

Identifying Gaps in Child Pedestrian Safety

Comparing What Children Do with What Parents Teach

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Vehicle/pedestrian conflicts are a primary cause of deaths among children age 5 to 12 in North America. Children under 14 are twice as likely as the general population to be involved in vehicle/pedestrian accidents. Parents may overestimate the cognitive abilities of children to handle complex traffic situations and may assume that pedestrian rules taught to children at a young age will help safeguard them when crossing independently. For this reason, parental guidance on crossing safety was compared to actual practice by children, with and without accompanying parents or baby-sitters. Investigations were conducted in Kitchener-Waterloo, Ontario, a midsize, urban community. Interviews were done of a small sample (30) of well-educated parents in the vicinity of facilities used by children. Their responses were compared with observations of children (208) crossing at signalized and nonsignalized intersections in the same areas. While a high proportion of parents, 87 percent, teach safety practices, and 70 percent restate them when crossing with their children, 20 percent do not make unobserved checks of their children. Of those parents who do make unobserved checks, 42 percent found that none of their safety rules were being followed. Observations of children, not necessarily related to the adults interviewed, found that children were less likely to search for traffic at signalized than at nonsignalized intersections ($p < 0.05$). At nonsignalized intersections, 33 percent of unaccompanied children performed no visual search before crossing, increasing to 48 percent at signalized intersections. Even smaller numbers (< 6 percent) of unaccompanied children looked behind them for turning vehicles. These findings suggest that, while more research is needed to improve parental training and child response, more emphasis should be placed on responsibilities of drivers and on countermeasures in the traffic environment.

Tragic accidents involving child pedestrians can result when children are allowed into traffic situations beyond their capabilities. Such accidents may result from a mismatch between the age at which parents allow their children to venture into traffic situations and the age at which children are capable of handling the situation safely.

CHILD PEDESTRIAN ACCIDENTS—EXTENT OF THE PROBLEM

Vehicle-pedestrian collisions have been identified as a primary cause of injury-related deaths among children aged 5 to 12 in North America. A website associated with child pedestrian safety reports that each year in the United States more than 50,000 children are injured as pedestrians and about 1,800 die (1). Further, it is estimated that for every death, approximately 10 children are seriously or permanently injured (2). In a Canadian study, children between the ages of 0 and 14 were found to be involved in 37 percent of pedestrian accidents, even though this age group comprised only 17 percent of the general population (3 as cited in 4).

A number of studies have examined the factors associated with child pedestrian accidents. Children between the ages of 5 and 9 are

more likely to be involved in pedestrian-vehicle crashes within 100 yards of their home, while those between the ages of 10 and 16 are more likely to be involved in incidents as part of the journey to or from school (5). A sudden appearance and unexpected movements of the child often are recorded as contributing factors in accidents involving younger children (6).

David and Rice examined 786 police reports on child pedestrian accidents occurring in Montréal over a 17-month period (4). They found that the accidents tended to occur on weekday afternoons during the summer months; they were likely to take place at midblock in residential areas under clear, dry weather conditions; and the victims most often were males between the ages of 5 and 8. Approximately a third of all child pedestrian accidents occur at intersections (1,6).

ROAD-CROSSING TASK

In order to cross a road safely, a pedestrian must be aware of oncoming traffic. If traffic is present, the speed of an oncoming vehicle and its initial distance must be estimated in order to determine when it is likely to arrive. The time required to cross to the other side of the path of the vehicle must be estimated as well. These two estimates must then be compared to determine whether the crossing can be made safely. Schofer and his colleagues point out that an intersection may pose considerably more complex sets of threats for pedestrians (6). The person crossing must monitor traffic as well as any traffic-control devices. He or she must watch for turning traffic that may be approaching from several directions simultaneously. In addition, the pedestrian must be aware that stop signs and signals provide uncertain protection.

The ability to cross a street safely develops with age. It has been estimated that "traffic maturity" is reached around 12 years of age (7,8). However, with age comes increased exposure to traffic safety education and exposure to actual traffic as children are permitted to travel further from home on their own or with friends. Such exposure also should lead to increased understanding of traffic hazards and increased experience in making the required estimates. The literature suggests that children below the age of 14 are overrepresented in pedestrian accidents (2,3). Thus, parents may be allowing children into traffic situations that they are not yet fully ready to handle on their own.

COGNITIVE LIMITATIONS FOR CHILDREN

Christoffel and her colleagues found that children who are perceived to be physically capable may be given (and/or take) greater freedom in their traffic crossing than less physically capable children (9). Parents may assume that children who are physically advanced for their age also are cognitively ready to handle crossing at intersections on their own. However, safely crossing a road requires a complex set of

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decision-making skills dependent on the individual's perceptual assessment of the immediate traffic environment. It also requires that the individual have a responsible sense of self-preservation so that the traffic environment is thoroughly monitored each and every time he or she crosses a roadway.

Perceptual skills involved with crossing roads include assessing visual and auditory cues associated with traffic flow. Research suggests that the high rate of pedestrian accidents among children could be related to limitations in their developing perceptual and cognitive abilities (10). These cognitive factors contribute to the ability to perform adequate visual search, to estimate time and distance of approaching vehicles, and to attend to auditory cues for approaching vehicles.

Children under the age of 12 have been found to have particular problems perceiving the direction of moving traffic (7), estimating the speed of oncoming vehicles (11), and performing adequate auditory estimates of approaching vehicles (12). Cited as one of the main contributing factors to child pedestrian accidents are inadequate search patterns at intersections (8,13). Educational campaigns have been found to be only marginally effective in improving child pedestrian behaviors. Preusser and Blomberg found that even when the majority of children in an educational campaign area acknowledged that they were aware of safe road-crossing messages, the rate of compliance in terms of actual visual search patterns still was below 30 percent (14).

RESEARCH OBJECTIVES

Studies of pedestrian accident rates, of traffic safety knowledge, and of performance all indicate that children take some years to develop the requisite skills and knowledge to become safe pedestrians. Education of children in the area of pedestrian safety is valuable but does not eliminate problems related to cognitive development. Parents need to be aware that presenting children with traffic-safety messages does not guarantee that they are cognitively ready to safely cross roads.

The goal of this research was to identify any gaps between parental expectations of children's abilities and their actual road-crossing behaviors. We used two complementary approaches to explore this issue: (a) observations of the road-crossing behaviors of children aged 5 to 12 at both signalized and nonsignalized intersections and (b) interviews with parents to explore their understanding of the capabilities of children between the ages of 5 and 12 for dealing with a variety of traffic situations. A full description of this study is found in Smiley, MacGregor, and Dunk (15).

METHODOLOGY

Data collection took place during the summer and early autumn of 1997 in Kitchener-Waterloo, Ontario, Canada. Observations were made of 208 children as they crossed at selected signalized and nonsignalized intersections. Thirty interviews of parents also were conducted. These parents were not necessarily the parents of any of the children observed.

Observational Sites

Observations were made at a total of two signalized and four nonsignalized intersections. All sites were selected based on their proximity to facilities frequented by children (i.e., playgrounds and public swimming pools), and they were located in high-residential/light-industrial areas. One signalized intersection had two lanes in

each direction crossing two lanes in each direction. The other had two lanes in each direction crossing one lane in each direction. Both signalized intersections had crosswalks and pedestrian signals and controls. Right turns on red lights are permitted in Ontario. At both intersections, the traffic volume would be considered moderate to heavy during daytime hours.

All four of the nonsignalized intersections had two-way stop control and crosswalks on the street with the lower traffic volume. One of these intersections was offset, another was a T-intersection, and the other two were standard right-angle crossings of two streets. At the nonsignalized intersections, traffic volume on the main road would be considered light to moderate during daytime hours.

Observational Method

Data collection for this project was carried out over a two-month period. All observations took place under "normal, dry" weather conditions. The original plan for data collection of child pedestrian behaviors was to videotape children as they crossed at the intersections. This method was changed, however, due to current community feelings about children's safety as well as privacy issues. Instead, two research assistants (RAs) made observations. Agreement between the RAs about age classifications that were arrived at independently served to partially validate the classification. Prior to the data collection, the RAs observed children enrolled in a summer day camp who were separated into different groups depending on age. The RAs formed a basis of comparison for future observations by observing facial and body characteristics, as well as gait, of children of known ages.

The observers positioned themselves so that they had a clear view of the intersection while making themselves as inconspicuous as possible. For children within the target age group of 5 to 12 years, the RAs recorded the following: their age; their gender; if they were accompanied by an adult, holding hands, with friends or in a group, or alone; and their behavior before and during the crossing. Behaviors that were recorded included whether the children stopped at the curb; whether they looked left or right immediately before starting to cross; and whether they looked left, right, or behind as they were crossing. Given the cognitive limitations of children under the age of 12 in terms of attention, visual search, and decision making, a more stringent approach to categorizing "looking" behavior was used than might be used when observing adult pedestrians. While adults may be able to perform subtle eye movements to look for traffic, we wanted to be sure that the child observed had made a direct attempt to search for traffic. For this reason, a "look" in a particular direction was considered to be a sustained head position (approximately 2 s or more). RAs also recorded if they thought that the child had done a "head swivel" (an unsustained turn of the head) as opposed to a full "look" in any direction.

Other recorded information included the mode of travel (walking, running, skateboarding, in-line skating, or bicycling); whether the child crossed in the crosswalk; whether there was a potential conflict with traffic (i.e., vehicle turning into path); whether the child hesitated before crossing; and whether the child seem distracted from the task of crossing (e.g., playing, talking, etc.). For signalized intersections, the state of the traffic lights and crosswalk signal was recorded.

A target of 30 observations per age group by intersection type was set. At the nonsignalized intersections, observations of 108 children were recorded: 47 males and 59 females; 37 five- to seven-year-olds, 40 eight- to ten-year-olds, and 31 eleven- to twelve-year-olds. At the signalized intersections, 100 children were observed: 65 males

and 35 females; 39 five- to seven-year-olds, 30 eight- to ten-year-olds, and 31 eleven- to twelve-year-olds.

Parent Interviews

Individuals were solicited outside of swimming pools and at a large city park. Participants had to fit the criterion of being a parent of at least one child between the ages of 5 and 12. An incentive of a lottery ticket or a gift certificate from a local ice-cream store was offered. Thirty parents were interviewed (26 females and 4 males). The majority (70 percent) of those interviewed had a university or college education, 17 percent had graduated from high school, and 13 percent had completed some high school. For the parents interviewed, the average age of the oldest child was 7.2 years. The relatively high level of education of the parents is not surprising given that the Kitchener-Waterloo area has two universities and a community college.

Questions included asking the participant to indicate minimum ages at which children should be allowed to cross streets; ages at which their own children were allowed to cross streets; street-crossing training that they had given their children; whether they had ever unobtrusively observed their children cross alone; and if so, whether the child followed the rules the parent had taught.

RESULTS

The responses from the parent interviews were compiled and compared with the observations made of child pedestrian behavior in the three age groups and at the two types of intersections (signalized or nonsignalized). All parents reported that they had taken steps to teach their children rules for safely crossing roads. A large majority of parents (87 percent) reported that they walked most new routes with their children before allowing them to journey on their own.

General Safety Rules for Crossing Roadways as Reported by Parents

Parents were asked, without prompting, to state the safety rules that they taught their children. Responses were categorized with reference to crossing a roadway without any traffic controls, crossing at a stop sign, crossing at a quiet residential traffic light, and crossing at a major intersection. No prompting was given. All parents reported that they gave their children specific training for the traffic situations of interest. Table 1 presents a breakdown of the rules cited. For all crossing situations, most parents (70 percent) reported that they reminded their children of this training every time they crossed together.

TABLE 1 Rules Taught by Parents for Crossing at Intersections

Safety Rules - Without Stop Sign	Percentage of parents citing rule
Look Both Ways	100%
Stop Before Crossing	70%
Listen for Traffic Coming	40%
Always Walk	33%
Look More Than Once	13%
Select the Right Place to Cross	10%
Look Behind	3%
Safety Rules - Stop Sign	
Look Both Ways	90%
Make Sure Car Stops	43%
Always Walk	23%
Look Behind	20%
Look More Than Once	13%
Cross at Crosswalk	13%
Safety Rules - Traffic Light	
Meaning of Walk/Don't Walk Symbols	80%
Meaning of Traffic Light Colors	70%
Meaning of Flashing Symbol	63%
Make Sure That Car Stops	33%
Always Walk	33%
Look Behind for Cars Turning	23%
Cross at Crosswalk	7%

NOTE: Parent interviews: $N = 30$.

Parents' Opinions on Minimum Age for Crossing Roadways

Parents were asked to state the youngest age at which they thought a child would be ready to cross under various traffic-control situations with and without accompaniment. The accompaniment conditions were crossing while holding hands with a baby-sitter, crossing with a baby-sitter but without holding hands, crossing with same-age friends, and crossing alone. The traffic-control situations were a quiet residential street corner without any traffic controls or stop signs, a residential street corner with stop signs, a residential street corner with a traffic light and a single lane of traffic in each direction, and a major intersection with traffic lights and two or more lanes of traffic in each direction. Table 2 presents the ages recommended for the various combinations of intersections and accompaniment.

Streets that require stop-sign controls typically are viewed as having higher traffic volumes or posted speed limits than those roads without such controls. The recommended ages for crossing with a stop sign are only slightly older than those recommended for crossing at a quiet residential corner without any controls (stop signs or traffic lights).

Streets that require traffic lights tend to have higher traffic volumes than those roads with only stop signs. If a child is accompanied by a baby-sitter, the recommended ages for crossing at a quiet residential traffic light are the same as for crossing at a stop sign. However, they are slightly higher, by approximately 6 months, for crossing with same-age peers and crossing alone.

Parents' responses reflect an understanding that crossing at a major intersection with traffic lights may be a more complex environment than crossing at a residential traffic light. The youngest ages cited for this crossing situation were almost 1 year older than those cited for crossing at a residential traffic light, regardless of whether the child would be crossing with an adult or alone.

Child Pedestrian Behaviors

The observations at the intersection sites were analyzed by age group and gender for patterns of behavior. Composite variables were created for "absence of search" and "full search" throughout the crossing sequence. To be coded as a full search, the child must have demonstrated a visual search ("look") to the left and right prior

to crossing as well as a search to the left, right, and behind while crossing. The percentages of children exhibiting crossing behaviors, by intersection type and age group, are presented in Table 3. Potential conflicts (i.e., vehicles turning at the same time the child was crossing) were involved in 19 cases (9 at nonsignalized intersections and 10 at signalized intersections). Descriptions of these cases were not detailed enough to allow for further analysis.

Chi-square analyses were carried out to explore potential differences in behavior among the three age groups and between males and females. In addition, analyses were conducted to find out if the behaviors of children crossing alone were significantly different from children crossing with an adult or friends. Relationships that met or approached the criterion level of significance ($p=0.05$) are discussed.

Pedestrian Behaviors at Nonsignalized Intersections

Very few significant differences were found between the behaviors of males and females and among the three age groups at nonsignalized intersections. One interesting difference pertains to stopping at the curb prior to crossing. Older children were less likely to stop at the curb before crossing than were younger children ($p < 0.057$). The 5- to 7-year-olds stopped at the curb 57 percent of the time, the 8- to 10-year-olds 43 percent, and the oldest group stopped only 28 percent of the time.

Visual search behavior before crossing was examined in terms of whether a look was made only to the right, only to the left, whether both directions were checked, and whether no visual search occurred. Overall, 37 percent of the children observed at the nonsignalized intersections did not look for traffic before crossing, 23 percent checked only to the left, 19 percent checked only to the right, and 21 percent checked to both the left and the right. During the crossing of the intersection, 34 percent did not look at all, 14 percent looked only to the left, 20 percent looked only to the right, and 32 percent looked both ways. Checking for traffic in both directions was slightly higher while crossing as opposed to before crossing. For both the "before crossing" or precrossing phase and the "while crossing" or crossing phase, child pedestrians were as likely to look both to the left and the right as they were to not look at all.

Finally, visual search behavior was combined for the precrossing and crossing phases. Across the age groups, only 26 percent looked both ways before and while crossing, 13 percent looked both ways

TABLE 2 Parents' Opinions of the Youngest Age at Which a Child Should Be Allowed To Cross a Roadway

Crossing Accompaniment N = 30	Without Stop Sign	With Stop Sign	Residential Traffic Light	Major Traffic Light
A. With an adult or teenage babysitter, while holding hands	2.7 yrs (1.6)	2.9 yrs (2.2)	2.9 yrs (2.0)	3.7 yrs (2.7)
B. With an adult or teenage babysitter, but not holding hands.	5.3 yrs (1.8)	5.5 yrs (2.1)	5.5 yrs (1.8)	6.5 yrs (2.3)
C. With friends the same age.	7.6 yrs (2.3)	7.7 yrs (2.2)	8.3 yrs (1.7)	9.6 yrs (2.0)
D. Alone.	7.9 yrs (2.4)	8.1 yrs (2.5)	8.9 yrs (2.0)	10.2 yrs (2.2)

NOTE: Mean age in years with standard deviation.

TABLE 3 Pedestrian Behaviors by Age Group and Intersection Type

Intersection Type	Non-Signalized			Signalized		
	Age Group 5-7 Year Olds N = 37	8-10 Year Olds N = 40	11-12 Year Olds N = 31	5-7 Year Olds N = 39	8-10 Year Olds N = 30	11-12 Year Olds N = 31
Cross with Adult (holding hands)	16%	3%	0%	20%	0%	0%
Cross with Adult (not holding hands)	32%	20%	16%	62%	27%	3%
Cross with Other Children	32%	50%	48%	8%	30%	48%
Cross Alone	19%	27%	36%	10%	43%	48%
Stop at Curb	57%	43%	29%	68%	70%	42%
Look Left Before Crossing	41%	45%	48%	36%	43%	48%
Look Right Before Crossing	38%	45%	39%	21%	27%	39%
Look Left While Crossing	49%	45%	45%	44%	60%	52%
Look Right While Crossing	57%	53%	45%	44%	37%	36%
Look Behind While Crossing	22%	10%	7%	10%	10%	7%
Absence of Visual Search	30%	35%	34%	51%	50%	43%
Full Visual Search*	11%	5%	3%	5%	0%	0%

* Looking to the left and right before crossing, and looking left, right and behind while crossing.

only during the precrossing phase, 27 percent looked both ways during the crossing phase, and 35 percent of all children neglected to look at all during either phase ($p < 0.02$).

Pedestrian Behaviors at Signalized Intersections

Few significant differences were found for gender or age group at signalized intersections, paralleling the findings at nonsignalized intersections. For the most part, the majority of children began their crossing when the light was green (91 percent); the remainder started crossing when the light was yellow. None of the children observed began their crossing while the traffic light was red.

As was the case with the nonsignalized intersections, there was a significant relationship between age and stopping at the curb prior to crossing; the oldest children were less likely to stop at the curb than the younger children ($p < 0.04$). Another significance was that, across age groups, children were more likely to check in both directions (26 percent) or to not do any visual search (26 percent) than they were to check only to the left or to the right while crossing ($p < 0.02$).

When visual search was classified as either a complete absence of search during the crossing event or some visual search, a significant relationship was found between the two intersection types. Children at nonsignalized intersections (67 percent) were more likely to perform some visual search than children at signalized intersections (52 percent) ($p < 0.05$).

Children Crossing with Adult Accompaniment

Since most parents reported that they reminded their children of safety rules every time they crossed together, we examined the

behaviors of children who crossed with adults versus those who did not. Given the relatively small differences in behaviors exhibited at the two intersection types, data were collapsed across signalized and nonsignalized intersections. There were three recorded classifications for accompaniment: no adult accompaniment (child crossed alone or with other children), crossing while holding hands with an adult, and accompanied by an adult but not holding hands. A separate set of analyses was run to compare the behaviors of children who crossed alone with those who crossed with other children. No significant differences were found, so the two classifications were considered together under the "no accompaniment" category.

Children who were not accompanied (43 percent) were less likely to stop at the curb than those who were accompanied by hand (53 percent) and those that were accompanied but not by hand (70 percent) ($p < 0.003$). While they were not as likely to stop at the curb, unaccompanied children were more likely to perform a visual search than children who were accompanied. Prior to crossing, unaccompanied children were more likely to check for traffic to the left (49 percent) than those who were accompanied by hand (13 percent) and those who were accompanied but not by hand (36 percent) ($p < 0.02$). This relationship held for looking to the right prior to crossing. Unaccompanied children were more likely to check for traffic to the right (40 percent) than those who were accompanied by hand (7 percent) and those who were accompanied but not by hand (36 percent).

Similar relationships between visual search and accompaniment were found during the actual crossing of the intersection. Children who were held by the hand (20 percent) were less likely to look to the left while crossing than those who crossed without holding an adult's hand (59 percent) and those who crossed without an adult (46 percent) ($p < 0.02$). Similarly, children who were held by the hand (20 percent) were less likely to look to the right while crossing

than those who crossed with an adult (45 percent) and those who crossed without an adult (53 percent) ($p < 0.07$). Regardless of accompaniment, very few children searched behind while they crossed (<13 percent for all groups).

Consideration was given to the fact that some of the differences between children crossing with and without accompaniment may be because a larger number of younger children crossed with adult accompaniment. A separate set of analyses was run on the 76 children in the 5- to 7-year-old age group. A similar pattern of results was found for these younger children. Children crossing without an adult (46 percent) were less likely to stop at the curb than children who were accompanied (72 percent) ($p < 0.03$). Prior to crossing, children without an adult were more likely to check to the left than were children who crossed with an adult.

Parents' Reported Observations of Their Own Children

All of the parents interviewed were asked for recent observations of their own children crossing roadways when the child was not aware of being observed. One-fifth of the parents reported they had not made such observations. Based on the other 24 parents, the most "typical" observation occurred in the week previous to the interview (38 percent), involved a midstreet crossing (67 percent), and was through light traffic (75 percent). In more than half of the cases, the child is reported to have used some or all of the rules taught by the parent. It is noteworthy that in 42 percent of the cases, the parent reported observing his or her child not exercising any of the safety rules taught.

DISCUSSION OF RESULTS

What Parents Teach and What Children Do

For the most part, the patterns of behaviors observed in this study coincide with other research findings on child pedestrian behaviors. Although a limited sample, the 30 parents interviewed are believed to be representative of parents of children observed in the target age groups (5 to 12 years of age). The fact that the parents interviewed have a relatively high level of education casts our results in an interesting light. It is not unreasonable to assume that if fairly well-educated parents can mistakenly assume that children under the age of 12 are cognitively capable of dealing with complex traffic situations, then less-educated parents may be more likely to assume that their children are ready to handle traffic situations at very young ages.

Our observational and interview results are discussed in terms of the basic elements of child pedestrian safety rules.

Stop at the Curb

While "stop, look, and listen" may be a popular phrase for remembering safe pedestrian behaviors, the rules cited by parents did not highlight those practices in all of the crossing situations. "Stop before crossing at corners without stop signs" was mentioned by the majority of parents. For the stop-sign and traffic-light situations, "make sure the car stops" was emphasized over the actions of the child. Such a shift in focus may help to explain why older children are less likely to stop at the curb at both nonsignalized and signalized intersections. It may be that older children make quick estimates of time and distance of approaching cars, in order to decide whether an approaching car is likely to stop, before making a decision to stop themselves.

Search for Traffic

When crossing at an intersection, a proper visual search involves checking to the pedestrian's left and right prior to crossing as well as checking to the left, right, and behind for turning vehicles during the crossing. Observational data collected in our study revealed extremely low rates of proper visual search, especially when "looking behind while crossing" was considered. At nonsignalized intersections, only 6 percent of children exhibited proper search behaviors, while 33 percent of all children did not do any visual search prior to or during the crossing. At signalized intersections, only 3 percent of children looked all ways throughout the crossing sequence, while 48 percent did not appear to do any visual search. Even without considering the "looking behind" behavior, visual search rates still were low. Fewer than 26 percent of all children at the nonsignalized sites and 18 percent of children at the signalized sites looked to the left and right both prior to and during the crossing. These rates are in keeping with other studies that found on average only 12 to 23 percent of children to exhibit proper visual searches at intersections (14).

All 30 parents interviewed in this study reported that they had given their children specific instructions on safely crossing roads. Their unprompted recall of the rules they had taught show an emphasis on certain behaviors in some crossing situations and a lack of emphasis in others. For example, all of the parents mentioned that they taught their children to "look both ways" when crossing at a corner without a stop sign. This dropped to 90 percent for crossing at a corner with a stop sign and was not mentioned by anyone as a safety rule for crossing at a traffic light. Reference to "look more than once" was made by 13 percent of the parents in conjunction with crossing at corners with and without stop signs. It was not mentioned explicitly by any of the parents as an important rule to be followed when crossing with traffic lights. The lack of emphasis on "look both ways" and "look more than once" as rules for crossing at traffic lights may help to explain, in part, why the percentage of children exhibiting such behavior was lower for the signalized intersections than it was for the nonsignalized intersections. Also, the children may have assumed that the traffic signal protected their crossing to a greater degree than a stop sign, lessening the need for caution on their part.

Listen for Traffic

The rule of "listening" for traffic was only stated in association with crossing at a corner without stop signs. Fewer than half of the parents mentioned this rule. While the observations made in our study could not account for any auditory searches made by the children, research suggests that 5- to 12-year-olds are unlikely to have developed the cognitive abilities to carry out adultlike auditory surveys (12). Along with their lack of stopping at the curb and their poor rates of visual search, this makes it doubtful that the children gave enough attention to the traffic environment to perform adequate auditory searches prior to or while crossing.

Obey Traffic Signals

Studies have reported that children are less likely to perform visual searches at signalized intersections than they are at nonsignalized intersections. Van der Molen relates it to the tendency for children to monitor the traffic signals for an indication that they have the right-of-way to cross (13). In our study, the children observed at signalized

intersections were less likely to perform a visual search than were the children observed at the nonsignalized intersections ($p < 0.05$). Interestingly enough, the majority of parents cited rules that emphasized the meaning of the traffic controls, particularly the meaning of the walk/don't walk symbols, rather than the search behaviors that children should carry out at intersections controlled by traffic lights. Such a shift in emphasis may encourage children to place their focus on monitoring the signals in terms of whether or not they have the right-of-way, rather than on carrying out a proper search for traffic.

Check for Turning Vehicles

Vehicles turning from behind the pedestrian's starting position have been associated with the largest number of conflicts and the lowest amount of observing behavior by pedestrians at intersections (16). Very few parents, however, mentioned "look behind for traffic" in association with crossing at a corner without a stop sign (3 percent), for crossing with a stop sign (20 percent), or in conjunction with crossing at traffic lights (23 percent). Despite the increase in citations of this particular rule as the complexity of the traffic situation increases, the low percentage of parents who report teaching it may explain why so few children check behind them for turning traffic.

Cross with an Adult

The literature would suggest that children should not be expected to be cognitively competent to handle complex traffic crossing situations until approximately 12 years of age. When asked their opinions as to the youngest age at which children should be permitted to cross roads without adult accompaniment but with friends, the parents suggested a mean age of 7.5 years for all crossing situations. The mean value for the youngest age recommended for crossing alone was 8 years. Based on these recommendations, all children in the youngest age category should have been accompanied by an adult. Yet our observational data identified 18 percent of children in the 5- to 7-year-old group as crossing with friends or alone at signalized intersections and 51 percent of the youngest age group crossing with same-age friends or alone at the nonsignalized sites.

Crossing with an adult does not guarantee that the child will carry out proper visual searches at intersections. Some significant, and somewhat disconcerting, differences in behaviors were found between children crossing with an adult and those who were not. Children in the company of an adult were more likely to stop at the curb than children who were unaccompanied ($p < 0.03$). It is difficult to tell from our observational data, however, whether the stop at the curb was initiated by the child or by the adult. One might suspect the latter. For all visual search behaviors recorded, children who crossed while holding the hand of an adult were less likely to perform a visual search than the other children ($p < 0.05$). Younger children were more likely to cross holding an adult's hand than were older children. In such situations, it may be that the child is expecting, and relying on, the adult to perform the searches for traffic. Unless the adult is ensuring that the child is performing a proper search, however, such accompaniment may do little to reinforce appropriate search behaviors.

Follow the Rules

From the observations made in this study, it is quite clear that not all children follow the basic rules of "stop, look, and listen." Given the

methodology used, we were unable to query any of the observed children after they had crossed the intersection to find out if they had neglected to stop and search for traffic because they were unaware that they should have done so or because they simply had forgotten. A common assumption is that children are taught the basic rules of safely crossing a road at an early age—first by their parents or guardians, and then at school. It is likely that the children observed in our study would have been exposed to the basic rules of pedestrian safety. The fact that children "forget" to stop, look, and listen is borne out by the reports of the parents interviewed. All of the parents reported that they had taught their children rules for safely crossing roads. However, of the parents who reported that they had unobtrusively observed their own children crossing, 42 percent said that their children did not use any of the rules that the parents had taught. This supports the notion that, for whatever reason, children do not always remember to follow the safety rules.

Bridging the Gaps Through Education

One might assume that the first step toward filling the gap in child pedestrian safety lies in further education of children. A number of articles on child pedestrian safety cite educational programs as part of the solution to the high incidents of child pedestrian accidents (4,6,17). Education of children alone is unlikely to solve the problem. While educational campaigns may increase children's awareness of safety issues, they do not ensure that children will comply with those safety messages (14).

Roberts and Coggan present an interesting and somewhat controversial position on traffic safety campaigns directed at children (18). They suggest that such campaigns help to further a "blame the victim" response to child pedestrian accidents by fostering the notion that children should be responsible for their own safety. By their very nature, educational campaigns imply that children can be "taught" to follow safe pedestrian practices and as such are capable of being responsible for their own safety—even though research on cognitive development would suggest otherwise. Roberts and Coggan point out that child education strategies are less likely to be effective countermeasures than approaches that consider the design of the traffic environment or the education of adults.

A number of gaps exist between the instructions parents give, and their expectations of children's capabilities, and what children actually do when crossing roadways. In our study, the parents interviewed recommended ages for crossing roads alone that were well below the "traffic maturity" age of 12 years. It would seem vital to the safety of children that parents be more aware of the cognitive limitations of children and the low rate of compliance even when they have been "taught the rules." Parents may then be able to make more informed decisions as to whether they will allow their young children to venture into traffic on their own. The results of our observational data suggest that parents may not be aware of the potential fallacy of "modeling accompanying adults." Children held by the hand during the crossing sequence were less likely to perform their own search behavior than other children ($p < 0.05$). Accompanying adults could be educated about methods of using street-crossing situations to review and reinforce proper search behavior in their children.

It is equally important to educate drivers about the cognitive limitations of children as pedestrians, so that drivers understand how unlikely it is that children will watch out for vehicles, particularly for turning vehicles at intersections. Although this places a heavier

burden of responsibility on drivers, one could argue that it is more appropriate to require adults to be vigilant than to expect children to shoulder such responsibility.

While education of children, parents, and drivers is important, it does not preclude the fact that none of us is able to be vigilant 100 percent of the time. Countermeasures that serve to make the traffic environment more forgiving for pedestrians and drivers (e.g., separate overpasses for pedestrians) acknowledge the limitations of our cognitive abilities. Research has shown that physical reminders at intersections may encourage pedestrians to look for turning vehicles when crossing at signalized crosswalks. Innovative solutions that are incorporated into pedestrian signals may serve to remind child pedestrians to look for turning vehicles. One method is to include auditory messages that are played in conjunction with visual pedestrian signals (19). Another solution, the "EYES" project, incorporates into the pedestrian signal an animated display of two eyes that appear to look to the left and the right. The signal is visible to both pedestrians and drivers and has been shown to increase visual search in adult pedestrians (20). Clearly, the adaptation of all possible traffic environments is not likely to be feasible in the near future. For this reason, it is important to continue to pursue educational campaigns in conjunction with feasible technological solutions.

RECOMMENDATIONS AND CONCLUSIONS

Research that makes use of observations and interviews is not without its limitations. We were not able to confirm the actual ages of the children observed. For this reason, rates of behaviors associated with particular age groups only can be assumed to be estimates. Our methodologies did not allow for follow-up interviews with the children observed, so we only can speculate as to why some children carried out proper visual searches while others did not. Future studies should include such a follow-up with the hopes of identifying ways of increasing compliance among children and how parents can train them more effectively.

A second limitation to this research lies in the small number of parents interviewed. Thus, these results must be interpreted as being suggestive rather than representative of parents' views of child pedestrian safety. Further, our interviews did not specifically probe parental understanding of the cognitive limitations of children with respect to specific crossing-behavior components (e.g., speed and distance estimates, auditory search).

Finally, we restricted our interviews to the views of parents with children in the target age group but who were not necessarily the parents of the children observed. A more complete study would link the responses of parents with the behaviors of their own children. This would allow us to track the effectiveness of particular parental approaches to educating children in the areas of traffic safety. In addition, a broader study also would involve interviewing drivers of various age groups and experience. The knowledge of the general driving population with respect to the cognitive and physical limitations of children as well as their typically observed pedestrian behaviors could then be examined.

To begin to bridge the gaps in child pedestrian safety through education, further exploration as to parents' and drivers' understanding of the cognitive limitations of children needs to be carried out. Further research into the mindset of children when crossing roadways should be conducted as well. In order to build effective

educational programs, it is important to understand which safety rules children remember as well as their reasoning behind which rules they choose to follow and which rules they choose to ignore.

The results of the above research should help road-safety professionals to compile an educational campaign for parents that will help them make appropriate decisions about their children's exposure to various traffic situations. An educational campaign directed at drivers also should be developed to make them aware of their responsibility to look out for children who cannot be depended upon to be responsible for themselves.

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