FINAL REPORT
INTERACTIVE PROGRAM TO TEACH BICYCLE SAFETY
(R44 HD36554)
ANN GLANG, PH.D., PRINCIPAL INVESTIGATOR

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CO-INVESTIGATORS:
KAREN MCLAUGHLIN, PH.D.
LYNNE SWARTZ, M.P.H.

PHASE II PROJECT AIMS

The objective of this project was to produce an interactive multimedia (IMM) program to teach bicycle safety skills to children in grades K-3. Bicycle accidents are the most common cause of brain injuries for children, the majority of which are caused by collisions with motor vehicles. The program was developed for use by classroom teachers as well as parents to teach children the key skills involved in being a safe cyclist. The program includes two lessons with instructional units on prerequisite skills (helmets, hand signals, and basic safety rules) and riding skills (riding on the sidewalk, riding on the street, and watching for cars). The Phase I prototype resulted in a CD-ROM prototype with a module targeting the basic safety rules (e.g., one child on a bike, hands on the handlebars).

In Phase II we completed the comprehensive program targeting a range of bicicyle safety behaviors. The program, delivered for both Macintosh and PC computers on two CD-ROMs, is designed for use in school and home settings. Print materials for parents and teachers describing the content of the IMM program, suggestions for teaching activities, and safety information are located in pdf files on the CD-ROM. The Phase II program was evaluated in a randomized control trial with a sample of 96 children in grades K-3.

SIGNIFICANCE OF THE PROJECT

Overview

Injuries are the leading cause of death and disability for children in America (National Center for Health Statistics, 1997). Childhood injuries account for approximately 16 million emergency room visits and 600,000 hospitalizations annually (Rodriguez, 1990; Mayer & Leclere, 1994). Based on data gathered by 61 children's hospitals and trauma centers, 20,000 children die as a result of injuries each year, with an additional 30,000 children suffering permanent injury-related disabilities (National Pediatric Trauma Registry, 1993). The costs of childhood injury and disability are staggering: total direct and indirect costs are estimated at $170 billion each year (National Safety Council, 1991). Clearly, the prevention of childhood injuries is an important public health issue.

Mechanisms of Injury

Each year over 500,000 people are treated in hospitals for bicycle-related injuries (CDC, 1997). Two-thirds of all bicycle related injuries occur in the 5 to 14 year age group (CDC, 1997), about 90 percent of which involve collisions with motor vehicles (Consumer Product Safety Commission, 1996). In addition to fatalities, bicycle crashes are the most common cause of serious brain injury in children (Weiss, 1994). Seventy-six percent of brain injuries from bicycle collisions occur in the <15 year old age group with more than 138,000 children in this age group sustaining bicycle-related brain injuries each year (Sacks et al., 1991). Paradoxically, as motor, reasoning, and perceptual abilities of children increase (age 5-9), so does their rate of bicycle injuries (National Pediatric Trauma Registry, 1993; Peterson, Gillies, Cook, Schick, & Little, 1994).

When combined, the associated causes for 80% of all serious childhood injuries have to do with mode of transportation (DiScala et al., 1997). The Oregon Department of Transportation reports that 45% of bicycle collisions involving motor vehicles occur at intersections; 20% occur at a driveway or alleyway; and 17% were the result of riding against traffic (Oregon Department of Transportation, 1995). There is a definite need to address bicycle-related injuries through means that include instruction in traffic movements. It is not enough to simply encourage children to wear bicycle helmets. Death and serious injury from bicycle crashes will not be prevented through helmet use alone (Rivara, Thompson, & Thompson, 1997; Scandlin, McCoy, Cohen, & Leibert, 1996).

Strategies for Decreasing Bicycle-Related Injuries

Strategies for the prevention of childhood injuries can be placed on a continuum from passive to active injury control (Wilson & Baker, 1987). Passive strategies involve the manipulation of environmental variables in order to protect the individual from injury and minimize the need for individual behavior change (Gielen, 1992; Rivara, 1992). Common examples of passive measures are pedestrian crosswalks with traffic signals and sidewalk overpasses that allow pedestrians an alternative to crossing busy streets. Passive devices have been shown to be effective in preventing injuries, but are difficult to apply (Christoffel et al, 1991) and not available in all situations (Durkin, Laraque, Lubman, & Barlow, 1999; Tuchfarber, Zins, & Jason, 1997; Rivara, Booth, Bergman, Rogers, & Weiss, 1991). Active strategies involve having individuals - either children or their caregivers - take some active step to reduce the risk of injury. Health education and behaviorally-based training programs are examples of active strategies.

Bicycle helmets. Bicycle helmets are one passive measure that have been shown to significantly decrease the incidence of bicycle-related head injuries (Finvers, Strother, & Mohtadi, 1996; Thompson, Rivara, & Thompson, 1996; Rivara et al., 1994). A wide range of community and educational programs have been developed to promote bicycle helmet usage (Durkin, Laraque, Lubman, & Barlow; 1999; Peterson et. al., 1997; Farley, Haddad, & Brown, 1996; Parkin, Hu, & Spence, 1995; Rivara et. al., 1994; Rourke, 1994; Witte, Stokols, Ituarte, & Schneider, 1993). However, despite knowledge of the preventive role of bicycle helmets regarding the incidence of head injury, the widespread efforts to encourage helmet use, and the push by policy-makers to mandate helmet usage, approximately 75% of children under the age of 14 continue to ride unprotected (Sacks et al., 1991). Two primary reasons for children not wearing helmets appear to be (a) children lacking awareness of the risk of injury (Loubeau, 2000) and (b) a lack of parental enforcement of helmet use (Miller, Binns, & Christoffel, 1996). Even among those children who do wear helmets, poor fit or improper helmet placement often leads to injuries to the forehead and face which result in brain injuries (Ching et al., 1997; Rivara, Astley, Clarren, Thompson & Thompson, 1999).

Safety education. Most injury prevention educational programs use a relatively passive approach to teach children safety behaviors. They are classroom based, and use book and lecture formats to teach safety rules and general safety information to children (West, Sammons, & West, 1993; Division of Health Promotion and Education, 1990; Ampofo-Boateng & Thomson, 1989; Singh, 1982). While generally low in cost to administer, most of these instructional methods lack measurable behavioral outcomes (Bureau of Curriculum Development, 1986). Some more active interventions attempt to engage either the caregiver or the child at risk by including counseling the parent in safety rules (Bass, Mehta, & Ostrovsky, 1991) and health fair presentations (Bean & Hutchinson, 1996). Methods such as these are informative and necessary, as parents tend to overestimate children's knowledge of safe behavior (Dunne, Asher, & Rivara, 1992), but provide limited, if any, opportunity for the child to actually practice new behaviors in a safe situation.

Several large scale community wide campaigns have been effective in reducing bicycle related injury rates (e.g., Rivara et al., 1994), especially with younger children (Wood & Milne, 1988). These efforts have been multi-faceted, including helmet give-away and bicycle safety education, so it is difficult to determine what proportion of the effects can be attributed to their safety education component.

The use of well thought-out behaviorally-based training programs can be effective in promoting and maintaining behavioral change in children (Rivara, Booth, Bergman, Rogers, & Weiss, 1991; Peterson & Schick, 1993; Peterson, 1984; Jones, Kazdin, & Haney, 1981). Several attempts have been made to actively engage children in learning safe pedestrian behaviors through the use of instructional packages that include (a) modeling combined with social reinforcement, descriptive feedback and prompts (Rivara et al.,1991; Yeaton & Bailey, 1978), (b) practice in simulated traffic environments (Durkin, Laraque, Lubman, & Barlow, 1999; Young & Lee, 1987), and (c) training in a real traffic environment (Rivara et al., 1991). Studies such as these have demonstrated that using active modalities, young children can indeed learn and implement safe street-crossing behaviors (Yeaton & Bailey, 1978). To our knowledge, these methods have not yet been applied to teaching bicycle safety.

Limitations of traditional safety education effort. To date, there are several major limitations of active attempts to teach children safety behaviors. First, safe traffic-related behavior requires a much larger set of judgments and discriminations than most safety education interventions reflect (Peterson & Schick, 1993). For example, traditional bicycle street safety training attempts to teach the child who is about to enter the crosswalk to make sure the light is green and to look right and left for oncoming cars. However, children also need to learn to make the embedded discriminations in safe bicycle skills—for example, they must learn to take into account the cars which might be turning into their path from adjacent cross streets, to judge the distance of oncoming vehicles, to ride with traffic, and to disregard other pedestrians or cyclists who might be crossing unsafely (Peterson, personal communication, March, 1996).

The second limitation of previous safety education efforts involves the lack of demonstrated generalization and maintenance of safe behaviors. The vast majority of traditional bicycle safety education efforts have not attempted to explore generalization of learned skills to real traffic situations or maintenance of these skills. Even those studies which have examined the degree to which safety behaviors transfer across settings and maintain over time (e.g., Yeaton & Bailey, 1978) have done so on a very limited basis.

The final limitation involves the expense of more active approaches. To have a significant public health impact, traffic safety education efforts must not only have efficacy but also be (a) adopted, (b) implemented, and (c) maintained (Glasgow, Vogt, & Boles, 1999). Active teaching approaches are prohibitively expensive; while on-site instruction is more effective than passive approaches, it is staff intensive (Rivara et al. 1991), and therefore expensive. The expense increases even more when teachers attempt to make traffic safety training most relevant and interesting to students by tailoring their program to their local community setting (e.g., urban, suburban, rural).

A promising cost-effective approach to active bicycle safety instruction is the use of interactive multimedia (IMM) programs. Simulated training packages using real-life imagery have recently been used to teach pedestrian safety (Glang, Swartz, Noell, & Ary, 2005) and other health-related behaviors (Woodward & Carnine, 1988). Computer technology and Internet connections are becoming more accessible to teachers and parents (Education and Libraries Networks Coalition, 1999), thus, the use of IMM to teach children safety and health behaviors is becoming quite feasible. Advances in computer technology have made it possible to present text, graphics, animations, videos, and audio clips in an integrated and fully interactive program. Moreover, the application of empirically-validated instructional design principles can ensure that those instructional programs which take full advantage of computer-based video training methods can (a) effectively and efficiently teach these skills, and (b) teach those skills in ways which will promote their generalization and maintenance (Engelmann & Carnine, 1982; Horner, McDonnell & Bellamy, 1986; Rosenshine & Stevens, 1986).

Research in Instructional Design

There is a substantial body of research regarding effective instruction of academic and community living skills that can be drawn upon in designing effective safety education programs.

Analysis of instructional content. Central to effective curriculum design is a comprehensive analysis of the instructional content. The first step in this process involves identifying the component skills within the more complex skills being taught. Component skills should be pre-taught in a simpler context rather than within a more complex context (Rosenshine & Stevens, 1986). Next, it is most efficient to teach a strategy that the learner can independently apply across a range of examples rather than requiring memorization of discrete skills or information (Carnine, Kameenui, & Woolfson, 1982).

The manner in which teaching examples are selected is critical to the instructional design process. General case instruction involves selecting a range of teaching examples that efficiently sample the “instructional universe” so that students will learn to apply the skills across appropriate stimulus conditions and not apply the skills in inappropriate conditions (Engelmann & Carnine, 1982; Horner et al., 1986; Albin & Horner, 1988). The examples are then sequenced so that they build on prior learning and carefully teach the required discriminations.

In the context of safe bicycle behavior, the component discriminations of judging traffic distance and taking into account traffic patterns at intersections are pre-skills which can be taught outside the context of learning to cross the street. Once these pre-skills are mastered, a generic strategy (e.g., “Look both ways”) can be taught using a range of examples that sample the entire range of intersections. Both relevant and irrelevant stimuli can be included in these examples.

Instructional presentation variables. A second set of instructional variables that contribute to positive learner outcomes involves the manner in which the instructional content is presented. Rapid instructional pacing is a factor which has been shown to increase the acquisition rate of new material (Carnine, 1976). Numerous studies have reported a strong correlation between maintaining high rates of learner success and increased acquisition and retention of newly learned information (Gersten, White, Falco, & Carnine, 1982; Weeks & Gaylord-Ross, 1981). Carnine (1976) documented the importance of sufficient practice on new skills to ensure mastery at each step in the learning process. When learners make errors, it is important that they receive corrective feedback so that they can successfully complete the task when it is presented again (Carnine, 1980; Gersten, Carnine, & Williams 1982). Finally, cumulative review of material ensures integration of new skills with previously learned information (Rosenshine & Stevens, 1986). The implications of this research indicate that a mastery learning approach—incorporating short (quick) vignettes with frequent acknowledgment of progress and sufficient practice and review—has the highest likelihood of leading to successful acquisition and retention of the skills taught.

Advantages of Multimedia Presentations

Instructional value of animations. The use of animations to present situations related to riding bicycles provides a means for removing irrelevant stimuli. The abstracted situations permit students to focus on critical details and respond to specific elements in the environment. By gradually replacing the animations with semi-abstracted examples (e.g., actual photographs of streets and intersections with animated cars, 3-D models with photographic backgrounds, etc.), generalizations from the abstracted scenes to the complex and dynamic situations can be induced. Once the core rules have been firmly established, the next step is to present action video examples.

Instructional value of video materials. Video materials provide many educational advantages over didactic presentation and printed material. For our particular purposes, video materials enable the effective teaching of generalizable bicycle safety skills by presenting real-life examples of biking scenarios, thereby creating a simulated teaching experience with the relevant stimuli similar to those present in natural environments (Horner et al., 1986). Both the animations and the videos provide several advantages over more typical didactic presentations and printed materials, including a more controlled presentation of the material, increased audience interest in the material, and simplification of the tasks required of the classroom teacher.

Special contribution of interactive multimedia (IMM) . One key advantage of IMM for use as an educational tool is the ability to engage the viewer actively. IMM requires the learner to attend carefully and respond overtly and frequently. These are behaviors which are related to increased performance in academic settings (Abramson & Kagan, 1975; Frase & Schwartz, 1975). The branching capabilities of interactive programs allow educational material to be tailored to user performance: the student can get immediate corrective feedback as needed, thereby increasing the efficacy of the program (Campbell, DeVellis, Strecher, Ammerman, Deveillis, & Sandler, 1994; Skinner, Siegfried, Kegler, & Strecher, 1993). Importantly, the overall program can still appear "seamless," despite the presence of numerous alternative branches.

Ease of use. A final advantage of the IMM format is that we can make it very simple to use. Users will need only minimal instruction in getting started with the program, and will be guided by the narrator on all aspects of program use. ORCAS has extensive experience in designing interfaces for both the very young (pre-literate) and the developmentally delayed/disabled. Even children with no computer or reading skills will be able to use the program, as was demonstrated in the evaluation of our prototype program (see below).

SUMMARY OF PHASE II ACTIVITIES

The specific aims for Phase II are to complete the following tasks:

1. Conduct meetings of the ORCAS Safety Education Advisory Panel (established for the Phase I project and composed of parents, educators, and safety officials) to provide input on content and format throughout the development process.
2. Conduct interviews with traffic and safety officials to ensure that all critical content is included.
3. Conduct focus groups with elementary curriculum coordinators, classroom teachers and parents to determine how to maximize the utility of the program for home and classroom use.
4. Conduct instructional analysis of content, and design teaching examples.
5. Design the overall program (i.e., flowchart, storyboard, and script).
6. Produce and edit animation and video.
7. Develop both CD-ROM and Internet programs.
8. Pilot test the program; revise and re-test as needed.
9. Develop the parent/teacher manual and videotape.
10. Evaluate program efficacy on a sample of 200 students in grades K-3.

Program Development (Tasks 1-9). Formative evaluation procedures (i.e., interviews and focus groups) were employed to (a) identify key content for the bicycle safety program, (b) develop specific program objectives and (c) determine the acceptability (to parents and teachers) of using a multimedia approach for training bicycle safety skills.

In Task 1, the Project Advisory Group was assembled to discuss the content and format of the program. The project advisory group was made up of parents, educators, state health and injury prevention specialists, and school district technology specialists. Advisory group discussions were audiotaped, transcribed, coded, and reviewed. Key concerns were listed and prioritized for integration into the multimedia program.

In Task 2, interviews with three traffic and safety officials were conducted. As with the advisory group meetings, interviews were audiotaped, transcribed, coded, and reviewed. Traffic and safety officials' concerns were listed and prioritized for use in modifying the priority listing created from the findings from Task 1.

Because the input needed for content refinement could be gathered individually, we did not conduct additional focus groups with educators and parents. Instead, for Task 3, we interviewed 3 educators, 2 principals, and six parents, each of whom represented different school and community contexts. Information from audiotaped transcriptions was integrated into program design.

In Task 4, the instructional analysis was completed and the teaching examples were designed. The instructional content, program examples, and instructional sequence were created to be consistent with standards established by state and federal safety agencies, and community-based sources for bicycle safety.

In Task 5, video scripts and program flowcharts were designed based on the instructional content established in Task 4.

In Task 6, animations to teach core skills were created. We worked with Moving Image Productions (MIP) to produce video-based teaching examples depicting safety information and real-life bike riding and traffic situations. MIP also produced introductory, concluding, and transition video footage for the program.

In Task 7, the control program was developed in Director, using Lingo. The video and animation segments were incorporated into the program as Quicktime digital video movies.

In Task 8, a total of 78 children in the target age group viewed the program as pilot testers. The children were from four local elementary schools representing a range of socioeconomic status. We employed an iterative process whereby data were analyzed and program changes made following several pilot testing sessions. Program revisions included adding additional or clearer teaching examples, refining remedial logic, and adding narration to clarify the instructional task. The program development process was one we have used previously, and is described in more detail elsewhere (Noell, Ary, & Duncan, 1997).

Parent and teacher materials were developed in Task 9. We created draft materials based on guidelines national and local bicycle safety commissions, as well as safety experts on our consultant panel. Materials contained basic bicycle safety information and rules, as well as activity suggestions to reinforce bicycle safety concepts in the classroom. The materials were reviewed by a panel of local parents and teachers and evaluated for clarity, usefulness, and attractiveness. Final versions of the materials were placed on the CD-ROM in pdf format.

Program Evaluation (Task 10). A random control design was employed to evaluate the program with 209 children in grades K-3. Students were randomly assigned to either the treatment condition (Bike Smart) or the control condition (a video on childhood safety). The evaluation took place over two days. On each day, both groups spent approximately 20 minutes viewing either the treatment or control program in the computer lab at their school. Pre and post-test measures involved the assessment of student ability to accurately identify a) a correctly worn helmet, b) use of appropriate hand signals in traffic, c) application of basic safety rules (e.g., keeping hands on the handlebars, one rider per bike), d) dangerous cars in an intersection, e) potential hazards when riding on the sidewalk or street (e.g, pedestrians in the way, car backing out of driveway), and f) to properly put on a bicycle helmet. Measures a through e (as indicated above) were presented on the computer and utilized video and still images. To identify helmet position, hand signal use, and safety rules, students viewed actors in various examples and non-examples. For identifying dangerous cars and riding hazards, students viewed scenes from a first person perspective. Students clicked yes or no, or clicked on a hazard in a scene to respond. In addition, students completed a behavioral measure of helmet use. Students were given a properly fitting helmet and asked to put it on without assistance. The student was then rated on a) position of the helmet on the forehead (so as to sufficiently cover forehead/frontal lobes), b) straight position from side to side, c) fastening strap, and d) strap sufficiently tight.

In order to ensure that any pre- to post-test differences on the computerized measures were not due to enhanced mouse skill gained in using the program (i.e., knowing how to locate and depress the mouse; selecting from a field of choices), students were pre-trained in using the mouse to navigate and indicate their responses through a computerized mouse training segment. First, students clicked on still images when prompted. Next, they clicked on moving images across the screen. Students were required to get a minimum of five correct clicks before moving on. The pretest followed directly after the mouse practice segment.

Each subject completed a social validation measure following the completion of the program. The RA asked them the following questions:

1. How did you like this program?
2. How important is the information in the program?
3. How easy was it to use this program?

4. Would you tell your sister/brother/friend to use this program?
5. Would you look at a program like this at home if you had it?

Subjects responded by pointing to a Likert type scale of "faces," ranging from most or very much (smile) to least or not at all (sad face).

RESULTS

Development (Qualitative) Findings (Tasks 1 -3)

Qualitative findings from interviews, focus groups, and advisory group meetings focused on both content and presentation variables. Interviewees and advisory board members thought that the proposed content was appropriate. They agreed that information on how to wear a helmet correctly and to navigate in real life environments were key to student learning. In addition, they provided specific variables that should be emphasized in the program (e.g., riding on the sidewalk until age 10, dismounting from the bike when crossing a busy intersection). Interviews with early elementary educators and safety consultants helped guide navigation and language so that the program would be accessible to students in grades K-1.

Evaluation (Quantitative) Findings

Participants. A total of 209 students from two schools were recruited to participate in the evaluation. The gender distribution was 42% female (n=88) and 56% male (n=118). Three students (2%) were not identified by gender. In terms of grade level, 10% of the participants were in kindergarten (n=21), 30% in first grade (n=62), 37% in second grade (n=77), and 23% in third grade (n=49). One school had 81 participants from all four grades. This school has 40% minority students and 77% of the students receive free or reduced lunches.. The other school had 128 participating students; this school has 34% minority students, with the same percentage receiving free/reduced lunches.

Pretest Group Equivalence. Prior to the main analysis gender rates were examined between the treatment conditions to ensure equal proportions. No significant differences were found

[$?^2$ (1,218) = 0.03; p = .852].

Intervention Effects.

Overall main effects. A doubly-multivariate repeated measures ANOVA was run to determine if there was an overall significant difference between the control and treatment conditions on all pretest and posttest scores. Based on Pillais test there was a highly significant overall differential condition by time effect [F(27,178) = 21.42; p <.001]. The effect size was very large (eta-square = .77).

Overall grade, gender, and cohort interactions with condition. Three assessed variables potentially could moderate the condition by time results: grade, gender, and cohort (i.e., school). Given the number of outcome measures, total scores were calculated (sum of all items) for (a) the computer presented items and (b) the observational helmet data. A repeated measures ANOVA was used to examine gender, cohort, and grade interactions with condition on the pre to post measures. The results are presented in Table 1.

Both computer-presented and the observed total scores showed significant condition by time interactions. The observed differences were significant and represent large and small effects for the computer-presented items and the observed helmet data total scores, respectively. All higher order three way interactions involving condition, time, and either grade, gender, or cohort were examined. None were significant. That is, regardless of gender, cohort, and grade, the subjects in the treatment subjects showed greater gains than control subjects in both the computer-presented items and the observational helmet measures.

Table 1. Comparisons of Treatment Conditions on Total Scores

Outcome Measure	**Time 1**				**Time 2**				**Condition X Time**		**Effect Size**
	TX		**CNT**		**TX**		**CNT**		**F-value**	**P-value**	**Eta-Square**
	M	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**			
Computer Program	13.1	2.6	13.1	2.5	20.1	2.3	14.2	2.5	233.1	<.001	.53
Helmet Data	2.5	0.9	2.4	0.9	2.8	0.9	2.4	1.0	6.1	.013	.03

Notes. TX = treatment; CNT = control; M = mean; SD = standard deviation; For eta-square a value of .10 is a small effect, .30 is a medium effect, and .50 is a large effect.

Condition effects on the individual computer-presented and observational items. In addition to intervention effects on the total scores, effects on the individual computer-presented and observational items were examined utilizing Chi-square analysis and the resulting Odds Ratio. As shown in Table 2, 17 of the 23 computer-presented items showed significantly greater gains for the treatment subjects. Several items demonstrated very large odds ratios (e.g., identifying if a biker's helmet was too high or too low; identifying the hand signal for stop). For the observed helmet measures, the measure evaluating straight placement on the forehead yielded a highly significant odds ratio of 3.4 and the side to side placement measure was found to have an odds ratio of 1.8, which approached statistical significance. The fastened helmet measure turned out to be scale-restricted with 90% of subjects already fastening their helmet at pretest. Consequently, this measure showed no change at post test. The measure of strap tightness was not significant.

DISCUSSION

The purpose of this evaluation was to determine if use of the Bike Smart program led to increased ability to identify and apply bicycling safety skills. In particular, we evaluated the students' ability to apply bike riding and related safety behaviors through both computerized and behavioral measures. The results of the evaluation demonstrated an overall significant difference between the control and treatment conditions on all pretest and posttest scores with a very large overall effect size. The vast majority of individual computer-presented measures were significant. Regardless of gender, cohort, and grade the subjects in the treatment subjects showed greater gains than control subjects in both the computer-presented items and the observational helmet measures.

The result on the observational measure of helmet placement of the forehead was significant and points to an important change in student behavior as a result of watching the program. This is a frequent error, with children often pushing the helmet up and off the forehead, thus exposing the frontal lobes of the brain to damage in case of an accident or fall (Rivara, Astley, Clarren, Thompson, & Thompson, 1999). Students who viewed the program were more likely to correct this placement of the helmet following the training. In addition, the measure of helmet placement side to side approached significance. However, the measure of strap tightening was not significant. During observation, many children failed to check this aspect of helmet fit. Interestingly, the number of children who correctly addressed this issue dropped in the post test for both the treatment and control conditions. One possible interpretation is that those students who informed the examiners of a loose strap in the pretest felt it unnecessary to do so again in the post test. Regardless of the cause of this result, it points to the importance of an adult checking the configuration of a helmet for younger children.

We believe these results suggest that the Bike Smart program can be an important component of safety training packages that include both skills based and experiential training. The main criticism of available behaviorally-based safety education programs involves their staff intensive nature and related costs. The major advantage of a software program to teach bicycle safety is the efficiency and cost. If students can be taught key safety skills in a simulated environment, teachers can more efficiently translate these skills to examples in real environments. We believe this program is an improvement over other safety curricula given its success with teaching component bicycle skills to mastery, and can form an important component of bicycle safety training in the schools.

Table 2. Frequencies of Pre- and Post-test Item Responses with Adjusted Odds Ratios Associated with Treatment Condition Predicting Post-test Response.

OUTCOME MEASURE	**Correct at Time 1**				**Correct at Time 2**				**Adjusted[a] Odds Ratio & p-value**	**95% CI**
	TX N	**%**	**CNT N**	**%**	**TX N**	**%**	**CNT N**	**%**		
Computer Program										
Safety skill discrimination:										
Helmet too high	18	16.7	19	18.8	103	95.4	20	21.8	159.5 <.001	(50.2,506.5)
Helmet too Low	34	31.5	30	29.7	94	87.0	28	27.7	23.9 <.001	(10.8,52.8)
Hand Signal-Stop	11	10.2	10	9.9	90	83.3	10	9.9	65.7 <.001	(25.1,172.1
Rider 1-No Helmet	87	80.6	80	79.2	99	91.7	82	81.2	2.8 .027	(1.1,6.8)
Rider 2-Safe	101	93.5	96	95.0	103	95.4	94	93.1	1.5 .469	(0.5,5.1)
Rider 3-Stuff in Hands	92	85.2	83	82.2	106	98.1	86	85.1	10.6 .003	(2.2,50.9)
Hazard discrimination										
Car 1	42	38.9	36	35.6	93	86.1	51	50.5	6.9 <.001	(3.4,14.0)
Car 2	52	48.1	53	52.5	105	97.2	61	60.4	29.3 <.001	(8.4,102.0)
Car 3	81	70.4	62	61.4	102	94.4	71	70.3	6.6 <.001	(2.5,17.3)
Riding on sidewalk: Driveway	68	63.0	66	65.3	107	99.1	87	86.1	22.6 .003	(2.8,181.4)
Pedestrian	33	30.6	35	34.7	84	77.8	32	31.7	9.5 <.001	(4.9,18.7)
Pedestrian	89	82.4	88	83.0	105	97.2	96	95.0	2.3 .275	(0.5,10.8)
Car Turn	62	63.9	55	54.5	91	84.3	71	70.3	2.3 .019	(1.2,4.6
Car in street	74	68.5	67	66.3	97	89.8	76	75.2	3.3 .005	(1.4,7.7)
Traffic Light	25	23.1	28	27.7	71	65.7	26	25.7	7.0 <.001	(3.6,13.5)
Approaching car	34	31.5	35	34.7	69	63.9	30	29.7	7.7 <.001	(3.6,16.5)
Pedestrian	96	88.9	91	90.1	102	94.4	94	93.1	1.5 .556	(0.4,5.1)
Truck in driveway	95	88.0	92	91.1	106	98.1	94	93.1	8.7 .023	(1.3,56.3)

[a] Odds ratios are adjusted for pre-test response.

Notes. TX = treatment; CNT = control; CI = confidence interval. An odds ratio of 1.5 is considered a small effect, 2.5 a medium effect, and 4.3 a large effect.

Table 2 (continued)

OUTCOME MEASURE	Correct at Time 1				Correct at Time 2				Adjusted[a] Odds Ratio	95% CI
	TX		CNT		TX		CNT			
	N	%	N	%	N	%	N	%		
Hazard discrimination, cont.										
Riding on street: Car approaching	82	75.9	78	77.2	105	97.2	84	83.2	13.5 <.001	(3.3,56.0)
Car approaching	80	74.1	71	70.3	90	83.3	80	79.2	1.3 .538	(0.6,2.6)
Opening car door	82	75.9	78	77.2	97	89.8	86	85.1	1.7 .237	(0.7,4.2)
Pedestrian	19	17.6	25	24.8	76	70.4	20	19.8	13.8 <.001	(6.6,29.0)
Driveway	55	50.9	46	45.5	72	66.7	58	57.4	1.4 .209	(0.8,2.6)
Helmet Data										
Straight on forehead	55	48.2	39	37.5	70	61.4	33	31.7	3.4 <.001	(1.9,6.2)
Straight side to side	87	76.3	89	85.6	100	87.7	83	79.8	1.8 .054	(0.9,3.9)
Fastened	102	89.5	93	89.4	103	90.4	95	91.3	0.7 .644	(0.1,3.5)
Strap tight	19	34.5	14	25.0	11	9.6	6	10.7	1.8 .291	(0.6,5.7)

[a] Odds ratios are adjusted for pre-test response.

Notes. TX = treatment; CNT = control; CI = confidence interval. An odds ratio of 1.5 is considered a small effect, 2.5 a medium effect, and 4.3 a large effect.

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