

Developing Brushing Performance In Second Graders Through Behavior Modification

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DENTAL HEALTH EDUCATION in school classrooms traditionally puts primary emphasis on knowledge gain, with little emphasis on the behavioral objective of improved dental health practices. This fact was pointed out clearly in the nationwide School Health Education Study (1). The study indicated that although children of all ages receive some form of dental health instruction in a majority of public schools in the United States, by the sixth grade students have extremely low

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scores in practices related to dental health. Thus, as in other areas of health behavior, a real difference exists between dental health knowledge and dental health practices.

The common didactic or demonstration approach to dental health education in school classrooms has consisted of a single session conducted by the teacher, a dentist, or both, or by a hygienist, most often during National Children's Dental Health Week. Podshadley and Shannon (2) recently documented that single-lecture demonstration sessions do not, however, result in a long-lasting improvement in oral hygiene practices. While the conclusions in their investigation did not "rule out the possibility of a cumulative improvement in oral hygiene practices" as a result of single annual dental health education programs, these authors recommended that a program with a "more comprehensive approach for teaching the importance of, and methods for, achieving good oral hygiene" be developed. They also recommended rigorous evaluation of the effectiveness of such programs.

Study Design

Our project was undertaken to test the effectiveness of a dental health education program designed to determine the utility of a behavior modification approach as an educational model for plaque reduction in a classroom setting. Second graders were chosen as the target population. While fourth, fifth, and sixth graders may be receptive learners of dental health information, the real need is to concentrate on a behavioral objective of establishing positive practices at an earlier age. From consultations with personnel of the University of Minnesota Child Development Center (personal communication, University of Minnesota Child Development Center, August 1969) we learned that in children 6 to 8 years old a variety of personal behaviors are in the process of being developed, but may not yet be firmly established. The consultants also indicated that the motor skills of second graders would be developed enough so that the children could learn to brush their teeth well. In addition, children at this age are likely to be interested in the loss of their primary teeth, the eruption of their new permanent teeth, and the process of decay.

For the project group, 6 second grade classrooms (169 children) were selected from 15 classes at 3 elementary schools which fulfilled the following two criteria: (a) a range of socioeconomic backgrounds representative of the community, and (b) a school principal who expressed interest in having a dental health education program integrated with other classroom activities. The teachers contacted were willing to have their classes participate.

Six control classes (162 children) were selected by the same two criteria as for the project group. Four of the control classes were chosen from the three schools which had classes participating in the project. The remaining two were selected from a fourth school that was not otherwise participating in the project.

The independent variables reported here include project participation, sex of child, time of day of clinical evaluation of oral hygiene performance (morning or afternoon), child's intelligence quotient score, level of child's reading ability in school (reading group), and parent involvement. The dependent variable, oral hygiene, was assessed using the PHP-M, a modification of the Personal Hygiene Performance Index (3).

Education Methods

Three broad educational concepts were used in the design and implementation of the education program for the children in the project classrooms: (a) behavior modification with token rewards and prizes to reinforce desired behaviors, (b) discovery learning through individual "contracts"—the children volunteering to participate in individual or group projects, or both—to gain dental health knowledge and information about how to get their teeth clean, and (c) individualized interaction with the dental hygienist as opposed to the didactic show-tell-do methods of group dental health instruction.

Children in the control classrooms received none of the educational components of the project, and participated only in the periodic examinations conducted by the project dentist. Teachers in these classrooms were asked to treat dental health education activities in the usual manner, as directed by the school system's curriculum.

A few days after all children had received a baseline dental screening examination by the project dentist, the project coordinator and the dental hygienist visited each of the project classrooms. They brought with them for each classroom a large cardboard storage box filled with prizes such as pencils, books, games, small cars, mirrors, puzzles, key rings, and animal erasers. The children were allowed to look in the box. It was then explained that they could earn color-coded plastic chips of different values, which could be exchanged for the prizes. To earn the plastic chips they needed only to brush their teeth and do a good job—the goal was to have clean teeth. All necessary brushing tools, including toothbrushes, fluoridated toothpaste, mouth mirrors, and chewable erythrosin dye tablets, were distributed to the children. Supplies of these and a lighted magnifying mirror were kept in the classroom for use at any time. No explicit brushing instructions were given.

The children were also told that the dental hygienist would visit their classroom at unannounced times to determine individually how well and how consistently they were brushing. During the school year the hygienist made 20 visits to each classroom. The schedule devised for the hygienist's visits to each of the project classrooms prevented children from rushing to brush their teeth once they learned that she was in the school. For example, during a morning she would indi-

vidually examine half of the children in one project classroom (approximately 10 children) at one of the three schools. The remainder of the morning she went to a different school to examine another half of a class. The same method was used for afternoon classes. With this method other children in the school who were to be tested would not be alerted to an examination that day. The visits were designed to provide reinforcement for brushing on a variable interval schedule. The intervals between reinforcements were increased on an established timetable so that at the conclusion of the program the effects of reinforcement would be minimized.

At each of the hygienist's visits plaque was stained with a dye tablet and scored on all erupted teeth. If the child had brushed and had left no plaque in any area, he was given a blue chip (10 points); if one or two areas were left uncleansed, a red chip (5 points) was given; if more than two areas were left, the child was given a white chip (1 point). Each child kept his chips on a chain. On Friday afternoons teachers in the project classrooms usually allowed the children to exchange their chips for prizes. If a child received two blue chips in a row, he was also rewarded with a T-shirt, on which "I KNOW HOW" was printed above a picture of a large toothbrush.

At each unannounced examination the hygienist gave the child a white, red, or blue chip and showed the child where he was having difficulty in brushing. He was not, however, told how to get his teeth clean unless he specifically and verbally asked. When children received white or red chips, some of them asked immediately how they could do better. The hygienist then would help them figure out how to get the spots they had missed. In time most of the children did ask for help and thus received assistance specifically related to their own teeth. The purpose of this approach was to allow each child to request help in order to reach a goal rather than giving him information or a method that he might not be able to use. The brushing method used varied for each child after account was taken of manual dexterity and variations due to erupting or malposed teeth or problems associated with orthodontic bands or appliances. Again, the goal was to help each child attain and maintain clean teeth rather than to emphasize any particular brushing routine or method. This segment of the program was aimed exclusively at the primary objective of establishing skill in brushing and encouraging brushing.

After 2 months, another segment, aimed at the secondary objective of providing dental health knowledge, was added to the program. Projects for which the child could contract to earn chips and points varied from reports to the class on different aspects of dental health to the writing and actual production of a slide series or a videotaped dental health skit. The variety and number of these projects made it possible for each child to choose only those which interested him and which he wanted to carry out. The complete projects were shared with the entire class so that all could benefit. Chips again were awarded, contingent upon performance and the difficulty of the task.

The parents of each project child were given an opportunity to participate in the program. They were invited by letter to a meeting after all baseline data had been obtained. Two additional meetings were held during the year for those parents who attended the first session. At these meetings the parents were informed about dental health, the study, and the performance of their children. The meetings also focused on influencing parents to reinforce the toothbrushing routine and skills which the children were learning in school.

Evaluation Methods

Objective evaluation of oral hygiene status was achieved through the PHP-M. Before the indexing each child chewed a disclosing tablet. The facial and lingual surfaces of six teeth were scored, and these scores were added to obtain total mouth scores (TMS). TMS were then averaged across classes and other subgroups to obtain total mouth average scores (TMAS).

Baseline TMS were obtained at the beginning of the school year before initiation of the educational portion of the program. Children in both the project and control groups were examined and scored at four unannounced and varied intervals during the project. All examinations were carried out in the school with a mirror, explorer, headlamp, and other necessary portable dental equipment.

A single dental examiner was calibrated for consistency before the study and performed all the evaluations throughout the project. The examiner did not know which schools were participating in the project or which classes within a school were in the project or control groups. Besides having the examinations carried out at different

Mean plaque scores for project and control groups, by examination session, time of examination, and sex of child

Examination session	Project children				Control children			
	Morning		Afternoon		Morning		Afternoon	
	Boys (N=20)	Girls (N=25)	Boys (N=26)	Girls (N=24)	Boys (N=29)	Girls (N=21)	Boys (N=30)	Girls (N=22)
1. October 1969.....	36.8	35.9	35.5	34.6	36.0	34.7	34.8	34.8
2. December 1969.....	29.6	25.8	26.4	23.2	35.9	32.5	31.9	32.6
3. March 1970.....	23.8	24.0	27.9	26.0	31.9	29.1	30.4	29.5
4. May 1970.....	25.3	22.1	28.4	24.4	32.8	30.4	27.7	28.2
5. November 1970.....	26.7	23.0	26.1	20.8	30.3	26.9	28.7	29.6

NOTE: Plaque scores are only for children present at all examination sessions.

schools during the mornings and afternoons to prevent children in afternoon classes from preparing for the examinations, as an additional check against possible examiner bias children of the project and control groups were intermingled at examination sessions.

A separate evaluation included an assessment of the level of brushing skill attained by the end of the school year. In May of the program year two project and two control classrooms from the same school were selected for a test of brushing skills. Each child was supplied with a new brush and toothpaste and instructed to brush and clean as well as he could. The children then stained their plaque and were scored.

A followup examination was carried out in the fall, 6 months after dental education activities had ceased in the classrooms.

Results

Only those children who were present for all examinations during the study are included in this report (project N = 95, control N = 102) except where noted. The overall results (mean PHP-M scores) are presented in the table.

The baseline TMAS of children in the project group declined from 35.6 to 25.0 by the fourth examination at the end of the school year (see table), a result which represents a plaque reduction of 30 percent. A subsequent and final appraisal, carried out 6 months after the activities ended in the classroom and more than 1 year after the project's inception, indicated that these children had not only maintained this level of performance but had slightly improved to a TMAS of 24.1.

The baseline TMAS of the control group also dropped by the end of the school year from 35.1

to 29.8, a plaque reduction of 15 percent. The control children also maintained this level of performance, showing a slight improvement on the final appraisal (29.0). The difference in plaque reduction for the project versus the control children was highly significant ($P = .000001$).

The girls in the project and control groups started with lower TMAS than the boys. This difference was significant ($P = .016$). Although the difference was not statistically significant ($P = .21$), girls in the project group reduced their TMAS more than boys even though they had started at a slightly lower baseline.

No significant differences were seen between children in the project group whose parents attended all three parent involvement sessions and children of parents who did not attend any of the sessions ($P = .96$). In addition, no significant relationships were found between the children's reading ability in school and TMAS ($P = .314$).

Intelligence quotient scores, as measured by the Lorge-Thorndike Test, were available for 97 of the project children. Small, but statistically significant, inverse correlations between IQ and TMAS were noted on both the first examination ($r = -.23$) and the last examination at the end of the school year ($r = -.23$). This inverse correlation was still present at the followup examination, but it was no longer significant ($r = -.15$).

The differential differences in TMAS between project and control groups when compared by time of day and examination sessions were significant ($P = .001$). The TMAS of the project children in both morning and afternoon sessions dropped dramatically at the second examination; the afternoon children had slightly lower plaque scores. This situation changed by the third examination; children in the morning session continued

to lower their scores while the scores of children in the afternoon examination sessions rose slightly and continued at about the same level to the end of the school year. No significant crossover was seen in the control group. At the followup examination, there was no difference between children examined in the morning or afternoon. A statistically significant interaction was noted between TMAS and time of day by examination session ($P = .017$).

The evaluation of TMAS after the brushing skill test conducted at the end of the school year indicated that children in the control group had 47 percent more plaque remaining than the project children. The TMAS were 19.2 for the control group and 13.1 for the project group.

Discussion and Conclusions

The most encouraging observation was that the children in the project group over a 6-month period which included summer vacation continued to maintain lower plaque scores than the control group without reinforcement sessions or tangible incentives.

The long-term lower plaque scores for project children may indicate that they were brushing more often; that is, they may have changed their behavior with respect to brushing routines. On the other hand, these lower scores may be a result of their increased skill in brushing, as indicated by results of the brushing test given at the end of the school year. Children in both the project and control groups substantially lowered their plaque scores when they were given the opportunity to brush and instructed to brush and clean as well as they could. The control group's TMAS after the skill test was 19.2, a reduction of 12.8 points from their TMAS at the fourth examination. The project group's TMAS dropped from their fourth examination level of 24.1 to 13.1. While both groups lowered their scores by approximately the same amount, the project children had a more desirable end result—the cleanest teeth.

Other encouraging findings were the nearly equal response to the program of both boys and girls, children of all reading group levels, and children of involved and noninvolved parents. When considered along with the small difference observed between children with higher and lower IQ scores, it would appear that this type of program has a broad appeal and may not be affected by these variables.

Ordinarily a marked difference between children of involved and noninvolved parents might be expected. While there was a difference, it was not statistically significant. Although children with higher intelligence quotients did better during the project, they were at the same level as the other children after the final examination.

Several possible reasons or combinations of reasons may exist for the plaque reduction observed in control children throughout the study. First, it is likely that children in both project and control groups would have some gain in manual dexterity or improvement in motor skills which could account for some improvement in plaque scores. Second, all children in the control group classrooms received some dental health education activities from their teachers or other consultants. Some of these educational activities were elaborate and included toothbrushing. The staining and scoring procedure, performed five times during the year, could have had some motivational effect and therefore cannot be ruled out as a reason for some plaque reduction.

Another reason for overall plaque reduction in the control group may be related to what might be termed a "brush-off effect," which was observed in the four control classrooms in the schools with project classrooms. It could be expected that children in control classes in project schools might be influenced by the program and thus lower their plaque scores. By the fourth examination, these children had reduced their TMAS by 18 percent while control children in nonproject schools had reduced their TMAS by only 8 percent. To further test the hypothesis of the brushoff effect, the difference in mean plaque scores at the end of the school year between children in control classes from project schools (29.4) and children in nonproject schools (32.0) was subjected to a one-tailed *t*-test. The difference was significant at the .05 level ($t = 1.92$).

Some interesting results were noted in the project group. The most dramatic (rapid) reduction in TMAS was observed at the second clinical examination in December. This trend in score reduction continued throughout the year for project classes except for class P-1. The P-1 class, after reducing its TMAS more than the other five project classes by the second clinical examination (38.3 to 25.1), lost its regular teacher, and at the third clinical examination it experienced a rise to 29.3. Its score remained at

that higher level so that the class finished with the highest TMAS at the final evaluation. Apparently the continuous understanding, involvement, and enthusiasm of the teacher play an important role in a project such as this.

Aside from the apparent positive behavior change in dental health practices, there were other benefits from the program. Teachers were enthusiastic about the use of behavior modification as related to dental practices because they could see positive results. They appreciated the use of contracts for the portions of the program designed to increase the children's knowledge, primarily because they were relieved from responsibility for the didactic presentation of dental health information. Teachers also observed that through this program the children acquired practice in speaking, counting, writing, and vocabulary and in using a camera, the telephone, and library facilities.

It might be hypothesized that analysis of scores of only those children who were present at all examination sessions might create a bias in favor of the project. This, however, was not the case. For example, at the final examination at the end of the school year, the 148 children present from the project group had a mean score of 24.6 as compared with the score of 25.0 when only those children included were those who attended all

examination sessions ($N = 95$). For this same examination in the control group, when all 150 children were included, the TMAS was higher (30.4) than when only those children present at all examinations were included ($N = 102$, $TMAS = 29.8$). This represents an even greater difference between project and controls at the final examination session. Thus, while it was necessary for the purposes of statistical analysis to look at the data in this manner, the actual results may be even more positive than previously indicated.

This project was designed to test the utility of a behavior modification approach as an educational model for children in reducing plaque within a classroom setting. The question, however, as to any possible relationship between reductions in plaque scores for these children and subsequent reductions or alterations in their future dental disease remains unanswered and unevaluated.

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Three broad educational concepts — behavior modification, discovery learning, and individual interaction with a hygienist—were employed for 1 year with the objective of developing improved brushing practices and skills in second grade children. The purpose of the project was to test the utility of a behavior modification approach as an educational model for plaque reduction in a classroom setting. For the project group, 6 second grade classes (169 children) were selected from 15 classes at 3 elementary schools. Four classes

for the control group (162 children) were chosen from the three schools that had classes participating in the project and the remaining two from a fourth school that was not otherwise participating in the project.

The PHP-M index, a modification of the Personal Oral Hygiene Performance Index, which was used at five unannounced intervals, indicated that the project group's average plaque reduction of 30 percent was significantly different from the average reduction of 15 per-

cent for the control group. The measure of plaque reduction provided an indication of behavioral change relating to plaque removal.

Both boys and girls, children having varied intelligence quotients and reading skills, and the children of parents who were involved and not involved in the study improved their brushing skills nearly equally. Children in the control classes in project schools reduced their plaque scores more than children in control classes in nonproject schools.