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Publication of this paper sponsored by Committee on Pedestrians.

Portable Intersection to Accelerate Travel Training of Mentally Handicapped Children

LOUIS J. PIGNATARO AND JOSE ULERIO

This paper describes the design and construction of a portable intersection system to facilitate the travel training of severely and moderately mentally handicapped children. It also describes the procedures used to evaluate the effectiveness of the portable intersection as a teaching tool. The test results showed a statistically significant improvement in test scores with the intersection trainer, both relative to pretraining scores and posttraining scores of a control group trained in the conventional way.

Most of us cross an intersection several times a day without thinking about it, but for thousands of mentally handicapped children this is a hazardous and sometimes impossible task to accomplish. Many handicapped children have learned to board a bus or train and reach their destination but cannot travel independently because of an inability to cross streets safely with consistency. Flashing DON'T WALK signs, traffic lights, street noise, and moving vehicles often confuse mentally handicapped children and create a potentially hazardous condition not only for the child but also for the motorist.

The New York City Board of Education's travel training program teaches handicapped students to travel independently on the public transportation system. The program is designed to provide individualized instruction in transportation skills to handicapped students. Included in this instructional program are the following skills:

1. Safe crossing of streets,
2. Identification and boarding of the correct bus or subway,
3. Exiting of bus or subway at the correct stop,
4. Obtaining assistance when necessary (i.e., lost situations), and
5. Appropriate behavior.

Travel Training is a citywide program that offers instructional services to handicapped students who attend special classes in schools throughout the city. Handicapped students who receive these services are taken out of their classrooms by specially trained travel trainers and return to their classrooms after completing the instructional program. Frequently these students have had little or no experience or specific instruction in travel or travel-related skills prior to entering the program. Therefore, the Travel Training staff uses considerable instructional time in teaching basic prerequisite travel skills, such as street crossing. Over a 10-year period, 85 percent of the handicapped students who participated in the Travel Training program have successfully achieved independent travel. As a result of the program's success, the New York State Education Department validated the program in 1976 and granted funds for the program to assist school districts throughout the state to replicate the program. The inability to cross streets safely with consistency is a major factor in the failure of those students who are not successful in travel training. The specialized nature of the program does not provide sufficient time for any of these students to acquire these basic skills. The present method of teaching street-crossing skills in the classrooms allows for little exposure to an actual intersection for safety reasons, especially when the students are young children or severely handicapped.

A method of exposing the child to a real intersection had to be developed if a child was to behave in a rational manner when approaching an intersection. He or she would have to know that when the signal changed to green he or she had the chance to cross the street. He or she would have to know that when he or she approached an intersection that did not contain a traffic signal, he or she would have to look in both directions before crossing when no cars were coming. The best way to accomplish this type of training was to build an intersection that could be placed inside a classroom where the training could be done by the teacher or an instructor. The intersection had to be relatively easy to assemble and disassemble, compact, and, most importantly, portable.

The Transportation Training and Research Center at the Polytechnic Institute of New York undertook the effort of designing and constructing a portable intersection to facilitate the travel training of severely and moderately mentally handicapped students.

The project's aim was to design, build, and test a small portable intersection that could be assembled and taken apart with relative ease and that could be stored within a relatively small area.

The project was divided into three phases:

Phase 1: Development of preliminary construction plans and construction of prototype model,
Phase 2: Construction of portable intersection, and
Phase 3: Testing and evaluation of the portable intersection.

The intersection system is made up of fiberglass modules that simulate sidewalks, traffic signals, and pedestrian crosswalks; traffic signs; a miniature car and bicycle; barricades to simulate construction areas; a tape recording of traffic noise at an intersection; and a video recording for training instructors and students on how to set up the intersection and training procedures. A prototype model was designed and built (see Figure 1) to aid in the development of the assembly procedures and for use by the training instructors.

The program for the evaluation of the methods and procedures used to assess the effectiveness of the portable intersection as an instructional tool was developed by the staff of the New York City Board of Education's Travel Training for the Handicapped Program. The lesson plan, the construction drawing, and other materials are available to interested parties.

Figure 1. Prototype model used in development of assembly procedures and also used by training instructors.

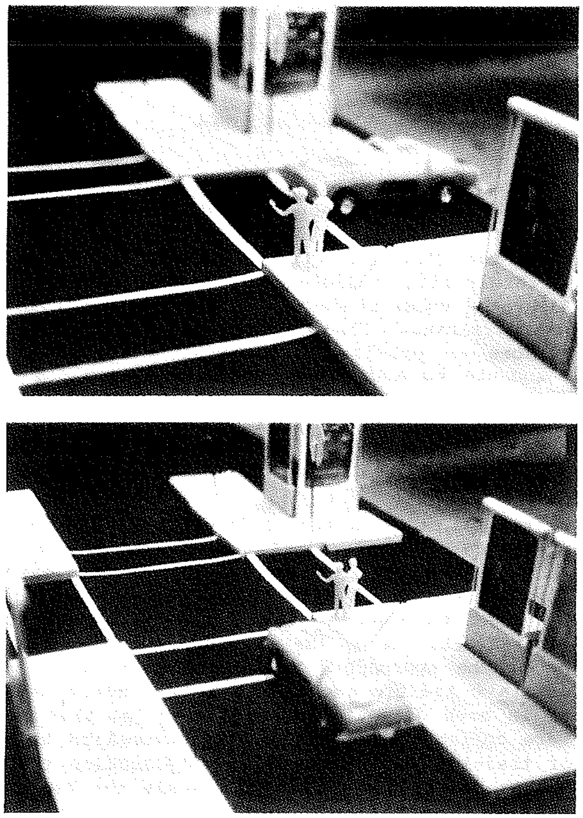
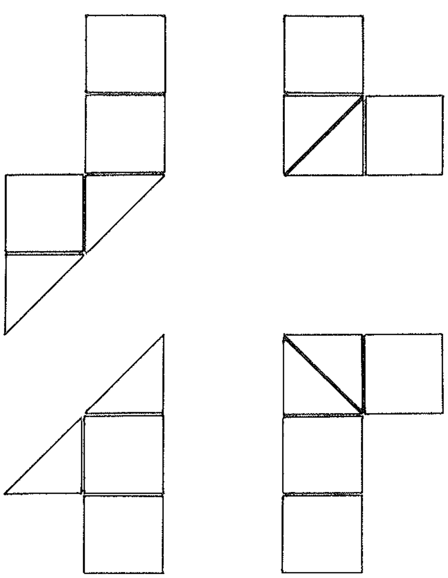


Figure 2. Possible ways to arrange modules to simulate different intersection configurations.



CONSTRUCTION OF PORTABLE INTERSECTION

The portable intersection consists of the following components, which attempt to simulate real-life conditions.

The sidewalks are simulated with twelve 4.5-ft square modules and eight 4.5-ft right triangular modules made of reinforced fiberglass. The fiberglass modules can be put together to resemble a number of different crossing zones and street corners. Figure 2 shows possible ways of arranging the modules to create different configurations at an intersection. Fiberglass was chosen because of its high strength, durability, and weather resistance. The portable intersection is assembled by a crew of mentally handicapped students under the supervision of a school instructor. It can be easily assembled in approximately 25-30 min in any multipurpose room or gymnasium that occupies an area of approximately 50x50 ft. The assembly of the intersection by the students is used as a workshop class in which the students learn to put the modules together.

Two miniature traffic signals and pedestrian crossing signals are provided to simulate real traffic signals that the student might encounter on a trip to or from school. The signals can operate automatically on a 30-s cycle length and also can be operated manually.

A miniature car and bicycle are provided to simulate moving traffic within the intersection and to educate the students about the dangers of a moving vehicle.

Various traffic signs that the students might encounter on a trip to school are provided so that they may be trained to respond to the different traffic situations that correspond to the different signs. Figure 3 shows the various signs used in the trainer.

Two A-frame barricades are provided to simulate construction areas. The students are instructed about the dangers involved in and around construction areas that might alter their behavior at an intersection.

Temporary marking tape is provided to create the pedestrian crosswalk where the students are taught to cross. Backdrops, 3.5x3.5 ft, made of plywood covered with simulated brick-vinyl adhesive paper were provided to simulate walls of buildings at the intersecting sidewalks.

A portable tape recorder and a recording of traffic noise at an intersection is provided to familiarize the students with the noise at an intersection.

A video-cassette recording was made for the training of instructors and students on how to assemble the modules. It also contains information that can be used for the training of the students in crossing streets. A prototype (scale) model was designed and built to aid in the development of placement of traffic control devices, assembling and disassembling procedures, intersection configurations, and a lesson plan.

Figure 4 shows the assembled intersection with some of its components as it appeared in a multipurpose room at the Polytechnic Institute of New York.

EVALUATION DESIGN

The portable intersection was field-tested at a school for severely and moderately mentally retarded

Figure 3. Various traffic signs that can be used to represent those encountered on city streets.

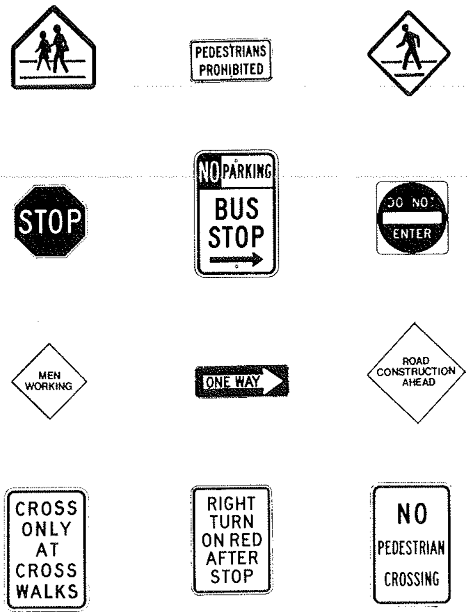


Figure 4. Assembled intersection with its various components.

adolescents, the Adult Skills Training Center in Brooklyn.

The evaluation phase was a comparison of a pretest and posttest of selected students based on their level of street crossing skills before and after a given instructional period. Students were divided into two groups--a control group and an experimental group. The experimental group received instruction in street crossing by using the portable intersection; the control group continued to receive instruction in street crossing with the method currently used by the Board of Education, which includes color recognition, word recognition, and class trips.

The New York City Board of Education's travel training program developed a test to evaluate street-crossing skills. The street crossing and related skills test assesses the following:

1. Student's knowledge of skills related to street crossing through picture identification (i.e., colors and words) and

2. Student's ability to cross streets under specific conditions (i.e., no traffic signals, traffic signals, and obstructions in street).

Forty-four severely to moderately mentally retarded students were tested on the street crossing and related skills test. Each student was tested individually. The testing procedure was carried out in the following manner.

Each student was brought into a room and asked to participate in a special project. The student was presented with a set of three pictures and asked to select the picture that identified a particular situation. After the selection was made, the three pictures were removed and another set of three pictures was presented. A total of six sets was used to assess each student's knowledge of colors, WALK-DON'T WALK signs, one-way streets, two-way streets, police, and use of a crosswalk.

Each student was taken outside the building to the streets adjacent to the school. Students were told to cross city streets that represented four street situations: no traffic signals, red signal at corner, green signal at corner, and double-parked car obstructing the crosswalk. Because there are no traffic signals in the immediate vicinity of the Adult Skills Training Center, the signals from the portable intersection were set up at two street corners, and a car was double-parked at the crosswalk of the third corner. A Travel Training staff person stood near each of the four corners to ensure the students' safety.

Each student was sent around the square individually and given the direction, "Cross the street when it is safe" as he or she approached the street. The first street crossing had no traffic signal; the second street's crosswalk was obstructed by a double-parked car; the third crosswalk had a red signal indication; and the fourth crosswalk had a green signal indication. The use of the portable intersection permitted control of the traffic signals to conform to the test situation.

Characteristics of Sample Population

The 44 students were all between the ages of 19-20. Their intelligence quotients (IQs) were below 50. The students were divided equally into an experimental and control group. The groups were matched as closely as possible in the following areas: IQ, language, sex, living situation, and pretest score on the street-crossing test.

In the control group the range of IQ scores was from 24 to 46, with a mean of 36.4. Of the 22 students, 21 spoke English and 1 spoke Spanish; 2 lived in a state developmental center, 3 lived in group homes for the mentally retarded, and 17 lived at home; 9 were female and 13 were male; the range of the pretest scores on the street-crossing test was from 2.3 to 19.7, with a mean score of 7.89. The maximum attainable score on the pretest was 23. These characteristics are shown in Table 1.

In the experimental group, the range of IQ scores was from 29 to 47 with a mean IQ of 36.6. Of the 22 students, 19 spoke English, 1 used sign language, 1 spoke Turkish, and 1 spoke Spanish; 4 lived in a state developmental center, 4 lived in group homes for the mentally retarded, and 14 lived at home; 10 were female and 12 were male. The range of the pretest scores on the street-crossing test was from 1.7 to 20.0, with a mean score of 8.59. These characteristics are shown in Table 2.

Instructional Program

After the pretesting was completed and the students

Table 1. Characteristics of students in control group.

Sex	IQ	Living Situation	Language	Score Pretest	Score Posttest
F	40	Home	Spanish	10.2	8.7
F	30	Home	English	4.0	4.8
F	Unknown	Home	English	4.3	8.7
F	32	Group home	English	2.3	0.7
F	36	Home	English	19.7	20.0
F	Unknown	Group home	English	6.0	5.5
F	46	Home	English	9.0	12.0
F	28	Home	English	7.0	12.0
F	Unknown	Home	English	8.2	3.2
M	40	Home	English	2.5	1.8
M	Unknown	Home	English	6.0	3.5
M	24	Developmental center	English	5.5	6.5
M	Unknown	Home	English	17.0	22.0
M	Unknown	Home	English	6.0	5.0
M	Unknown	Home	English	11.0	10.5
M	Unknown	Home	English	10.0	8.0
M	36	Home	English	4.3	2.7
M	40	Home	English	4.7	2.3
M	Unknown	Home	English	9.3	2.8
M	40	Developmental center	English	6.3	18.7
M	Unknown	Home	English	9.2	11.8
M	45	Group home	English	11.0	5.2

Table 2. Characteristics of students in experimental group.

Sex	IQ	Living Situation	Language	Score Pretest	Score Posttest
F	30	Group home	English	8.0	7.0
F	Unknown	Home	English	9.0	14.0
F	28	Home	English	11.5	23.0
F	33	Home	English	3.0	14.0
F	40	Home	English	1.7	4.3
F	Unknown	Home	English	5.0	9.0
F	47	Group home	English	16.0	23.0
F	Unknown	Home	English	15.0	23.0
F	Unknown	Home	English	5.0	14.0
F	39	Home	English	15.0	22.0
M	42	Developmental center	English	10.0	8.0
M	30	Group home	English	4.5	16.0
M	40	Developmental center	Sign language	2.0	9.0
M	Unknown	Home	English	7.0	8.5
M	47	Developmental center	English	10.0	11.0
M	Unknown	Home	English	12.0	17.5
M	40	Home	Spanish	20.0	20.0
M	30	Home	Turkish	5.7	3.3
M	40	Home	English	13.3	20.7
M	34	Developmental center	English	6.0	2.0
M	29	Group home	English	3.7	7.0
M	Unknown	Home	English	5.5	10.0

were divided into the control and experimental groups, instruction on the portable intersection was initiated for the experimental group. A travel training paraprofessional developed the instructional model, which was started on December 3, 1980, and completed on February 6, 1981. Due to school holidays and personnel absences, instruction lasted for a six-week period.

The portable intersection was assembled each morning by a crew of mentally retarded students. The only space available was the combination lunchroom and gymnasium. The space was shared with the physical education instructor who conducted small group activities in half of the room while the portable intersection activities were going on in the other half. The hours available for instruction were 9:30 to 11:00 a.m. because the space was needed for lunch services at 11:20 a.m.

The travel trainer brought a group of four students to the room at a time and conducted individual and small group training activities. The length of the instructional period varied according to the student's needs and abilities, ranging from 1 h to 10.25 h of instruction over the six-week period. Eight students received less than 3 h of instruction. Of these, four achieved skill mastery on the intersection, three presented behavioral problems or refused to participate, and the fourth was absent frequently. The remaining 14 students received a minimum of 3 h of instruction each, spread out over the instructional period. These students received approximately 0.5 h of instruction one to three days per week over the six-week period. Specific street-crossing skills were taught, including stopping at corners, using the crosswalk, responding appropriately to traffic signals, and looking for and responding to cars. The 22 students in the control group continued to receive instruction in traffic safety and street crossing from their classroom teachers in the usual manner.

At the completion of the six-week instructional period, the 44 students were again tested outside by using the street-crossing and related skills test. The format and procedures for the posttest were identical to those for the pretest.

Statistical Procedure

The t-test was selected to compare the pretest and posttest scores for the control and the experimental groups.

Pretest Scores Control Group	Pretest Scores Experimental Group
19.7	20.0
17.0	16.0
11.0	15.0
11.0	15.0
10.2	13.3
10.0	12.0
9.3	11.5
9.2	10.0
9.0	10.0
8.2	9.0
7.0	8.0
6.3	7.0
6.0	6.0
6.0	5.5
6.0	5.7
5.5	5.0
4.7	5.0
4.3	4.5
4.3	3.7
4.0	3.0
2.5	2.0
2.3	1.7

In the above table, because there is a computed difference between the means of the pretest scores for the control group (7.89) and for the experimental group (8.59), the t for testing the difference between uncorrelated means in two samples of equal size was used. The computed value of t is 0.496, and there were 21 degrees of freedom. At the $\alpha = 0.01$ level of confidence, the tabulated $t = 2.831$ for a two-sided test, which is appropriate. Therefore, the t-score of 0.496 shows that there is no detectable difference between the pretest scores of the control and experimental groups. The standard deviation is 4.30 for the control group and 5.02 for the experimental group.

To determine the significance of the difference between the pretest and posttest scores for the

Table 3. Comparison between pretest and posttest scores.

Control Group			Experimental Group		
Before (X)	After (Y)	Y-X[a]	Before (X)	After (Y)	Y-X[b]
19.7	20.0	0.3	20.0	20.0	0.0
17.0	22.0	5.0	16.0	23.0	7.0
11.0	10.5	-0.5	15.0	23.0	8.0
11.0	5.0	-6.0	15.0	22.0	7.0
10.2	8.7	-1.5	13.3	20.7	7.4
10.0	8.0	-2.0	12.0	17.5	5.5
9.3	2.8	-6.5	11.5	23.0	11.5
9.2	11.8	2.6	10.0	8.0	-2.0
9.0	12.0	3.0	10.0	11.0	1.0
8.2	13.2	-5.0	9.0	14.0	5.0
7.0	12.0	5.0	8.0	7.0	-1.0
6.3	18.7	12.4	7.0	8.5	1.5
6.0	5.0	-1.0	6.0	2.0	-4.0
6.0	3.5	-2.5	5.5	10.0	4.5
6.0	5.5	-0.5	5.7	3.3	-2.4
5.5	6.5	1.0	5.0	14.0	9.0
4.7	2.2	-2.5	5.0	9.0	4.0
4.3	2.7	-1.6	4.5	16.0	11.5
4.3	8.7	4.4	3.7	7.0	3.3
4.0	4.8	-0.8	3.0	14.0	11.0
2.5	1.8	-0.7	2.0	9.0	7.0
2.3	0.7	-1.6	1.0	4.3	2.7

Note: For the control group, the standard deviation of X is 4.30, of Y is 6.05, and of Y-X is 4.19. For the experimental group, the standard deviation of X is 5.02, of Y is 6.81, and of Y-X is 4.58.
[a]For paired t-test, t = 0.132.
[b]For paired t-test, t = 4.53.

control and experimental groups, the t-formula for testing the difference between correlated pairs of means was used by using a one-sided test because one would expect a positive improvement in each case (see Table 3). Further, a level of confidence of $\alpha = 0.01$ was used in each case, to ensure greater power to the result if the hypothesis of no difference were rejected. (The procedure was taking only 1 in 100 chance of rejecting a true hypothesis of no difference.) The results may be summarized as follows.

Control Group

The mean for the control group's pretest was 7.89 and for the posttest was 8.00. The difference in mean scores was 0.12. At the $\alpha = 0.01$ level of confidence, the computed t = 0.132, and there were 21 degrees of freedom. The tabulated t = 2.52; therefore, the t-score of 0.132 reveals no statistically significant difference between the pretest and posttest scores for the control group.

Experimental Group

The mean for the experimental group's pretest was 8.59 and for the posttest was 13.01. The difference in mean scores was 4.43. The computed t = 4.53, and there were 21 degrees of freedom. At the $\alpha = 0.01$ level of confidence, t = 2.52; therefore, the t-score of 4.53 causes one to reject the hypothesis that there is no difference in the pretest and posttest means.

Comparison

Thus, there is a clear indication that the portable intersection trainer was an effective instructional mechanism for the target population. Moreover, for the particular evaluation procedure used, it was shown to be more reliable than the existing mechanism, for no improvement in the aggregate control group was detected. (Inspection of the data in Table 3 does show individual successes with each mechanism, but a more-consistent pattern occurred with the portable intersection).

SUMMARY

Safe street crossing is a complex task. Achievement of this skill provides benefits to children in other areas of their lives, such as the following:

1. Making decisions for themselves; in order to cross a street safely, a child must decide when to wait and when it is safe to cross the street. This is often the first major decision children learn to make for themselves.
2. Assuming responsibility for themselves; in deciding when to cross a street, a child assumes responsibility for getting across the street safely.
3. Achieving a sense of independence; in learning to cross a street safely, children take a step toward being able to move around the community on their own.

The portable intersection can be an effective tool in helping mentally handicapped children adapt to community life. By learning basic safety and street-crossing skills and by increasing their awareness of traffic and pedestrian rules, the mobility of the children can be increased. Class trips should be easier for classroom teachers and shopping trips should be easier for parents.

The results of the experiment of using a portable intersection in a simulated environment to teach street-crossing skills to severely and moderately mentally retarded adolescents show that the skills acquired were transferable to actual conditions on city streets. The difficulty in using the portable intersection is its size, bulk, and the number of people required to assemble it. However, the need to stand up to intensive use mandates some sturdiness. At the Adult Skills Training Center a crew of five mentally retarded young men learned to assemble the intersection in 0.5 h and to disassemble it in 20 min. The learning experience of assembling and disassembling the system is valuable in itself for students old enough and strong enough to do the task.

The amount of time and number of people required to assemble the unit would prohibit its use in some circumstances, such as a single-unit classroom of handicapped young children and one teacher. The portable intersection could best be used as an educational tool by moving it to schools that have a large population of students and with sufficient support staff. Because of its size and weight, we recommend that the intersection be semipermanently set up. Instead of setting it up daily, setting it up on a weekly basis might be better. This would depend, of course, on the amount of room available to a particular school.

The travel-training observers and instructor thought that the students in the experimental group benefitted greatly from the experience. The portable intersection has been shown to do what it was developed to do; that is, to serve as an educational tool to accelerate the teaching of mentally handicapped students to safely cross streets.

ACKNOWLEDGMENT

We wish to express gratitude to the New York City Department of Transportation Sign Shop for donating the traffic signs; to Onofrio Russo, who designed and built the prototype model; to staff members of the Board of Education's Travel Training for the Handicapped Program, particularly to Peggy Groce and Arlene Isaacson, who provided very valuable information and assistance; to M. Voelker, who donated the brackets for mounting the traffic signs; to Victor Ross and John Passalaqua, of the New York City Department of Transportation, for their enthusiastic support for the project and their assistance in the administrative execution of the project; and to William R. McShane of the Polytechnic Institute, who provided some insights into the statistical data that were of special value.

This document is disseminated under the sponsorship of the U.S. Department of Transportation, the New York State Governor's Traffic Safety Committee, and the New York City Office of Highway Safety. The above-mentioned assume no liability for its contents or use thereof.

Publication of this paper sponsored by Committee on Pedestrians.

Effect of Pedestrian Signals and Signal Timing on Pedestrian Accidents

CHARLES V. ZEGEER, KENNETH S. OPIELA, AND MICHAEL J. CYNECKI

The purpose of this study was to determine whether pedestrian accidents are significantly affected by the presence of pedestrian signal indications and by different strategies for signal timing. Data related to pedestrian accidents, intersection geometrics, traffic and pedestrian volumes, roadway environment, and signal operation were collected for 1297 traffic-signalized intersections in 15 cities throughout the United States. The data were analyzed by using various statistical tests, which included branching analysis, correlation analysis, chi-square analysis, and the analysis of variance and covariance. The results showed no significant difference in pedestrian accidents between intersections that had standard-timed (concurrent walk) pedestrian signals compared with intersections that had no pedestrian signal indications. In addition, exclusive-timed locations were found to be associated with lower pedestrian accident experience for intersections with moderate-to-high pedestrian volumes when compared with both standard-timed intersections and intersections that had no pedestrian signals. In some cases pedestrian accidents were also found to be significantly affected by other variables, including street operation (one-way and two-way streets), presence of local bus operations, and area type.

Recent pedestrian safety research has uncovered numerous problems regarding current pedestrian signalization practices. The lack of uniformity in strategies and devices for pedestrian signal timing has been thought to contribute to the ineffectiveness of the signals in achieving improved pedestrian safety. Further, pedestrians have expressed considerable confusion and misunderstanding regarding the meaning of the flashing DON'T WALK indication (or flashing hand) for the clearance interval and the flashing WALK indication (or flashing man) to warn pedestrians of turning vehicles. Such confusion over the meaning of pedestrian traffic-control devices may also contribute to pedestrian safety problems.

Although many problems have been attributed to the current uses of pedestrian signals, a literature review failed to find conclusive studies that adequately quantified the effect of pedestrian signals on pedestrian accidents. The effect of pedestrian signals on safety must be understood in order to determine whether the continued use of pedestrian signals is justified. The results of this analysis can help to determine whether changes are needed in the design and deployment of pedestrian signals.

The impact of the various pedestrian signal-timing schemes on operational strategies also need to be evaluated. Schemes for pedestrian signal timing include the following (1):

1. Concurrent (standard)--allows pedestrians to walk concurrently with the movement of traffic;
2. Early release--allows pedestrians to leave the curb before vehicles are permitted to turn;
3. Late release--holds pedestrians (with respect to vehicles) until a certain portion of the phase has been given to turning vehicles;
4. Exclusive--traffic is held on all approaches to allow pedestrians to cross any street; scramble (or Barnes dance) timing is a form of exclusive timing that also allows for diagonal crossings; and
5. Other--variations of the above where pedestrians are given different indications on parallel crosswalks to protect them during special traffic phases (i.e., special left-turn phases, or split phasing).

The purpose of this study was to determine whether pedestrian accidents at signalized intersections are affected by different uses of pedestrian signals and signal-timing schemes. We hoped that the results of this analysis would (a) help to identify the types of intersections or situations where pedestrian signals are most (or least) desirable from a safety standpoint and (b) aid in determining whether changes are needed in the design of pedestrian signals to improve their effectiveness. Such information should be of considerable value to the traffic engineering community, which is responsible for the installation and timing of pedestrian signals.

BACKGROUND

Although in recent years considerable research has been conducted regarding pedestrian safety, little has been published specifically on the issue of pedestrian signals and safety. In terms of the effect of pedestrian signals on accidents, Fleig and Duffy found no significant reduction in the proportion of unsafe acts or pedestrian accidents after the installation of scramble-timed pedestrian signals at 11 locations (2). Their accident data were limited to 27 accidents in the before period and 25 accidents in the after period, with each of these periods only one year in duration. The authors of the study concluded that pedestrian signals are not effective in reducing pedestrian accidents, but the limited data used raise questions about the statistical validity of this conclusion.

Several studies have been conducted concerning the effect of pedestrian signals on pedestrian compliance and behavior, which are sometimes considered to be indirect measures of pedestrian safety. A study by Abrams and Smith in 1977 concluded that higher pedestrian compliance rates are associated with late-release techniques and that early-release timing may provide an additional measure of safety,