

*THE DEVELOPMENT OF CORRECT TOOTHBRUSHING
TECHNIQUE IN PRESCHOOL CHILDREN*

CHERYL POCHE, HEATHER MCCUBBREY, AND TOM MUNN

WESTERN MICHIGAN UNIVERSITY

This study examined the effects of an intensive training program on the toothbrushing skills of three preschool children, using both performance measures and outcome (plaque level) indicators. Toothbrushing was broken into 16 steps that involved actual manipulation of the brush in the mouth. Correct brushing included four criteria: (a) appropriate angle of bristles, (b) appropriate motion of brush, (c) appropriate tooth surface, and (d) minimum duration of brushing. Training included instructions, a three-phase modeling procedure, physical guidance, and reinforcement. Results of a multiple baseline design across subjects showed that the children completed an average of 8.6% of the steps prior to training, as compared with an average of 95.8% of the steps following training. Plaque levels decreased from an average of 58% during baseline to 24.6% after training. Follow-up measures revealed that 86.6% of the steps were maintained. The study demonstrated that the effectiveness of the procedures in teaching very young children a complex motor skill that is essential to their future health.

DESCRIPTORS: dental hygiene, preschool children, preventive dentistry, behavioral medicine, health-related behavior

The need for early dental hygiene training is clearly evident. Half of all 2-yr-olds have one or more cavities, and 90% of all children have dental decay by the age of four (Greenberg, 1977). Though primary teeth are lost, tooth decay can be transmitted from primary to permanent teeth. Periodontal disease may also occur at an early age and persist after primary teeth are gone. If decay results in premature loss of primary teeth, costly space maintainers may be needed (Moss, 1977).

Most oral hygiene programs are directed toward elementary school children rather than preschoolers. Though it is assumed that parents teach their preschool children or clean their children's teeth, it is not clear that either occurs.

Thus, an effective program for teaching dental hygiene to preschoolers is greatly needed.

Effective procedures for the maintenance of oral hygiene behaviors have been demonstrated for adults (Iwata & Becksfort, 1981) and for children as young as second grade (Lattal, 1969; Martens, Frazier, Hirt, Meskin, & Proschek, 1973), but little information exists on the acquisition of these behaviors. Horner and Keilitz (1975) taught a 15-step toothbrushing chain, of which 3 steps involved actual brushing behaviors. No outcome measures such as plaque levels were taken. Perhaps research on early dental hygiene training has been discouraged by assertions that children below the age of seven have neither the motor skills nor the motivation to brush their teeth adequately.

This study sought to extend behavioral approaches to preventive dentistry by teaching toothbrushing to children as young as 3 years of age, by developing a more refined definition of brushing, and by monitoring plaque levels as outcome measures.

Reprints can be obtained from the first author, P.O. Box 50847, Main Place Station, Dallas, Texas 75250. The authors acknowledge the valuable advice given by Margaret Snow, Instructor, Dental Hygiene Training Program, Kalamazoo Valley Community College, Kalamazoo, Michigan.

METHOD

Children and Setting

One male and two females, ages three to four, were selected to participate in the study on the basis of their lack of toothbrushing skills as measured by a pretest of brushing. All the children displayed three prerequisite skills: following instructions, imitating simple fine-motor behaviors, and holding a toothbrush firmly in one hand. The study was conducted at a preschool in which the children were enrolled. Sessions were conducted once daily in small empty rooms with sinks, and lasted approximately 15 min.

Materials

Materials included a fluoridated gel, adult and child-size toothbrushes with soft bristles and flat surfaces, and a large mirror behind the sink in which the child and trainer could see themselves. A mouth mirror and disclosing fluid were used for scoring plaque. A chart of brushing steps and paper stars was also used.

Task Analysis of Toothbrushing Steps

Toothbrushing was broken into 16 steps involving the actual manipulation of the brush in the mouth. Correct brushing at each step included four criteria: (a) holding the bristles at a 45° angle with the tooth surface; (b) using a circular "soft-scrub" motion; (c) brushing the appropriate tooth surface in the sequence described in the task analysis; and (d) brushing this surface continuously for at least 5 sec. The 16 steps included the outside/inside surfaces of the upper/lower teeth (left, front, and right) and the biting surfaces of the upper/lower teeth (left and right). The easiest steps, involving the outer surfaces, were taught first, whereas the inner surfaces were taught last. Brushing of all surfaces was accomplished by moving in a circular fashion around the mouth. During baseline, any steps performed correctly were recorded, regardless of the sequence in which they were performed. During training, the steps had

to be performed in the sequence in the task analysis in order to be considered correct.

Procedures

Baseline. Each child was brought individually to the training room, handed a toothbrush with gel on it, and given the instructions: "(Name), brush your teeth the best way that you can." No consequences were provided for correct brushing behaviors. The session ended when the child displayed no additional brushing skills for a period of 20 sec. The child was handed a cup for rinsing the mouth and a towel for wiping the face.

Training. Instruction was provided by three undergraduate psychology students and consisted of the following components. (1) Simple instructions were used to describe each step in the sequence. (2) Modeling consisted of demonstrating correct brushing by exaggerating the motions and providing examples of good and poor brushing. After the trainer modeled the correct step alone, the trainer and the child performed the step together. Finally, the child performed the step alone. (3) Physical guidance was used as a correction procedure. The trainer gently wrapped his or her hand around the child's hand, so that both of them held the brush, and moved the brush in the desired motion and angle on the tooth surfaces. The trainer's hand was gradually removed as the child displayed the correct response. (4) Descriptive praise was initially given after each occurrence of a correct component of brushing. Later, praise was delivered after the completion of several components. A star on a chart of brushing steps was awarded upon mastery of each of the 16 steps.

Follow-up. Approximately 8 wk after the completion of training, the child was brought to the training room and asked to brush the best way that she or he could. At the end of the session, the trainer gave descriptive praise for correct completion of any steps but used no other training procedures.

Observation Procedures

Brushing skills. A pretest of brushing skills was conducted at the beginning of every session to assess the durability of responses from the prior session. A posttest was conducted immediately after every training session to measure the number of components mastered in that session. In each case, the child was requested to brush the best way she or he could. In order to observe the child's brushing behaviors, the trainer sat or squatted to one side and slightly behind the child so that she or he could see the child's movements clearly in the mirror behind the sink. Components correctly performed were recorded on a simplified drawing of a set of teeth. For each of the 16 steps, the behavioral requirements of angle, motion, location, and duration were recorded.

Plaque levels. Twice during baseline and at least once per week thereafter, plaque levels were assessed by applying disclosing fluid to the child's teeth and examining them for plaque. Each tooth was divided into four surfaces, the proximal and distal sides of the buccal and lingual surfaces, giving a total of 80 surfaces. The presence of plaque on each of these surfaces was noted. This method is a modification of the Patient Hygiene Performance Index or PHP (Podshadley & Haley, 1968). Plaque scores were obtained after the pretest in the sessions.

Reliability Procedures

On approximately 25% of the sessions, a reliability observer sat slightly behind and to the other side of the child and recorded the child's behaviors. An agreement was counted if both observers scored a component of a step as correct. Occurrence agreement during baseline ranged from 84.4% to 100% and averaged 94.5%. Agreement during training ranged from 93.8% to 100% and averaged 96.9%. A reliability observer was also present on approximately 25% of the sessions in which plaque levels were obtained. The trainer/observer

scored one quarter of the surfaces and then the reliability observer scored the same quarter, until all surfaces were scored. An agreement was counted if both observers scored the presence of plaque on a surface. Occurrence agreement during baseline ranged from 64.8% to 100% and averaged 88.9%. Agreement during treatment ranged from 76% to 100% and averaged 91.3%.

Experimental Design

The study used a multiple-baseline design across subjects.

RESULTS

Figure 1 illustrates the performance of the children during baseline, training, and follow-up conditions. Before training, Tray performed an average of 1.63, or 10.2%, of the steps correctly. After training, he performed all the steps correctly, while at follow-up, he performed an average of 15.7, or 98.2%, of the steps. Holly performed no steps correctly before training. After training, she mastered 14, or 87.5%, of the steps, at which time she left the school for vacation. Nancy performed an average of 2.5, or 15.6%, of the steps correctly before training, all of the steps after training, and an average of 12, or 75%, of the steps at follow-up.

As the number of brushing skills increased, the amount of plaque on the children's teeth decreased. For Tray, the percentage of tooth surfaces with plaque decreased from 48.6% before training to 31.8% after training. For Holly, plaque levels decreased from 53.8% to 31%. For Nancy, plaque levels decreased from 71.5% to 11.1%.

DISCUSSION

An intensive training program was successfully used to produce acquisition of 16 tooth-brushing steps. As a result of training, a decrease in plaque levels was observed in all the

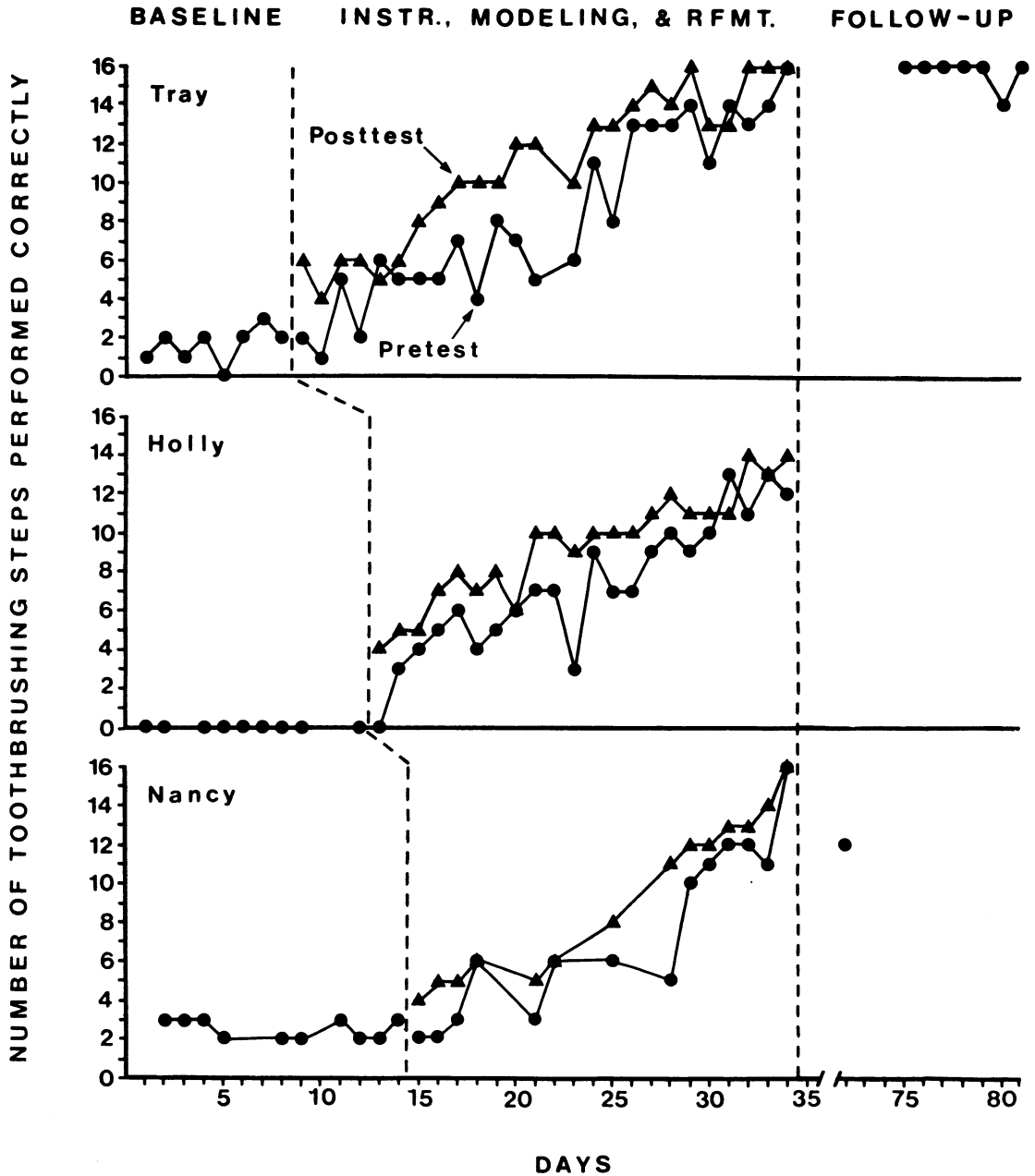


Fig. 1. The number of toothbrushing steps correctly performed by the three children in the baseline, training, and follow-up conditions.

children. The training produced good results with children previously thought to be too young to learn the complex skills required for thorough and accurate brushing. The high levels of skill maintenance observed in the two

children at follow-up suggest that the effects of training were not short-lived.

The skill maintenance of the third child may have been improved even further had training been continued until she showed correct perfor-

mance of all 16 steps for three consecutive days. Time restraints prevented the occurrence of additional training sessions. Even so, she performed nearly all of the steps at least 2 mos after training.

Several components of the training may have been responsible for the good short-term maintenance. First, the training procedures were repeated at each of the 16 steps. Second, the children were required to brush the surfaces in one logical sequence rather than in a haphazard order. This consistent sequence may have promoted the development of a response chain. Third, the high rate of praise, the active involvement of the adults in modeling the behaviors, and the brief length of the sessions may have contributed to making the toothbrushing enjoyable and thus enhanced maintenance effects.

The authors chose to teach the brushing techniques to children rather than their parents since, in a couple of years, the children would have to be taught anyway and the task might be less onerous if performed by the child alone. Behaviors such as applying paste to the brush and wiping the mouth were not formally taught because the children could perform these behaviors with a minimum of assistance and because an effective training program for these less complex components of toothbrushing has already been demonstrated (Horner & Keilitz, 1975). A complete toothbrushing program might combine the behaviors taught in the present study with those taught by Horner and Keilitz (1975).

Plaque levels were reduced by at least one half for all children, though some plaque remained on the teeth. A 10% plaque level is considered by some professionals to be the lowest score that a person with good dental care habits could reasonably attain. Though only one child's final plaque score approached this level, several points should be considered. First, the children's teeth had not been professionally cleaned by an oral hygienist to remove calculus, a hardened form of plaque that accumulates over time and that cannot be removed by ordi-

nary brushing. This cleaning is performed in many dental hygiene studies and could effect a reduction in plaque levels that could maintain for several weeks. Second, the plaque score method used was a very stringent one. Third, the children had brushed all or most of their teeth correctly only one to three times. They could be expected to improve their scores with years of practice. Fourth, most professionals agree that brushing alone does not remove all the plaque on teeth, since flossing is essential to remove plaque between teeth (Loe, 1970). It is recommended that brushing be done after flossing, to remove particles loosened by the flossing (Moss, 1977). Thus, the present reductions in plaque are clinically helpful and directly related to acquisition of brushing skills, but further reduction could be expected with practice, flossing, and professional cleaning.

It would have been desirable to conduct plaque assessments during follow-up and to collect data on the generality of responding outside of the training setting. The maintenance data collected were relatively short-term, though there is anecdotal evidence that one child who remained at the preschool performed the steps correctly more than a year after training. Though more long-term maintenance data would have been desirable, the primary purpose of this study was to examine the acquisition of brushing skills in very young children and to supplement earlier studies that suggest several procedures for the maintenance of brushing.

Because of the small sample size and the requirement that children be able to follow simple verbal instructions and imitate simple hand movements, the generality of the results may be limited.

Future research should examine the generality and long-term maintenance of the procedures. Future investigators might also extend the procedures to teach flossing to young children. In addition, follow-up research should involve parents in the training and maintenance of oral hygiene behaviors.

The present study demonstrated that very young children can alter the probabilities regarding their future health status. Additional research is needed to develop effective procedures for teaching other health-related behaviors to preschool children.

REFERENCES

- Greenberg, J. S. An analysis of various teaching modes in dental health education. *Journal of School Health*, 1977, 26-32.
- Horner, R. D., & Keilitz, I. Training mentally retarded persons to brush their teeth. *Journal of Applied Behavior Analysis*, 1975, 8, 301-309.
- Iwata, B. A., & Becksfort, C. M. Behavioral research in preventive dentistry: Educational and contingency management approaches to the problem of patient compliance. *Journal of Applied Behavior Analysis*, 1981, 14, 111-120.
- Lattal, K. A. Contingency management of tooth-brushing behavior in a summer camp for children. *Journal of Applied Behavior Analysis*, 1969, 2, 195-198.
- Loe, H. A review of the prevention and control of plaque. In W. D. McHugh (Ed.), *Dental plaque*. London: E. and S. Livingston, 1970.
- Martens, L. V., Frazier, P. J., Hirt, K. J., Meskin, L. H., & Proshok, J. Developing brushing performance in second graders through behavior modification. *Health Services Report*, 1973, 88, 818-823.
- Moss, S. *Your child's teeth*. Boston: Houghton Mifflin, 1977.
- Podshadley, A. G., & Haley, J. V. A method for evaluating oral hygiene performance. *Public Health Reports*, 1968, 83, 259-264.

Received December 23, 1980

Final acceptance July 22, 1981