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IMPACT OF A COMPREHENSIVE SAFETY PROGRAM ON BICYCLE HELMET USE AMONG MIDDLE-SCHOOL CHILDREN

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A bicycle helmet program was evaluated in three middle schools using a multiple baseline across schools design. Two of the three schools had histories of enforcement of helmet use. During baseline many students riding their bikes to and from school did not wear their helmets or wore them incorrectly. A program that consisted of peer data collection of correct helmet use, education on how to wear a bicycle helmet correctly, peer goal setting, public posting of the percentage of correct helmet use, and shared reinforcers, all of which were implemented by the school resource officer, increased afternoon helmet use and afternoon correct helmet use in all three schools. Probe data collected a distance from all three schools indicated that students did not remove their helmets once they were no longer in close proximity to the school, and probe data collected in the morning at two of the schools showed that the behavior change transferred to the morning.

DESCRIPTORS: bicycle helmet use, goal setting, enforcement, public posting, peer data monitoring, bicycle safety

It is estimated that 70% of children aged 5 to 14 years ride bicycles (Sacks, Kresnow, Houston, & Russell, 1996). Although riding bicycles has significant health benefits, bicycles are associated with more injuries than any other consumer product except motorized vehicles (Hoover-Wilson, Baker, Teret, Shock, & Garbarino, 1991). Data from the National Highway Traffic Safety Administration (2005) indicate that 725 bicyclists were killed and 41,000 were injured in 2004, and 21% of those killed and 32% of those injured were under the age of 16. These data also show that the 10- to 15-year-old age group had the highest fatality and injury rates, with fatality rates 54% and injury rates 140% higher than the average rate for all bicyclists.

Head injuries account for 60% of bicycle-related deaths and more than two thirds of bicycle-related hospital admissions (Brewer et al., 1995). Bicycle helmets have been documented to reduce the risk of head injury by 85% and brain injury by 88% (Thompson, Rivara, & Thompson, 1989). Other studies have shown that the introduction of bicycle helmet legislation is associated with both increased helmet use and reductions in bicycle-related deaths and injuries (Graitcer, Kellerman, & Christoffel, 1995; Mackinan & Medenorp, 1994; MacPherson, To, & Macarthur, 2002). These data suggest that helmet use should be a major intervention target for middle-school children.

The most commonly employed countermeasures to increase helmet use include legis-

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lation, helmet giveaway programs, and education programs. A review evaluating the effects of helmet legislation has documented variable increases in helmet use following the introduction of helmet laws (Karkhaneh, Kalengal, Hagel, & Rowe, 2006). Another strategy for increasing helmet use is the helmet giveaway program. Two studies have evaluated the effects of this program on helmet use. One found that an extensive giveaway program failed to produce an increase in helmet use by low-income students (Parkin et al., 1995). The other found that a giveaway program increased helmet use by elementary-school students from 3% to 38% but had no effect on helmet use by middle-school students (Logan et al., 1998). Jointly these studies suggest that giving middle-school students helmets alone will not increase their helmet use. Parkin et al. (1993) evaluated the effects of an educational program on helmet use at 18 Canadian schools. They found an increase in helmet use from 3.4% to 16% following the introduction of the educational intervention.

Behavior strategies to change transportation safety behaviors related to the use of safety equipment have typically focused on safety-belt use. Some interventions that have increased safety-belt use are posted feedback (Malenfant, Wells, Van Houten, & Williams, 1996), enforcement (Van Houten, Malenfant, & Rolider, 1985), peer monitoring (Cooper & Phillips, 2004), and incentives and rewards (Geller, Kalsher, Rudd, & Lehman, 1989). We have not found any systematic behavioral study to increase middle-school bicycle helmet use. The purpose of the present study was to evaluate a treatment package that included some of the above-mentioned behavioral elements to increase bicycle helmet use by middle-school children who ride their bicycles to school.

METHOD

Participants and Setting

Participants were children from three Florida schools who commuted to school on their bicycles. Two schools were located in Saint Petersburg, and the third school was located in Bonita Springs. One of the schools (Riviera Middle School) had been exposed to the program the previous year as the pilot school. The two remaining schools (Meadowlawn Middle School and Bonita Springs Middle School) had no prior experience with the program.

Departure Measures

Adult observers. The first and second authors, with the assistance of a research assistant, recorded several behaviors as the children left school at the end of each day. Observers seated in vehicles parked at the exit next to the bicycle compound recorded helmet use at the end of the school day at the two Saint Petersburg schools. The school resource officer collected data at a location with a view of the students leaving the bicycle compound at Bonita Springs.

Observers recorded whether the helmet was on the student's head and whether the helmet was on correctly. To be scored as correctly worn, the helmet had to be buckled snugly (the loop formed by the buckle must not form a loop the observer estimated would accommodate more than a few fingers), and the helmet needed to be level (if the forehead was exposed because the helmet was tipped up in the front, or the back of the head was exposed because the helmet was raked forward, it was not scored as level).

The percentage of students wearing a bicycle helmet each day was computed by dividing the number of children wearing a helmet by the total number of children bicycling. The percentage of helmets worn correctly was calculated by dividing the number of children wearing a helmet correctly by the total number of children bicycling. The first author trained all adult observers by illustrating each of the possible response outcomes for correct helmet use.

Peer observers. The officer at each school selected students to observe and record bicycle

helmet use. Students recorded helmet use only during the treatment condition at Riviera and Meadowlawn, whereas students at Bonita Springs collected data throughout the experiment. Five students were selected at Riviera, 8 students were selected at Meadowlawn, and 8 students were selected at Bonita Springs. The officer selected students who he believed would be reliable and responsible to observe and score helmet use.

During the treatment condition, 1 or 2 peer observers were assigned to observe helmet use each day. Helmet use was observed and recorded the same way by student observers as it was by the adult observers. The officer trained observers to record helmet use by demonstrating examples of correct and incorrect helmet use and showing the children a video on correct helmet use. Student observers were then taken outside as a group on the 1st day of the intervention and observed and recorded helmet use of students departing school on bicycles; the officer then reviewed whether each helmet was scored correctly or incorrectly. Students were trained to use the same definitions for target behaviors employed by adult observers.

Probe Measures

Adult observers collected two probe measures. The first, collected at two schools, involved children riding to school at a specified time (morning). The second, collected at all three schools, involved children riding home from school at specified distances (approximately 0.5 mile from the school). The distance measure was included to determine if the children removed their helmets after leaving the school area. Both measures were included to assess whether the treatment generalized over time and was maintained over distance. Distance probe data were collected by research assistants who sat in a car parked along the route (to decrease the likelihood that students would notice that they were being observed). Morning data were scored by adults parked across from the school.

Interobserver Agreement

A measure of interobserver agreement was obtained for three to five sessions during each condition of the experiment at each site. Interobserver agreement data for distance probes were collected for half the distance measures at Riviera and Meadowlawn. No interobserver agreement data were collected for probe measures at Bonita Springs or for morning probe measures.

Experimental Design

A multiple baseline across schools design was employed. After collecting baseline data at all three schools, the treatment condition was introduced at Bonita Springs, while the other two schools remained in the baseline condition. Once correct helmet use had stabilized at Bonita Springs, the treatment condition was introduced at Riviera, while Meadowlawn remained in the baseline condition. Once helmet use had stabilized at Riviera, the treatment condition was introduced at Meadowlawn.

Baseline. During baseline, the officers at Riviera and Meadowlawn periodically wrote tickets for failure to wear a helmet as they had done during previous years. Tickets were not written at Bonita Springs (Florida law requires all children and youth under the age of 16 to wear a bicycle helmet).

Helmet-use program. At the start of the helmet program, the officer called all students who rode their bicycles to school to an assembly. During this assembly, the officer explained the importance of helmet use and reviewed the reasons for wearing a bicycle helmet. He also showed a video on the correct fitting of bicycle helmets. Students were told that peers would be collecting data on helmet use, and the percentage of correct helmet use each week would be posted on a chart in the cafeteria along with the record, and another displayed at the administrative office at the school entrance. They were then asked to select a helmet-use goal for the school.

Goal setting was done by consensus, and the officer asked if they could do better if someone

initially set a low goal. The goal set at Riviera and Meadowlawn was 80%, and the goal set at Bonita Springs was 70%. Students were further instructed that if they met the goal before the end of the school year they would celebrate their success with a party with pizza, ice cream, soda, and small prizes. They were also told that a bicycle had been donated and that it would be raffled off at the party.

At the end of the meeting, free helmets were given to students who did not have helmets (six to eight helmets were distributed at each of the schools), and the officer fitted helmets for those students. The peer data-collection procedure was initiated during the afternoon of the assembly, and the charts were put up showing the baseline mean level of correct helmet use. Each week the officer met briefly with the peer observers to collect their data sheets. After this meeting, the percentages displayed on the charts were changed based on data collected by the student observers.

RESULTS

School Departure Helmet Use

The percentage of students wearing bike helmets when departing from the three middle schools at the end of the school day is presented in Figure 1. Helmet use averaged 14% at Bonita Springs, 82% at Riviera, and 52% at Meadowlawn during baseline. During treatment, helmet use increased to 45% at Bonita Springs, 98% at Riviera, and 95% at Meadowlawn.

The percentage of correct helmet use by students departing from the three middle schools at the end of the school day is presented in Figure 2. During baseline the percentage of correct helmet use at departure averaged 9% at Bonita Springs, 64% at Riviera, and 30% at Meadowlawn. It should be noted that correct helmet use showed an upward trend during baseline at Meadowlawn. During treatment, correct helmet use increased to 40% at Bonita Springs, 80% at Riviera, and 78% at Meadowlawn.

Data on the mean number of riders were computed each day for baseline and the treatment condition. At Bonita Springs the number of riders per day averaged 30 during baseline and 30 during treatment. At Riviera the number of riders per day averaged 25 during baseline and 23 during treatment. At Meadowlawn the number of riders per day averaged 34 during baseline and 37 during treatment. The baseline mean level of helmet use at Riviera the previous year was 76%, and the mean level of helmet use during the treatment condition the previous year was 98%.

Probes

Distance probe data were collected approximately 0.5 mile from the school at all three schools. The officer suggested locations that a majority of the students needed to pass on their way home that met criteria for the distance probe. School departure helmet use during these probes averaged 26% at Bonita Springs, 72% at Riviera, and 68% at Meadowlawn. After the introduction of the treatment condition, helmet use increased to 36% at Bonita Springs, 100% at Riviera, and 100% at Meadowlawn.

During baseline, correct helmet use at probe locations averaged 15% at Bonita Springs, 30% at Riviera, and 30% at Meadowlawn. Following treatment, correct helmet use at the distance probe sites increased to 32% at Bonita Springs, 70% at Riviera, and 80% at Meadowlawn. Note that probe data could differ from data collected at the school the same day because not all children needed to pass the probe site on their way home.

The percentage of morning helmet use during the single morning probe at Bonita Springs was 23%, and correct helmet use was 17%. During the treatment condition, morning helmet was 48%, and correct use was 35%. The percentages of helmet use during two morning probes at Meadowlawn were 81% and 83% during baseline and 97% during a single morning probe during treatment. The percentages of correct helmet use during two morning

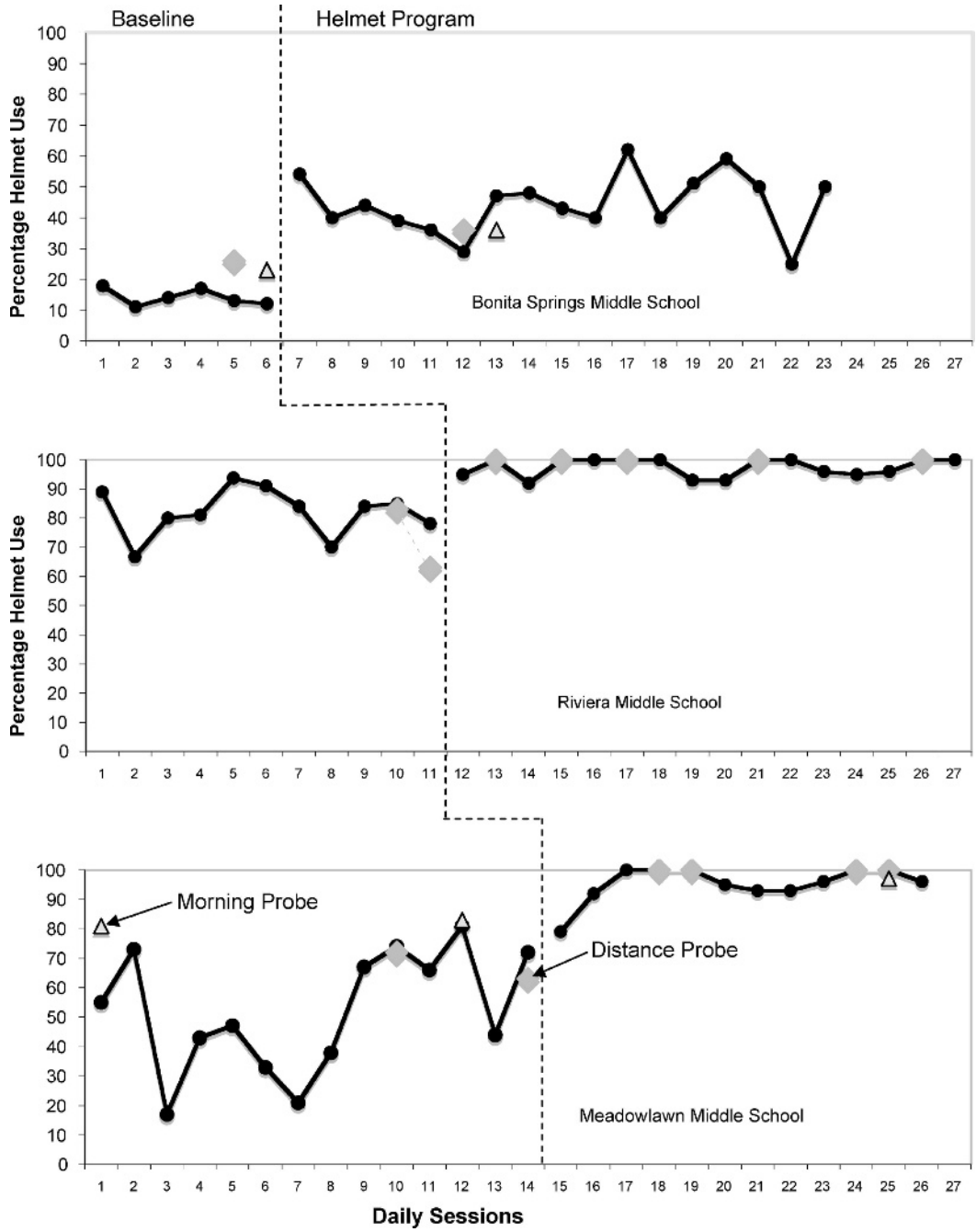

Figure 1. The percentage of students wearing bicycle helmets at all three middle schools. The last 4 days of the helmet program at Riviera were after the party, as was the last day of the helmet program at Meadowlawn. Gray diamonds show the percentage of helmet use during the distance probes taken after school. Gray triangles show the percentage of helmet use during the morning probes.

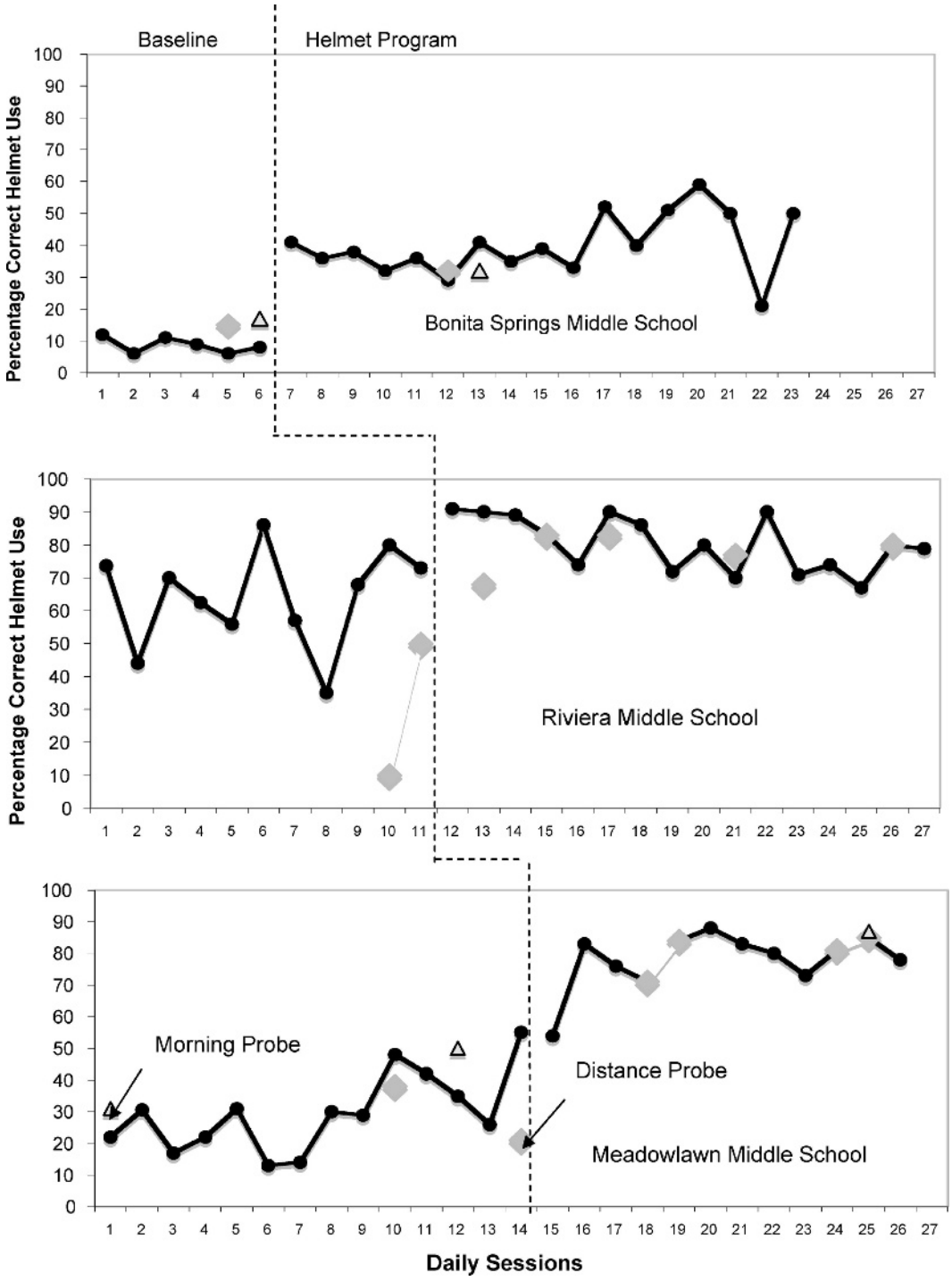

Figure 2. The percentage of students wearing bicycle helmets correctly at all three middle schools. The last 4 days of the helmet program at Riviera were after the party, as was the last day of the helmet program at Meadowlawn. Gray diamonds show the percentage of helmet use during the distance probes taken after school. Gray triangles show the percentage of helmet use during the morning probes.

probes at Meadowlawn were 31% and 50% during baseline and 87% during treatment.

Peer Data Collection

It was not possible to make an observation-by-observation comparison of student-recorded data with adult-recorded data because the students and adults scored behavior from two different vantage points. However, it is possible to compare daily mean helmet use recorded by student observers and adult observers. At Riviera student-recorded data averaged 3% higher for helmet use and 16% higher for correct helmet use. At Meadowlawn student-recorded data were 4% higher for helmet use, and for correct helmet use were 6% higher.

Interobserver Agreement

Interobserver agreement was calculated for helmet use and correct helmet use (data collected by adults) for cyclists departing school and for probe data by dividing the number of agreements on the occurrence of the behavior by the number of agreements on occurrence plus the number of disagreements. Interobserver agreement on the occurrence of helmet use at Bonita Springs averaged 98% (range, 91% to 100%), and interobserver agreement on the occurrence of correct helmet use averaged 91% (range, 67% to 100%).

Interobserver agreement on helmet use was 100% at Riviera, and agreement on correct helmet use averaged 93% (range, 84% to 100%). At Meadowlawn, agreement on helmet use averaged 98% (range, 87% to 100%), and agreement on correct helmet use averaged 93% (range, 67% to 100%).

DISCUSSION

The results of this experiment showed that the intervention was associated with a consistent increase in bicycle helmet use and correct bicycle helmet use at all three middle schools. Data for helmet use were stable for all three schools, but data for correct helmet use showed an increasing trend at Meadowlawn, although they were somewhat stable over the last 5 days. Unfortunately, it was necessary to introduce the treatment at this site before this trend stabilized because the end of the school year was rapidly approaching.

The results also indicated that the schools with a baseline history of enforcement for nonuse of helmets had higher baseline levels of helmet use and that the intervention produced near-perfect levels of helmet use and relatively high levels of correct helmet use at both of these schools. The program alone was able to produce a moderate level of helmet use and correct helmet use similar to baseline levels at the two schools with a history of bicycle helmet enforcement. The number of citations written at Meadowlawn for violating the helmet law averaged 16 per month prior to treatment, but none were written after the treatment was introduced.

At Riviera, eight citations were written per month during baseline, and only two were issued during treatment, with both issued during the 1st week. Because the program was more effective at the two schools with a history of enforcement, fewer citations were written at these two schools following the introduction of the program.

Although the threat of citations likely had some effect on behavior, many bicyclists received multiple citations. The officers said the students rarely paid the fines, even though they were informed that the Department of Motor Vehicles would require payment of all unpaid fines before they could get a driver's license. The difference in treatment efficacy between the schools with and without a history of enforcement may have been the result of rule-governed behavior influencing a subset of students, or the aversiveness of being stopped by the officer.

Although it is possible that the program improved helmet use by discouraging students from riding their bicycles to school, this seems highly unlikely because the number of children

riding to school remained constant over the course of the experiment. The observers also noted the same students riding their bicycles on a regular basis throughout the study period.

At Riviera, baseline measures used in this study were collected 1 year later, and they showed a partial reversal of the effects produced by treatment. One reason for the decline may have been that some components of the treatment were reversible. Another explanation is the turnover of a third of the students from year to year.

It is also interesting that children were frequently observed riding their bicycles with a helmet in their possession, usually attached to the handlebars or backpack. On several occasions observers recorded whether children had a helmet in their possession that was not worn. The incidence of this phenomenon averaged 20% during baseline. However, no reliability data were recorded for this measure because only one of observers who collected interobserver agreement data recorded it. It is likely that children took their helmets with them because of parental pressure to wear a helmet. This explanation is consistent with the somewhat higher percentage of helmet use observed during morning probe measures than in the afternoon.

Most students scored as not wearing a helmet correctly did not have it buckled or had the strap too loose. Of the smaller proportion that did not have the helmet level, in almost all cases the helmet was higher in the front (leaving the forehead exposed). Based on informal observation and analysis it appeared that after the intervention was introduced, helmets scored as not correctly worn were most often loose rather than unbuckled. Further research should be conducted to determine why students did not fasten their helmets more securely.

Several features added to the strength of this study. First, the use of distance probes and morning probes confirmed that students were not taking off their helmets on the way home, and that the effects of the treatment had transferred to times when the peer observers were not present. Because the adults who recorded probe data did so from parked cars, it is unlikely that the students were aware of being watched. Another feature of this study that has not been implemented in other studies with middle-school students was the use of peer observers. This made the treatment more cost effective and may have contributed to the efficacy of the program.

We evaluated an intervention that contained multiple components because we could not find prior behavioral research addressing this problem and wanted to increase the probability of obtaining a successful outcome. We were unable to perform a component analysis because of the limited time available before the end of the school year. One element of the package was the helmet giveaway to students who said they did not have a helmet. Although studies have demonstrated that helmet giveaways alone or in conjunction with traditional educational programs are ineffective, it is possible that this element contributed to the efficacy of the behavioral intervention even though it has been documented to be ineffective in isolation. We recommend that future research address the question of how much each component contributes to the success of this intervention package.

It appears from this study that helmet use is a much easier target behavior to change than correct helmet use. Perhaps training methods should be used that require more active responding on the part of the trainees. The Florida Department of Transportation (FDOT) prepared a program package consisting of an interactive DVD and other materials needed to carry out this program. The dissemination of this program is now being funded by the FDOT Safety Office and is being implemented through the Florida Technology Transfer Center at the University of Florida with the assistance of the Florida Bicycle Association.

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