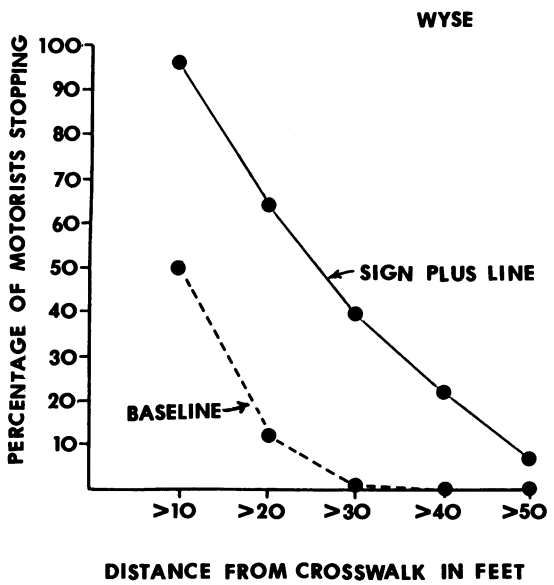

Figure 3. The percentage of motorists stopping more than 10, 20, 30, 40, or 50 ft from the crosswalk during baseline and the sign plus stop line condition of Experiment 1.

EXPERIMENT 2

Method

Subjects and setting. This experiment was carried out approximately 1 year after the first experiment and involved two crosswalks. The first was the same one reported in the first experiment and had been in the baseline condition (i.e., no signs or special lines on the road) for 6 months prior to the start of this experiment. A second crosswalk on Portland Street traversed a five-lane street connecting a bus stop with a residential area. Advance markers indicating a crosswalk ahead were painted 50 m on each side of the crosswalk. All data were collected during the spring and summer months after the last snowfall.

Apparatus. The signs and removable line markings used in this experiment were of the same type reported in the previous experiment.

Measures. Data were collected in the same manner as reported in the previous study. Measures of interobserver agreement were obtained three times on each street during each condition of the experiment. Interobserver agreement averaged 99% (range, 95% to 100%) on the occurrence of conflicts, 94% (range, 88% to 100%) on distance stopped, and 95% (range, 91% to 100%) on yielding.

Experimental design. A multiple baseline across settings (crosswalks) design was used in this experiment. The baseline condition as well as the sign plus stop line intervention were carried out in the same manner as reported in the previous experiment.

Results and Discussion

The total number of motorist–pedestrian conflicts recorded on each street during each condition

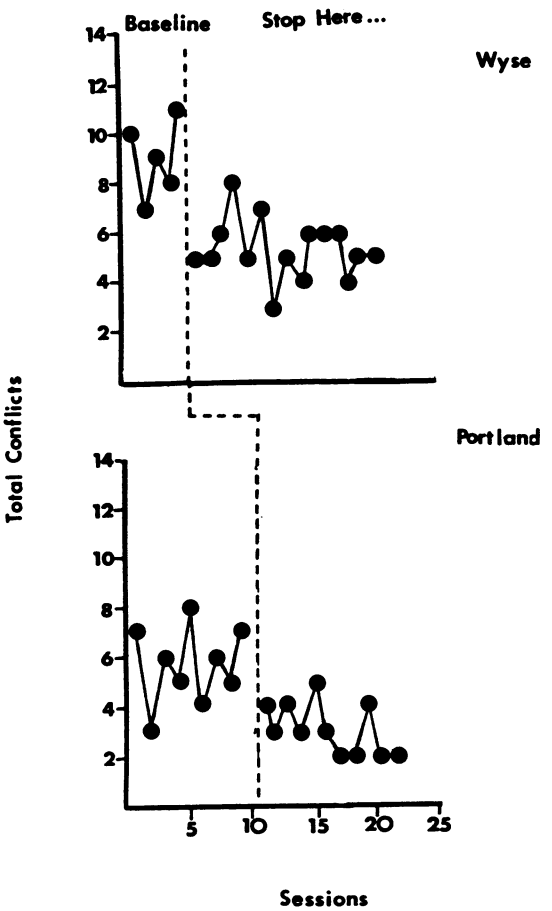

Figure 4. The total number of motor vehicle–pedestrian conflicts on Wyse Road and Portland Street during each condition of the experiment.

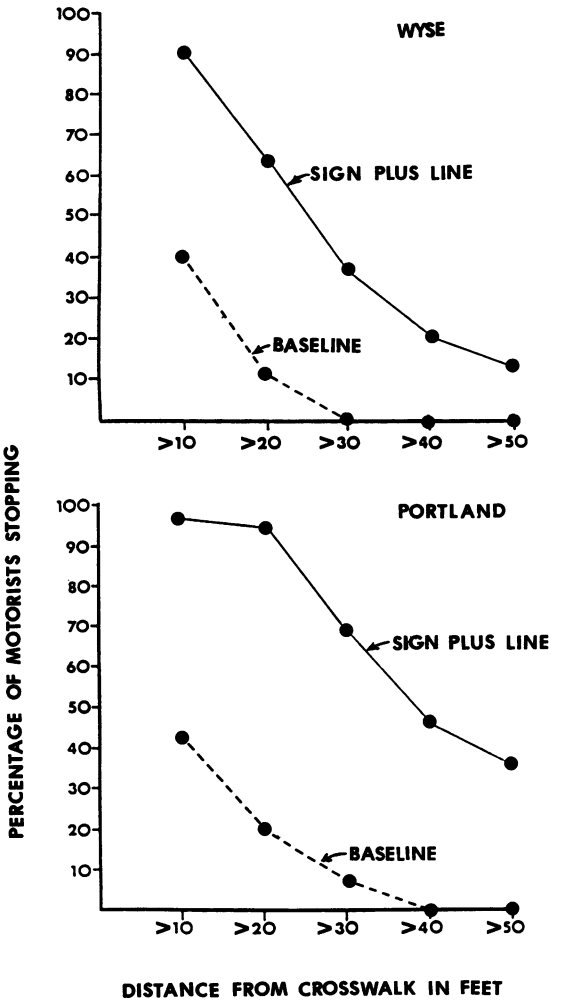

Figure 5. The percentage of motorists stopping more than 10, 20, 30, 40, or 50 ft from the crosswalk during the baseline and sign plus stop line condition on Wyse Road and Portland Street during Experiment 2.

is presented in Figure 4. The introduction of the sign plus stop line condition reduced the mean number of conflicts on Wyse Road from a baseline level of 9.0 per session to a posttreatment level of 5.3 per session and reduced the mean number of conflicts on Portland Street from a baseline level of 5.67 per session to a posttreatment level of 3.3 per session. The percentage of motorists yielding right of way to pedestrians increased slightly on Wyse Road from a baseline level of 32% to a treatment level of 39%. On Portland Street the percentage of motorists yielding right of way to pedestrians increased from 20% to 30%.

Data collected on motorists stopping behind the line are presented in Figure 5. The introduction of the sign plus stop line condition resulted in a large increase in the percentage of motorists stopping more than 10 ft from the crosswalk on both streets.

GENERAL DISCUSSION

Results of these experiments demonstrate that a simple inexpensive prompting intervention can re-

duce conflicts between motorists and pedestrians. Although the treatment procedure did not produce a large increase in the percentage of motorists yielding to pedestrians, those who did yield tended to do so further back from the crosswalk.

Because crosswalks must be repainted annually, the cost of painting the advance stop lines on all crosswalks traversing multilane roads should be minimal. The cost of a pair of signs for each road in Nova Scotia is approximately $100. However, once the signs have been in place at a large enough number of sites, it is quite possible that motorists will learn to respond to the presence of the stop lines alone.

This research was carried out with the cooperation of the Nova Scotia Department of Transportation and the Traffic Co-ordinator for the City of Dartmouth. After becoming aware of the results of this research, the Nova Scotia Department of Transportation began incorporating the use of advance stop lines for marking crosswalks on multilane streets. At present the national body regulating highway standards is considering whether to adopt these markings on a nationwide basis.

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Received January 12, 1987
Initial editorial decision April 6, 1987
Revisions received May 12, 1987; July 20, 1987
Final acceptance August 28, 1987
Action Editor, Brandon F. Greene