

*THE GOOD TOOTHBRUSHING GAME: A SCHOOL-BASED
DENTAL HYGIENE PROGRAM FOR INCREASING THE
TOOTHBRUSHING EFFECTIVENESS OF CHILDREN*

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There has been a serious lack of experimentally verified, effective dental hygiene programs in the schools. In and of themselves, the instruction-alone programs which comprise children's dental education do not produce proper toothbrushing skills. In the present study, a school-based contingency dental hygiene program designed to increase the effectiveness of children's toothbrushing skills at home was implemented with grade one and two classes. Each class was divided into teams and participated in the "Good Toothbrushing Game." Each day four children from each team had the cleanliness of their teeth assessed according to the Simplified Oral Hygiene Index (Greene & Vermillion, 1964). The team with the lowest mean oral hygiene score was declared the daily winner. Winning teams received stickers and had their names posted. A multiple baseline across classrooms single-subject group design (Hersen & Barlow, 1976, pp. 228-229) established that the good toothbrushing game greatly increased the effectiveness of children's oral hygiene skills. The treatment terminal level for the grade one scores was 2.0 as compared to a baseline terminal level of 5.0, and for the grade two's was 2.3 compared to 5.7 at the end of baseline. A 9-mo follow-up indicated that these results were maintained. The data strongly suggest that proper implementation of behavioral principles is essential to the success of oral hygiene programs.

DESCRIPTORS: dental hygiene, multiple baseline, behavioral medicine, contingency management, children

Improvements in the level of general dental health can only be realized if children receive good dental care from the time their first teeth erupt (Dollard & Sandal, 1961). Unfortunately, the oral health of children has long been neglected, despite widespread dental problems before age 3. Most schools conduct dental programs. The most frequently implemented program consists of a single lecture and demonstration (Podshadley & Schweikle, 1970). However, it has been demonstrated that such instruction-only programs have little or no effect on the cleanliness of children's teeth (Hudson, 1974; Podshadley & Schweikle, 1970; Podshadley &

Shannon, 1970). Despite their ineffectiveness, these programs continue to be the major form of dental education provided in the schools.

The ineffectiveness of the single lecture program is not surprising given repeated demonstrations that instruction, in and of itself, will not produce behavior change, (e.g., Baer, Rowbury, & Baer, 1973). Instructions contain discriminative stimuli which cue the occurrence of instruction-following behaviors (Skinner, 1957). Instruction-following behaviors (e.g., effective toothbrushing) are operants and, as such, to be maintained they must be reinforced. Thus, behavior modification principles have much to offer in producing compliance with dental hygiene instructions.

Behavior modification has been used in a children's oral hygiene program by Stacey, Abbott, and Jordan (1972). At a summer camp, children were reinforced with toys and activities for clean teeth. Stacey et al. obtained moderately

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effective results, using only an AB nonreversal design.

A dental program using group consequences for individual behaviors based on the "Good Behavior Game" (Barrish, Saunders, & Wolf, 1969) was developed for classroom use. The behavior modification game adapted for oral hygiene was titled the "Good Toothbrushing Game." The "Good Toothbrushing Game" differed from the "Good Behavior Game" in two major respects: (a) oral hygiene skills rather than classroom conduct constituted the behavioral target, and (b) the target response (toothbrushing) was to be engaged in at home rather than at school. The "Good Toothbrushing Game" was designed to establish effective dental hygiene skills among children, by making reinforcement contingent on effective team performance. It was expected that the effectiveness of behavior modification principles in improving children's toothbrushing skills would be experimentally verified and that the "Good Toothbrushing Game" would be a practical, easily implemented program.

METHOD

Students and Setting

Twenty-two grade one students (8 girls and 13 boys), and 23 grade two students (11 girls and 12 boys) in a small elementary high school participated. Parental permission was obtained for each child's participation in the dental hygiene program.

At the beginning of the program, the dental checks took place in the classroom. On day 6 of baseline the dental checks were made in a separate room because the teachers expressed concern that the checks were somewhat disruptive for the other students. Baseline levels appeared unaltered by this change.

Equipment and Materials

Each child received a dental kit containing a toothbrush, toothpaste, and disclosing tablets. "Redcote" mint-flavored disclosing tablets con-

taining 2% FDC Red #3 (erythrosine) were used to detect oral debris. To assess the teeth, an 8½ cm dental mouth mirror with an attachable 1.5VAA battery-operated light source was used. Sterilized 5 × 5 cm gauze sponges, cotton swabs, tissue, rubbing alcohol, and water were used to clean the mirror. Reinforcers included a variety of fruity, fragrant "Scratch n' Sniff" stickers with printed phrases such as "well done" on them. In addition, the children's names were posted on a "Snoopy" winner's poster.

Measuring and Recording Teeth Cleanliness

Disclosing tablets. Arnim (1963) reported that disclosing agents are useful in measuring the effectiveness of teeth cleaning procedures, by accurately determining the cleanliness of an individual's teeth. He recommended a food color tablet of FDC Red #3 because the tablet readily dissolves; it produces a pleasing shade of red; it does not stain teeth or fillings; and its discoloration dissolves in saliva within 1-2 h.

Simplified Oral Hygiene Index (OHI-S). The cleanliness of the children's teeth was measured according to the Simplified Oral Hygiene Index (OHI-S). This index, used by practicing hygienists (Wiecek, Note 1), classifies oral hygiene by evaluating the extent of debris or plaque on six representative tooth surfaces (Greene & Vermillion, 1964).

The six teeth that were assessed included: outside surface of last top right-hand molar; outside surface of right of center top front tooth; outside surface of the last top left-hand side molar; inside surface of last bottom right-hand side molar; outside surface of left of center bottom front tooth; inside surface of last bottom left-hand side molar. The scale criteria used to assess these teeth were as follows: 0 = no dental debris present; 1 = debris covering not more than ⅓ of the tooth surface; 2 = debris covering more than ⅓ but not more than ⅔ of the tooth surface; 3 = debris covering more than ⅔ of the tooth surface. The oral hygiene score for each child was calculated by adding the OHI-S ratings for the six teeth. The team score

was calculated by adding the individual oral hygiene scores and dividing by 4 the number of children checked for a team each day.

Interobserver Reliabilities

The first author conducted dental assessments. Interobserver agreement on the rating of teeth cleanliness was obtained weekly from ratings by the teachers or a graduate student during baseline and treatment conditions. A community worker collected reliability data during the follow-up condition. Reliability scores were calculated as the number of single tooth OHI-S ratings (i.e., 0, 1, 2, or 3) agreed upon, divided by the number of agreements plus disagreements, and multiplied by 100. During baseline and the experimental phase, the observers were aware of the experimental procedures, but during the follow-up the observer was naive as to the purpose and procedures of the study. Independence of observations was assured by the separate assessment of the children with the observers' backs to one another and approximately 1.5 m apart. The interobserver reliabilities for the grade one class averaged 88% (87% for baseline, 85% for treatment, and 92% for follow-up) and for the grade two's averaged 77% (77% for baseline, 71% for treatment, and 84% for follow-up).

Procedure

The research design was a multiple baseline across groups, i.e., classrooms (Hersen & Barlow, 1976, pp. 228-229). Baseline data were collected on both grade one and two children before the "Good Toothbrushing Game" was first introduced to the grade one's and later to the grade two's.

Instructions. At the beginning of the program the experimenter arranged for a dental hygiene student to talk to the children and to present a dental health kit to them. The instructional package presented was the standard one used by the University of Manitoba School of Dental Hygiene in all the schools, and consisted of a single lecture and demonstration on oral hygiene. The

hygienist's presentation ensured that all children had the proper equipment to clean their teeth and that they had received instruction as to correct dental care.

Team assignment. The two classes were each randomly divided into two teams. Each day four children from each team were randomly selected to be checked. The children were selected without replacement until the entire team had been assessed. This team "block" random selection was then repeated, using a different random order of selection. As a result, the children were checked at least twice a week, sometimes on consecutive days. Only eight children were selected to represent the class each day, as checking the entire class would have been impractical and time consuming.

Baseline. During baseline the children were unaware that they had been divided into teams. Dental checks were made at 9:00 a.m. with the grade two's and at 9:30 a.m. with the grade one's. The eight selected children received a disclosing tablet which they were instructed to chew, swish around their mouths for 30 sec, and then rinse their mouths. A dental mirror was used to check and rate the children's six designated teeth according to the OHI-S. During baseline the children received no praise or specific feedback regarding the effectiveness of their hygiene skills. If a child was absent, another child was randomly selected from the same team.

"The Good Toothbrushing Game." The experimenter explained to the children that they would be participating in a daily class game and announced the team members. The children were told that the object of the game was to be the team that had the cleanest teeth. It was emphasized that this meant effective as well as regular brushing. The dental checks and the game contingencies were then carefully explained to the children, and the reinforcements were displayed.

As in the baseline, four children were randomly chosen to represent their team each day. Since they never knew in advance when they

would get their teeth checked, the children were reminded that they always had to brush their teeth well after breakfast. After the eight selected children were checked according to the same procedures followed in baseline, the team with the lowest score or cleanest teeth was announced as the winners. The winning team had their names posted on the winners' poster and every member of the winning team received a "Scratch n' Sniff" sticker.

In addition, the children were praised for a low score (below 2), and received verbal feedback as to the areas that they did not brush well (e.g., "You did not properly clean the inside of your bottom teeth"). Additional feedback was given on the children's data sheets because they knew that 0 was "good" and 3 was "bad." The program ended on the last day of the school year.

Follow-up. Follow-up data were collected 9 mo after the program ended. The children were not aware that they were going to be checked and the experimenter arrived unannounced. Exactly the same random selection and dental assessment procedures were followed as during the baseline phase, and at the same assessment times. Eight children were assessed in each class on three consecutive days, until all children had been checked once.

RESULTS

The dependent variable, cleanliness of the children's teeth, was measured by the OHI-S. Each of the six tooth surfaces was given a score between 0 and 3; thus the highest possible total score for any child was 18 (3×6). The mean oral hygiene score was the average score of the eight children checked on any one day.

The mean oral hygiene scores for the two classes are presented in Figure 1. The grade one class baseline was quite stable at approximately 5.0. The grade two class baseline was slightly higher and more variable with a mean of 5.5.

When the grade one's began the game, their scores immediately decreased from 5.0 to 3.3.

For the duration of the program the grade one's mean oral hygiene scores remained below 4.0 and showed a decreasing trend. There were no overlapping points between baseline and intervention phases. While the scores for the grade one class dropped during the game, the scores for the grade two class still on baseline, remained relatively stable at their original level.

When the game was implemented in the second grade, these children's scores also decreased dramatically from 5.7 to 4.4. The first intervention mean oral hygiene score was the only data point that overlapped with baseline. Most scores are below 3.0 and a downward trend is evident.

The data clearly indicate that the children's scores substantially improved when the "Good Toothbrushing Game" was played. The terminal baseline levels for the grade one's and two's were 5.0 and 5.7, respectively. The terminal intervention levels for the grade one's and two's were 2.0 and 2.3, respectively. Thus, there was a decrease in mean oral hygiene scores of 3.0 for the grade one's and 3.4 for the grade two's.

Also illustrated in Figure 1 are the follow-up data collected 9 mo after treatment termination. The mean oral hygiene scores for the grade one's were 2.2, 2.5, and 2.6. Although these scores are slightly higher than the treatment termination level of 2.0, they are well below the baseline termination level of 5.0. The mean oral hygiene scores for the grade two's were 3.1, 3.2, and 2.7. Similar to the grade one data, the grade two scores were slightly above their treatment termination level of 2.3 but well below their baseline termination level of 5.7.

Individual data were collected on all 45 children. These data were limited, however, in that there were so few scores. This limitation was a direct result of the nature of the game and the fact that the program had to be terminated with the end of the school year. Because of the periodic nature of the dental checks, there was often a 3-day lapse between data collections on each child. Thus, in some children's data there were only one or two data points in baseline or inter-

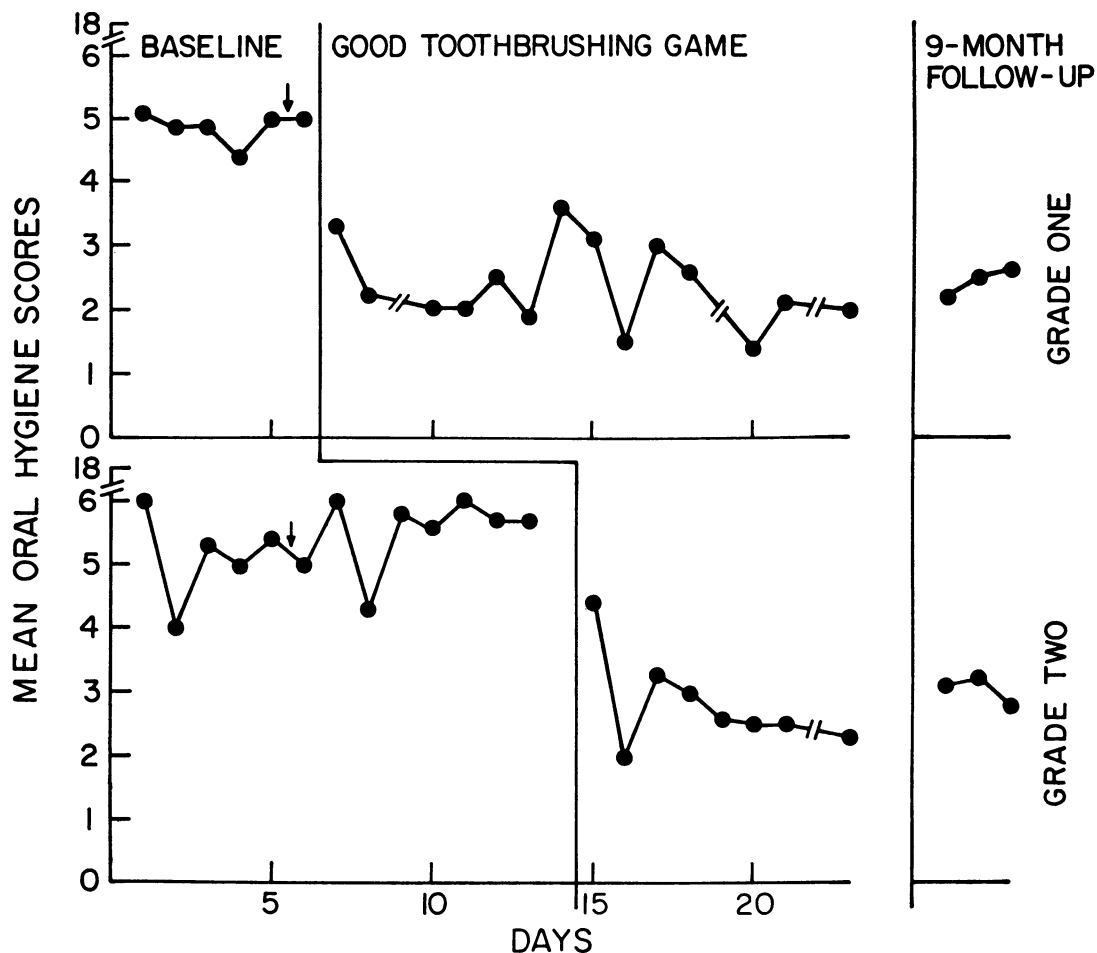


Fig. 1. The effects of the "Good Toothbrushing Game" on oral hygiene. Note: missing data points (//) are due to in-services and class activities such as field meets. The assessment setting was shifted from the classroom to a small room location prior to the sixth baseline measurement for each class as indicated by the arrow (\downarrow).

vention, making analysis of individual trends difficult (Hersen & Barlow, 1976, p. 76). As some indication of the relative variability that may be expected of individual subject data, the mean standard deviations for baseline, treatment, and follow-up conditions were 2.1, 1.5, and 1.2, respectively, for the grade one data and 2.0, 1.6, and 1.1, respectively, for the grade two data.

DISCUSSION

The results suggest that the "Good Toothbrushing Game" produced more effective toothbrushing behavior. Although toothbrushing was not directly monitored, it was the instructed be-

havior and therefore likely produced improved oral hygiene rather than uninstructed behavior, e.g., flossing. In addition, the follow-up data indicate that there was maintenance of increased toothbrushing effectiveness over a substantial (9 mo) period. That the effects of the game were durable over time is important, given the necessity that good toothbrushing skills generalize over time.

Any one of the game components (e.g., feedback, instruction, reinforcement) may have been effective alone. The "package" program was chosen in contrast to a single variable investigation because dental hygiene is a relatively new area of behavioral research. As such, it is bene-

ficial to study as many components as is necessary to obtain positive treatment results, and then to do a single variable component analysis after success has been obtained (Azrin, 1977).

Providing effective dental education is in agreement with the emphasis placed on the "whole" child in today's schools. A healthy child is desirable, and that includes having healthy teeth. As is evidenced in children's poor dental health in general, "home" control of proper oral hygiene is not always successful and thus the school is an optimal environment (one that controls large numbers) to teach oral hygiene. For the teacher interested in dental health, the good toothbrushing game is practical for the class schedule. The entire daily procedure took only 20 min and used inexpensive items. The scoring procedures were easily learned by individuals unfamiliar with dental procedures.

Clinical significance of results is an important consideration. Although the children's baseline scores were characteristically low for their age group (Forgay, Note 2), these scores indicated a sufficient amount of oral debris to produce a considerable number of cavities (especially since only six teeth were checked). The game scores revealed that the children were closer to maintaining debris-free teeth than during baseline. Five hygienists, informally surveyed, maintained that this change was clinically significant. They said that it was unlikely that these scores could be further reduced, since plaque continually forms on the teeth and thus a score of "0" is implausible. In addition, the children were eager to play the game and parents reported that their children brushed diligently.

Directions for future research may include studying the effects of the game on populations with characteristically poor dental health (e.g., rural children), investigating game component effects, and involving parents by teaching them assessment and reinforcement procedures or by using "dental report cards." Continuing behavioral research on oral hygiene is important given

the costly effects of poor dental health, and is essential if "Mr. (Ms.) Tooth Decay" is to succumb to behavioral control.

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