Published in final edited form as:

Transp Res Part F Traffic Psychol Behav. 2014 September 1; 26 Pt A: 171–179. doi:10.1016/j.trf.2014.07.005.

Children's Pedestrian Route Selection: Efficacy of a Video and Internet Training Protocol

David C. Schwebel and Leslie A. McClure

University of Alabama at Birmingham

Abstract

Objective—This randomized controlled trial examined one aspect of child pedestrian behavior, route selection across intersections, to evaluate whether a combination of widely-available videos and websites effectively train children in safe pedestrian route selection compared to active pedestrian safety control training and a no-contact control group.

Methods—A sample of 231 seven- and eight-year-olds were randomly assigned to one of four groups: training with videos and internet websites, active control groups of individualized streetside training or training within a virtual pedestrian environment, or a no-contact control group. All training groups received six 30-minute training sessions. Pedestrian route selection was assessed using two strategies, vignettes accompanied by illustrations and tabletop models of intersections, on three occasions: prior to intervention group assignment, immediately post-training, and six months after training.

Results—Although there were differences in route selection over time, no time by condition interaction effects were significant ($ps > .05$), suggesting children in the video/internet training group did not learn pedestrian route selection skills at a rate different from those in the other training groups or those in the no-contact control group.

Conclusion—Safe route selection is a critical component of pedestrian safety. Our results suggest children may not learn route selection from widely-available videos or websites. Explanations for the null finding and implications for both research and future practice are discussed.

Keywords

pedestrian; route selection; injury; safety; randomized controlled trial

© 2014 Elsevier Ltd. All rights reserved.

Corresponding Author: David C. Schwebel, Department of Psychology, University of Alabama at Birmingham, 1300 University Blvd, CH 415, Birmingham AL 35294 USA, Phone: (205) 934-8745, Fax: (205) 975-6110, schwebel@uab.edu.

The content is solely the responsibility of the authors and does not necessarily represent the official views of the Eunice Kennedy Shriver National Institute of Child Health & Human Development or the National Institutes of Health.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Pedestrian injury is a leading cause of child morbidity and mortality in the United States and worldwide. In the United States, 459 children died from pedestrian injuries in 2010 and another 215,188 were treated in emergency departments following pedestrian injuries (National Center for Injury Prevention and Control, 2013). Global data are less precise, but estimates exceed 30,000 child pedestrians killed annually worldwide (Toroyan & Peden, 2007). The present paper was designed to test strategies for training 7- and 8-year-old children in safe pedestrian route selection.

Skills Required for Safe Pedestrian Behavior

To engage safely in street environments, children must develop a wide range of skills. Some skills are perceptual: safe pedestrians must perceive the speed, distance, and acceleration/deceleration of oncoming traffic accurately. Other skills are cognitive: safe pedestrians must interpret and process information about the street environment and the vehicles in it, and then decide when a safe gap in traffic appears to permit crossing. Still other skills involve strategic decision-making: safe pedestrians must determine the safest place and route to cross an intersection. Those skills, the focus of the present investigation, involve consideration of environmental factors such as parked vehicles, hills, and curves in the roads. Safe child pedestrians must learn to determine where their vision of oncoming traffic is best. They must also determine what the safest path across roads or intersections is. Adult pedestrians generally cross intersections at crosswalks using direct paths that minimize exposure to traffic by traveling efficiently across streets (e.g., Tabibi & Pfeffer, 2003, 2007). Novice pedestrians – including many young children – cross diagonally and without crosswalks, creating longer and more dangerous exposure to traffic (e.g., Ampofo-Boateng et al, 1993; Barton et al, 2012).

Previous Work on Children's Pedestrian Route Selection

Early research on children's pedestrian route selection established that children are unskilled at choosing safe routes across the street prior to about age 8 (Ampofo-Boateng & Thomson, 1991; Ampofo-Boateng et al, 1993; Barton & Schwebel, 2007; Demetre & Gaffin, 1994). Around age 9, children begin to recognize the safety of spending the least amount of time in the street as possible. They also recognize at that age the risk of barriers or obstacles that could occlude their vision of oncoming traffic, including parked cars, curves and hills in the roadway, and other such obstacles. By age 10 or 11, most children choose pedestrian routes that correspond to adult decisions and are considered the safest possible (Ampofo-Boateng & Thomson, 1991).

Several factors are associated with development of safer pedestrian route selection. Previous research reports, for example, the role of cognitive development on pedestrian route selection by showing children's attention skills, including both selected and divided attentional processing as well as speed of processing and visual search skills, are associated with pedestrian route selection (Barton, Ulrich, & Lyday, 2012; Tabibi & Pfeffer, 2003, 2007; Tabibi, Pfeffer, & Sharif, 2012). Others have reported demographic (female gender, higher income, majority ethnic background; Barton et al, 2012; Barton & Schwebel, 2007;

Tabibi et al, 2012) and temperament (more temperamental control; Barton & Schwebel, 2007) factors associated with safer route selection paths.

Training Children in Safe Pedestrian Route Selection

A handful of published studies have considered ways to teach children relevant skills for safe pedestrian route selection (Schwebel et al, in press). The present research builds upon those studies. The first published set of studies designed to teach children safe route selection was conducted by Thomson and Ampofo-Boateng (Ampofo-Boateng et al, 1993; Thomson et al, 1992). Ampofo-Boateng and colleagues (1993) trained 5-year olds in six individualized sessions with an adult, either using table-top replica models or at actual streetside locations. Children trained with both strategies showed substantial improvement in post-training evaluations, and retained that improvement in assessments months later. This initial study indicated that safer pedestrian route selection can be learned, even as young as age 5. A limitation to that original result was the labor involved with individualized training of children. Most schools and other child-oriented agencies lack the manpower to train children individually in pedestrian safety. Recognizing this limitation, Thomson and colleagues (1992) conducted a follow-up study using group training. Groups of five children each, again age 5, were trained using either table-top models or at streetside locations. Results generally replicated the findings from individualized training, although learning was not as consistent as it was with the individualized training programs.

More recently, Zeedyk and colleagues (2001) tested three interventions designed to improve 4- and 5-year-old children's pedestrian route selection: individualized training using a playmat and doll characters showing pedestrian situations, a commercially-available board game that teaches pedestrian safety played by groups of four children under the supervision of an adult, and an informal and interactive "lecture" by an adult with groups of 8-10 children. Results showed a slight but consistent and stable increase in selection of safe routes when children were shown photographs and asked to identify and explain what was a safe or dangerous pedestrian route. However, the training did not improve children's behavior when inconspicuously videotaped while crossing actual streets during a "treasure trail" activity.

Taken together, available evidence suggests children as young as age 5 have the capacity to learn safe pedestrian route selection. A major limitation of existing effective intervention programs is that they are laborious, requiring an adult to engage individually with children for the optimal results and with small groups of children to achieve sub-optimal results. Such training exceeds the capacity of most schools and community centers. An alternative is to use videotapes and websites that train children in the relevant skills without significant adult assistance. If such programs are effective, they may be much more efficient than alternative training strategies.

Research on the use of videos and websites to train children and adults in healthy behaviors yields mixed results (see Baranowski, Buday, Thompson, & Baranowski, 2008; Gagliano, 1988; Primack et al, 2012 for reviews). Some have reported positive change from use of videos/computer software to improve children's ability to judge safe traffic gaps in

pedestrian settings (Glang, Noell, Ary, & Swartz, 2005; Limbourg & Gerber, 1981; Preusser & Lund, 1988), but other have not, both in the pedestrian safety domain (Zeedyk & Wallace, 2003) and in related child health education domains such as dog bite prevention (Schwebel, Morrongiello, Davis, Stewart, & Bell, 2012).

The Present Study

The present study was designed to examine the efficacy of widely-available videotapes and websites – training tools that require no or minimal adult support to implement – to teach children safe pedestrian route selection skills compared to alternative pedestrian safety training strategies, including one-on-one training with an experienced adult pedestrian that was focused primarily on gap selection but also addressed route selection. We studied 7- and 8-year-olds, just before the age at which safe route selection typically develops (Ampofo-Boateng & Thomson, 1991). Thus, we sought to train children at the age they are most likely to have the developmental capacity to learn the required skills (Vygotsky, 1978). We assessed route selection ability through two simulations developed in previous work (Barton & Schwebel, 2007), one using a table-top model and the other using short vignettes accompanied by illustrations of the street environment.

Based on available evidence (Baranowski et al, 2008; Gagliano, 1988; Primack et al, 2012), we hypothesized that children trained in route selection via videotapes and internet websites would demonstrate improved route selection performance compared to children actively trained in other aspects of pedestrian safety over an equivalent amount of time (one group trained in a virtual pedestrian environment and the other group trained with individualized streetside training on detecting safe traffic gaps) and also compared to a control group of children provided no pedestrian safety training.

Methods

Participants

As part of a larger study, 240 seven- and eight-year-old children were recruited from community sources in the Birmingham, Alabama area, and 231 were randomly assigned to condition (see Figure 1 for CONSORT flowchart of participation). Recruitment sources included several local schools, an existing laboratory database, and word of mouth. The sample was 43% male and an average age of 8.0 years old ($SD = 0.7$). It was racially diverse, with 52% of parents identifying their children as White, 42% as African American, and 7% as other races/ethnicities, or as bi-racial or multi-racial. All participants' parents provided written informed consent, and children provided informed assent. The study was approved by the Institutional Review Board at the University of Alabama at Birmingham.

Protocol

These data address an ancillary question of a larger randomized controlled trial. Details of the study protocol (Schwebel & McClure, 2010) and primary findings (Schwebel, McClure, & Severson, in press) appear elsewhere. Following consent processes, children completed 12 (if randomly assigned to an intervention group) or 6 (if randomly assigned to the control group) sessions. Of particular relevance at present were laboratory sessions pre-intervention,

post-intervention, and at 6-month follow-up. During those sessions, children completed pedestrian route selection tasks using two strategies, a tabletop model and short vignettes, both detailed below.

Following pre-test assessment, children were randomly assigned to one of four groups: the video/computer training group, the virtual reality (VR) training group, the streetside training group, or the no-contact control group. Training in all three intervention groups was comprised of six sessions, scheduled bi-weekly over 3 weeks. For the present study, the video/computer training group served as the active intervention group of interest. The VR training group and the streetside training group served as active control groups because they were exposed to pedestrian safety lessons not directly relevant to route selection. The no-contact control group comprised a third control group that received no attention.

Children in the video/computer training condition were exposed to several readily-available, widely-used pedestrian training tools. The tools were chosen based on their broad use (e.g., recommended by state Departments of Transportation), broad accessibility (accessible to broad population), and relevance (focused primarily on child pedestrian safety). Each session lasted about 30 minutes, with all sessions including some training on pedestrian route selection topics (range = about 1-8 minutes, depending on how long children played particular segments of websites/software). Materials presented, by trial, were:

Training Trial 1: *WalkSmart* computer software (Oregon Center for Applied Research)

Training Trial 2: *I'm no Fool* (Disney) and *Willie the Whistle* videos (National Safety Council/National Highway Traffic Safety Association, US Department of Transportation)

Training Trial 3: *Safer Journey* website (Federal Highway Association, US Department of Transportation)

Training Trial 4: *Step to Safety with Asimo* (National Safety Council/Honda Motor Company) and *Otto the Auto School Bus Safety* videos (AAA Foundation for Traffic Safety)

Training Trial 5: *Otto the Auto* computer software (California State Automobile Association, American Automobile Association)

Training Trial 6: *Otto the Auto Pedestrian Safety* and *Being Seen in Traffic* videos (AAA Foundation for Traffic Safety)

Children in the VR training group received six sessions of training in a virtual pedestrian environment, each comprised of three segments of 15 virtual crossings (45 total crossings per session) and lasting about 30 minutes. The training focused on traffic gap selection and did not entail any route selection behaviors. The virtual environment used in this study is an interactive, semi-immersive system that replicates an actual mid-block crossing at a two-lane bi-directional road near a local school. Children are semi-immersed atop a wooden curb with three monitors in front of them. They view traffic moving bi-directionally, listen to ambient and traffic noise, and are instructed to step down when they deem it safe to cross. Upon stepping, children trigger the system to initiate a race- and gender-matched avatar to

cross the simulated street, such that the environment switches from first person to third person and allows children to learn whether their crossing was safe or not. The avatar walks at the child's typical walking speed (as assessed previously in a different room across five trials). Each crossing is accompanied by computer-generated feedback concerning safety delivered by a child-friendly cartoon character. Difficulty of crossing, defined by both traffic density and speed of traffic, was tailored to children's abilities, with the goal that children succeed on about 85% of trials and traffic became increasingly difficult as success rates improved. Details about the VR environment, including hardware and software specifications and validation data, are elsewhere (Schwebel, Gaines, & Severson, 2008).

Children in the streetside behavioral training group were exposed to six sessions of individualized streetside training from trained research assistants. During all sessions, the child and adult stood adjacent to each other and to the street. The training program was grounded in behavioral theory (e.g., modeling, reinforcing, chaining) and developed from strategies used by Rothengatter (1984), Young and Lee (1987), and Barton and colleagues (Barton et al, 2007). A semi-structured and flexible approach educated children based on each child's strengths, limitations, and abilities (as judged by the trainer during training sessions), with two primary foci: attending to traffic in both directions and selecting safe traffic gaps. Route selection was not a primary focus of the streetside training, but it was addressed according to the written protocol and included topics such as checking safety of parked cars before crossing, having vision past corners and other obstacles to view oncoming traffic, and using crosswalks to cross streets. Streetside locations were selected at marked crosswalks that became increasingly more challenging (heavier traffic) across the six sessions; all were two-lane bi-directional roads with mid-block unsignaled crosswalks.

The control group received no formal training from the research team and had no researcher contact during the period between assessments.

Measures

Demographics—Basic demographic information was reported by parents.

Verbal Intelligence—Because intelligence may influence learning of cognitive skills such as pedestrian routes, a verbal intelligence screening was conducted as a covariate using the Peabody Picture Vocabulary Test-IV (PPVT-4; Dunn & Dunn, 2007). Normed on a large national sample, the PPVT-4 has excellent internal and test-retest reliability, and converges well with other measures of verbal intelligence (Dunn & Dunn, 2007; Pullen, Tuckwiller, Konold, Maynard, & Coyne, 2010).

Pedestrian Experience—Children's pedestrian experience may also influence learning, so it was assessed as a covariate by parent report using the pedestrian behavior questionnaire (Stavrinou, Byington, & Schwebel, 2009), which addresses children's typical weekly walking habits in multiple domains (e.g., to school, to friends' houses, to walk dog, etc.). Responses were summed to yield parent-report of the child's total average weekly distance walked.

Pedestrian Route Selection—Children's pedestrian route selection ability was assessed using two strategies, table-top models and pedestrian vignettes. The table-top models were identical to those used previously in our laboratory (Barton & Schwebel, 2007) and similar to those used by others (Ampofo-Boateng et al, 1993; Barton et al, 2012). Children were placed in front of two static table-top models arranged in a single room. Both models were proportional at a 1:36 ratio to real-life pedestrian settings. The first was based on an intersection between a four-lane and two-lane street in an urban setting. The second was based on a T-shaped intersection between a major artery and a minor street in a residential setting. Models were marked with relevant cues, including traffic lights, crosswalks, and road striping as well as trees, shrubs, buildings, and parked unmovable vehicles. Evidence from previous research suggests children's pedestrian route-selections on table-top tasks are similar to that found in outdoor simulations on real roads (Ampofo-Boateng & Thomson, 1991).

To engage in the task, children manipulated a small wind-up toy to retrieve three numbered flags at pre-selected locations on each model. Children were told to imagine they were on the street and to make the toy “walk” the way they would if they were on a real street. The wind-up toy was placed at the starting position and the child was asked to choose a direction to start the crossing to flag #1. Children released the wind-up toy and were permitted to adjust it as needed to reach the flag. Children's route selection was recorded by experimenters; shorter but riskier routes required less time for the toy to reach a flag (e.g., crossing a street diagonally rather than perpendicularly) and longer routes required more time, but were safer. Children then proceeded to “walk” the toy to flags #2 and #3, and then followed the same process for the other model. Experimenters scored the child's routes according to risk: crossing at a crosswalk with a traffic light = 1, crossing at a crosswalk without a traffic light = 2, crossing streets mid-block at a 90° angle to the curb = 3, and crossing streets or intersections diagonally = 4. In all, children completed six crossings (two models with three flags each) and scores were averaged into a single total for risky pedestrian behavior on the table-top models (range = 1-4).

Along with the table-top models, children's route selection was also evaluated using four brief pedestrian vignettes. Used in previous research (Barton & Schwebel, 2007), each vignette ended with children choosing from three possible routes across a street to reach a desirable or obligatory goal (e.g., buy ice cream from the ice cream truck, return home to dinner). Each vignette was accompanied by an illustration on which children indicated two routes, their preferred route and the route they judged safest. Children were permitted to indicate the same route for both responses, and many did so. As in the table-top task, shorter routes were riskier but quicker; longer routes were safer but slower. The scoring scheme for the vignettes was similar to that of the table-top task, with routes rated on a 3-point scale and averaged to yield a single score for risky pedestrian behavior across the four vignettes (range = 1-3).

Analysis Plan

Descriptive data were considered first, both for the full sample and within randomly-assigned groups. We tested for balance across the groups using chi-square tests of

association (categorical variables) and analysis of variance (continuous variables). Primary hypotheses were tested using repeated measures ordinal logistic regressions to examine whether the scores varied by condition over time. Pedestrian route selection served as dependent variables and time (pre vs. post vs. follow-up) and condition (VR vs. streetside vs. video vs. control) as independent variables. We assessed the interaction between time and condition to determine if the changes in condition over time differed, and if so, we performed contrasts to determine which pairs of conditions differed over time. We also assessed whether there were changes over time, regardless of condition.

Results

Table 1 presents descriptive data for those children who were randomized, both overall and by intervention group ($n=231$). No groups differed statistically on the baseline factors. We also compared the 211 children who completed the full study with the 20 who did not complete all assessments. The non-completers were more likely to be African-American and to come from families with lower socioeconomic status, but otherwise the two groups were comparable on demographics (age and gender), pedestrian experience, and randomized group assignment. Given this, subsequent analyses were conducted using all available data.

Table 2 presents descriptive data and results from the three repeated measures ordinal logistic regression models. None of the models yielded statistically significant interactions, suggesting no significant changes over time across conditions. The main effect for change over time was significant for two of the models, testing the tabletop task ($F(2,412) = 13.70$, $p < .0001$) and the safest route on the vignettes ($F(2,413) = 4.33$, $p < .05$), indicating children improved as they developed to an older age. For the tabletop task, the mean decreased from 2.82 ($SD = 1.10$) at pre-intervention to 2.64 ($SD = 1.18$) post-intervention and 2.48 ($SD = 1.16$) at follow-up. For the safest route selection on the vignettes, respective scores were 1.38 ($SD = 0.46$), 1.35 ($SD = 0.55$), and 1.28 ($SD=0.61$), respectively, for pre-intervention, post-intervention, and follow-up. The main effect for condition was not significant in any of the models.

Discussion

The results suggest that 7- and 8-year-old children improve their pedestrian route selection somewhat over time, but that children trained with videos and websites did not learn route selection more quickly or better than children who received no training, or than children in either of the active comparison groups. Children in the active training groups also did not learn route selection more effectively than children in the no-contact control group.

Previous work reported that children as young as age 5 learn pedestrian route selection skills, especially when they were exposed to individualized and focused training with an adult (Ampofo-Boateng et al, 1993; Thomson et al, 1992; Zeedyk et al, 2001). However, most schools and community agencies have insufficient resources to provide individualized training in pedestrian safety so identification of tools that may teach large groups of children efficiently, or that may allow for self-learning, would be valuable. The present results suggest that widely-used videos and websites may not accomplish this goal.

Interpreting the Null Results

Interpreting null results is challenging. We believe our study was conducted with the scientific rigor and statistical power to detect a difference between groups, but none emerged. Several possible explanations may be posited. First, our finding may simply be anomalous; replication is recommended. Second, it may also be that we chose inappropriate video/computer training tools for route selection. All training sessions in the video/computer training group covered route selection in their materials, but most covered those topics only rather briefly and in the context of a broader discussion of pedestrian safety. In total, children were exposed to about 10 minutes of film on route selection, plus individually-varying time spent on relevant software/website activities, based on their preferences while using the software. Further, route selection is a broad construct that involves multiple pieces (e.g., choosing routes where vision is not impaired by parked cars; choosing routes with less traffic; choosing routes that are safer due to marked crosswalks) and we assessed only some aspects of route selection in our outcome measures.

Third, it may be that none of the particular videos/website we chose were effective training tools and that other training strategies, either already existing or to be developed in the future, may be more effective. Fourth, it may be that children did not attend to the videos/websites presented to them, or did not attend to the relevant portions of the programs on route selection. To assess this possibility, we conducted observational coding of children's fidgeting/restlessness and distraction/attention while watching the videos/using the websites. Each characteristic was rated by individual training session off videotapes using objective 6-point scales. Inter-rater reliability was established on 20% of the sample and was adequate ($\kappa > .70$). The mean score for fidgeting/restlessness was 2.79 ($SD = 1.10$), where 2 indicated "sitting in the chair, wiggling a bit, but mostly still for the 30-minute session" and 3 indicated "sitting in the chair, but moving some for the 3-minute session". The mean score for distraction was 2.78 ($SD = 1.04$), where 2 indicated, "quite focused for the full session. Seems to be attentive and interested essentially all the time" and 3 indicated "fairly focused. Mind or eyes seem to wander occasionally, for brief time periods. Focused and probably absorbing lessons for at least 80% of the 30-minute session". Thus, available data indicate children randomly assigned to training via videos/websites were attentive for most or all of the relevant training sessions, but it remains plausible that children failed to attend to relevant route selection lessons.

Fifth, it may be that children simply do not change their pedestrian behavior based on exposure to lessons from films and websites. This possibility is supported by findings both in child pedestrian safety (Zeedyk & Wallace, 2003) and in related domains like child dog bite prevention (Schwebel et al, 2012) which suggest children might learn valuable knowledge by watching films or videos, or by playing computer software, but that this knowledge does not translate to safer or healthier behavior patterns. Continued research on ways to teach children health-related behaviors efficiently and effectively is recommended.

It is notable that the other two active intervention groups – one that received individualized streetside training in pedestrian safety and the other that received training in a virtual environment – also did not have significant change in pedestrian route selection safety compared to the control group. We did not anticipate the children training in the virtual

environment would demonstrate change, as they were exposed to lessons on gap selection rather than route selection. The children who received individualized training at streetside locations did have some exposure to lessons on route selection, but this topic was not emphasized during training and the minor exposure they received was apparently insufficient to elicit significant change compared to the control group.

A significant complication in effective teaching of pedestrian route selection is identifying the specific skills children need to learn, and then helping children translate that knowledge into behavior. Is it sufficient to teach children rote rules that are subsequently followed (e.g., cross at crosswalks; do not cross intersections diagonally; be sure you can see oncoming traffic before entering a roadway)? We believe it is not. More valuable might be lessons that teach children to learn, develop, and hone the cognitive skills required to evaluate specific pedestrian situations and then make safe choices given the contexts they face. Such skills might include internal review of perceptual angles, consideration of the options available to reach one's destination, and evaluation and decision-making about the best crossing scheme. These are complex cognitive skills that must be generalized and then tailored to individual situations, and it is unclear at what age such skills typically develop or could be taught. It is also unclear if training can be accomplished simply by watching videos or engaging in computer-based games. Future research, conducted both from the perspective of basic cognitive development to accomplish pedestrian route selection as well as from the applied perspective of how children engage in various environments, will be needed to continue progress toward efficient and effective child pedestrian safety instruction that reduces child pedestrian injury rates globally.

Strengths and Limitations

This study had strengths and limitations. One strength was the research design, which incorporated random assignment of a large sample into four groups. We assessed pedestrian route selection through two simulations, but did not include actual route selection behavior at streetside locations as part of our evaluation (Zeedyk et al, 2001). We also did not ask children to explain their route selection decisions. It may be that children knew what the safest route was but selected a less safe one for a valid reason. Our choice of control groups was limiting also. One active control group included interaction with adults, and a second active control group used a novel technology (virtual reality) but did not instruct children in route selection.

Also limiting was our selection of several videos and internet websites, having children view/use all of them without examining the products individually. We also tested children after using all six of the products over a three-week period, potentially clouding results. Finally, although we chose programs that are used widely, we omitted many commercially-available programs that could have been included.

Conclusions and Implications

In summary, results of this randomized trial suggest 7- and 8-year-old children's pedestrian route selection improves somewhat over time as they develop, but that the interventions tested were ineffective in improving children's selection of safe routes over a no-contact

control group. Of particular interest, exposure to several videos and websites that incorporate route selection into safe pedestrian behavior training was ineffective in improving children's behavior compared to two active control groups and a no-contact control group.

Practitioners seeking methods to train children in safe pedestrian route selection should be hesitant to assume the training programs tested in this trial are effective. Instead, practitioners might turn to individualized training that has been demonstrated effective in previous work (e.g., Ampofo-Boateng et al, 1993; Thomson et al, 1992; Zeedyk et al, 2001) or data from future trials that show efficacy of products not tested in this study.

Acknowledgments

Thanks to Elizabeth O'Neal, Anna Johnston, Ksenia Shingareva, and the students of the UAB Youth Safety Lab for their extensive help with data collection, entry, and coding; Jodie Plumert and Kathy Christoffel for consulting work; Aeron Gault for IT support; and the Digital Artefacts team for VR development and support. The research was supported by Award Number R01HD058573 from the Eunice Kennedy Shriver National Institute of Child Health & Human Development.

References

- Ampofo-Boateng K, Thomson JA. Children's perception of safety and danger on the road. *British Journal of Psychology*. 1991; 82:487–505. [PubMed: 1782518]
- Ampofo-Boateng K, Thomson JA, Grieve R, Pitcairn T, Lee DN, Demetre JD. A developmental and training study of children's ability to find safe routes to cross the road. *British Journal of Developmental Psychology*. 1993; 11:31–45.
- Baranowski T, Buday R, Thompson DI, Baranowski J. Playing for real: Video games and stories for health-related behavior change. *American Journal of Preventive Medicine*. 2008; 34:74–82. [PubMed: 18083454]
- Barton BK, Schwebel DC. The influences of demographics and individual differences on children's selection of risky pedestrian routes. *Journal of Pediatric Psychology*. 2007; 32:343–353. [PubMed: 16801325]
- Barton BK, Schwebel DC, Morrongiello BA. Brief report: Increasing children's safe pedestrian behaviors through simple skills training. *Journal of Pediatric Psychology*. 2007; 32:475–480. [PubMed: 17012736]
- Barton BK, Ulrich T, Lyday B. The roles of gender, age and cognitive development in children's pedestrian route selection. *Child: Care, Health and Development*. 2012; 38:280–286.
- Demetre JD, Gaffin S. The salience of occluding vehicles to child pedestrians. *British Journal of Educational Psychology*. 1994; 64:243–251.
- Dunn, LM.; Dunn, DM. PPVT-4: Peabody Picture Vocabulary Test, Fourth Edition, Manual. Minneapolis: Pearson; 2007.
- Gagliano ME. A literature review on the efficacy of video in patient education. *Journal of Medical Education*. 1988; 63:785–792. [PubMed: 3050102]
- Glang A, Noell J, Ary D, Swartz L. Using interactive multimedia to teach pedestrian safety: An exploratory study. *American Journal of Health Behavior*. 2005; 29:435–442. [PubMed: 16201860]
- Limbourg M, Gerber D. A parent training program for the road safety education of preschool children. *Accident Analysis & Prevention*. 1981; 13(3):255–267.
- National Center for Injury Prevention and Control. WISQARS™ (Web-based Injury Statistics Query and Reporting System). 2013. Retrieved April 18, 2013, from <http://www.cdc.gov/injury/wisqars/index.html>
- Preusser DF, Lund AK. *And Keep on Looking: A film to reduce pedestrian crashes among 9 to 12 year olds*. *Journal of Safety Research*. 1988; 19:177–185.

- Primack BA, Carroll MV, McNamara M, Klem ML, King B, Nayak S. Role of video games in improving health-related outcomes: A systematic review. *American Journal of Preventive Medicine*. 2012; 42:630–638. [PubMed: 22608382]
- Pullen PC, Tuckwiller ED, Konold TR, Maynard KL, Coyne MD. A tiered intervention model for early vocabulary instruction: The effects of tiered instruction for young students at risk for reading disability. *Learning Disabilities Research and Practice*. 2010; 25:110–123.
- Rothengatter T. A behavioural approach to improving traffic behaviour of young children. *Ergonomics*. 1984; 27:147–160. [PubMed: 6723615]
- Schwebel DC, Barton BK, Shen J, Wells H, Bogar H, Heath G, McCullough D. Systematic review and meta-analysis of behavioral interventions to improve child pedestrian safety. *Journal of Pediatric Psychology*. (in press).
- Schwebel DC, Gaines J, Severson J. Validation of virtual reality as a tool to understand and prevent child pedestrian injury. *Accident Analysis and Prevention*. 2008; 40:1394–1400. [PubMed: 18606271]
- Schwebel DC, McClure LA. Using virtual reality to train children in safe street-crossing skills. *Injury Prevention*. 2010; 16:e1–e5. [PubMed: 20179024]
- Schwebel DC, McClure LA, Severson J. Teaching children to cross streets safely: A randomized controlled trial. *Health Psychology*. (in press).
- Schwebel DC, Morrongiello BA, Davis AL, Stewart J, Bell M. The Blue Dog: Evaluation of an interactive software program to teach young children how to interact safely with dogs. *Journal of Pediatric Psychology*. 2012; 37:272–281.10.1093/jpepsy/jsr102 [PubMed: 22173883]
- Stavrinos D, Byington KW, Schwebel DC. The effect of cell phone distraction on pediatric pedestrian injury risk. *Pediatrics*. 2009; 123:e179–185. [PubMed: 19171568]
- Tabibi Z, Pfeffer K. Choosing a safe place to cross the road: The relationship between attention and identification of safe and dangerous road-crossing sites. *Child: Care, Health, & Development*. 2003; 29:237–244.
- Tabibi Z, Pfeffer K. Finding a safe place to cross the road: The effect of distractors and the role of attention in children's identification of safe and dangerous road-crossing sites. *Infant and Child Development*. 2007; 16:193–206.
- Tabibi Z, Pfeffer K, Sharif JT. The influence of demographic factors, processing speed and short-term memory on Iranian children's pedestrian skills. *Accident Analysis and Prevention*. 2012; 47:87–93. [PubMed: 22326414]
- Thomson JA, Ampofo-Boateng K, Pitcairn T, Grieve R, Lee DN, Demetre JD. Behavioural group training of children to find safe routes to cross the road. *British Journal of Educational Psychology*. 1992; 62:173–183.
- Toroyan, T.; Peden, M., editors. *Youth and road safety*. Geneva: World Health Organization; 2007.
- Vygotsky, LS. *Mind and society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press; 1978.
- Young DS, Lee DN. Training children in road crossing skills using a roadside simulation. *Accident Analysis and Prevention*. 1987; 19:327–341. [PubMed: 3675805]
- Zeedyk MS, Wallace L. Tackling children's road safety through edutainment: An evaluation of effectiveness. *Health Education Research*. 2003; 18:493–505. [PubMed: 12939131]
- Zeedyk JS, Wallace L, Carcary B, Jones K, Larter K. Children and road safety: Increasing knowledge does not improve behaviour. *British Journal of Educational Psychology*. 2001; 71:573–594. [PubMed: 11802818]

Highlights

- We considered how children select pedestrian routes across intersections.
- Seven- and 8-year-olds' pedestrian route selection was assessed at 3 time points.
- Seven- and 8-year-olds improve pedestrian route selection as they develop.
- Pedestrian route selection learning did not vary across training programs.

Figure 1.
 CONSORT flowchart of study participants.

Table 1

Descriptive Data: Percentages and Means (SD)

Variable	Overall (N=231)	VR (n=59)	Streetside (n=57)	Video (n=57)	Control (n=58)
Sex					
% male	43	46	39	39	48
Ethnicity					
% White	53	59	53	53	47
% African American	40	39	39	40	43
% Other/Biracial	7	2	9	7	10
Age (years) ¹	8.0 (0.65)	7.9 (0.67)	7.9 (0.68)	8.1 (0.63)	8.1 (0.63)
Mother's Education					
% <= HS	10	10	9	11	10
% Some College	29	27	35	28	24
% College Grad	34	32	30	33	38
% > College Grad	27	29	25	28	24
Father's Education					
% <= HS	19	20	16	12	24
% Some College	21	19	25	18	19
% College Grad	29	29	25	33	22
% > College Grad	30	27	23	33	29
Household Income					
% < \$40k	27	22	26	28	28
% \$40k-<\$100k	38	27	35	28	38
% >= \$100k	35	27	37	40	33
PPVT-4 IQ Screen ¹	106 (16)	107 (16)	108 (16)	104 (18)	105 (15)
Pedestrian Experience ²	2.5 (0.3, 5.8)	2.1 (0.3, 5.1)	2.1 (0.5, 4.5)	2.5 (0.1, 5.7)	3.3 (0.4, 7.0)

¹ Mean (Standard Deviation) reported for this continuous variable.² Median (25th percentile, 75th percentile) reported for this highly skewed continuous variable.

Table 2
Outcome Measure, Means (SD), and Results, F (p-value) of Repeated Measures Ordinal Logistic Regression

	VR				Streetside				Video			Control			Regression Results		
	Pre IV	Post IV	FU		Pre IV	Post IV	FU		FU	Post IV	Pre IV	Post IV	FU		Condition Main Effect ¹	Time Main Effect ²	Condition × Time Interaction ³
Tabletop Task	2.9 (1.1)	2.8 (1.2)	2.6 (1.2)		2.8 (1.1)	2.7 (1.1)	2.6 (1.2)		2.5 (1.2)	2.5 (1.2)	2.9 (1.1)	2.7 (1.2)	2.5 (1.2)		0.52 (0.67)	13.70 (<.0001)	1.17 (0.32)
Vignettes																	
Safest Route	1.4 (0.44)	1.4 (0.54)	1.3 (0.40)		1.4 (0.40)	1.4 (0.49)	1.4 (0.57)		1.3 (0.48)	1.4 (0.55)	1.4 (0.50)	1.3 (0.53)	1.3 (0.44)		0.21 (0.89)	4.33 (0.01)	0.60 (0.73)
Preferred Route	1.9 (0.58)	2.1 (0.62)	2.0 (0.60)		1.9 (0.63)	1.9 (0.60)	2.0 (0.67)		2.0 (0.62)	2.0 (0.74)	2.0 (0.62)	1.9 (0.66)	1.9 (0.58)		0.10 (0.96)	0.81 (0.45)	1.10 (0.35)

¹ df = 3,412 for tabletop and 3,413 for vignettes

² df = 2,412 for tabletop and 2,413 for vignettes

³ df = 6,412 for tabletop and 6,413 for vignettes