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The Effects of a Token Economy upon Reduction of Plaque Concentration on Teeth of Elementary School Children

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THE EFFECTS OF A TOKEN ECONOMY UPON REDUCTION OF PLAQUE CONCENTRATION ON TEETH OF ELEMENTARY SCHOOL CHILDREN

by

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This study was designed to evaluate the effect of a toothbrushing reinforcement program upon subsequent levels of plaque concentration of teeth of elementary school children. Bacterial plaque, an invisible substance which accumulates over time on teeth that have not been properly cleansed, is responsible for causing dental disease. In 1963, Arnim developed a "disclosing wafer" which, when chewed, stains plaque red thereby making areas of plaque concentration visible. In a study with junior and senior high school students, Evans, Rozelle, Lasater, Dembrowski and Allen (1968) first effectively employed disclosing wafers as a chemical indicator of toothbrushing behavior.

The focus of most research on dental hygiene programs implemented in public schools has been on the nature of the communications delivered to students (Higbee, 1969). Janis and Feshbach (1953) initiated this area of research when they presented three versions of an illustrated lecture on dental hygiene to each of three groups of high school students. While each version stated the dangers of dental neglect and recommended specific programs for tooth care, they differed in the vividness and degree to which possible dire consequences of such neglect were emphasized. Janis and Feshbach found that the minimal-threat communication produced a higher degree of reported conformity to the recommended procedures for tooth care than the high-threat communication. In a more recent study, Evans, Rozelle, Lasater, Dembrowski and Allen (1970) presented persuasive appeals to junior high school students: (1) high fear followed by a set of specific recommendations, (2) low fear followed by the same recommendations, (3) positive appeal

(emphasizing good looks and popularity) followed by recommendations, (4) set of recommendations only, and (5) elaboration of specific recommendations. The results of this study indicated that a positive motivating appeal condition coupled with an elaborated recommendations condition was most effective in changing actual behavior (as measured from slides of the children's teeth taken after they had chewed disclosing wafers), while high fear and recommendations only conditions were more effective in changing reported behavior (the children's own reports of their tooth care behavior). However, a six-week post-communications check revealed that effects of all appeals upon actual and reported behavior had dissipated. Evans et al. concluded that such research designs would be enhanced by repeated presentations or by other reinforcers of the messages.

The present study is a sequel to one implemented with elementary school children in the preceding year (Snow, 1974). For one week, fourth grade children were exposed daily to an elaborated set of recommendations for tooth care. In three subsequent visits to the school, children were rated on the amount of plaque present on their teeth (measured by disclosing fluid) and on the amount of dental knowledge retained (oral questioning). These data were compared against that obtained from fifth graders who were rated on the same measures and who had participated in the dental hygiene program the year before. The results of the study showed considerably more plaque reduction for the fourth graders than for the fifth graders, although dental knowledge was retained by both. Snow concluded that while toothbrushing habits are easily learned, they require strong reinforcement over an

extended period of time in order to become habitual. As an example of such reinforcement, Snow suggested utilization of a token economy system or other behavioral reinforcement techniques.

In response to these suggestions that dental care communications, once presented, need to be reinforced in order to effect tooth care behavior over an extended period of time (Evans, et al, 1970; Snow, 1974), the present study attempted to examine the relative effects of hygiene lectures, prompts, and one method of reinforcement. A token economy system was implemented to reinforce toothbrushing behavior and subsequent plaque reduction.

Token economies have enjoyed widespread use in school settings with "problem" children (Wolf, Giles and Hall, 1968; Orme and Purnell, 1968); with special populations such as retarded children (Bernbrauer, Wolf, Kidder and Tague, 1965) and juvenile delinquents (Cohen, 1967); and with entire classes of children in regular class settings (Grieger, 1970; Bushell, Wrovel, Michaelis, 1968). The emphasis of a token economy is not on the extinction of undesirable behavior, but on the reinforcement of desired behavior and on the development of personal responsibility (Krasner, 1969). Certain behaviors are specified as desirable, hence reinforceable; a medium of exchange, the token, is designated; and back-up reinforcers are selected.

The purpose of this study was to determine if plaque levels of school children could effectively be reduced through implementation of a dental hygiene communication program backed up by a token economy reinforcement system.

METHOD

Subjects

The treatment group consisted of 57 elementary school children (grades 4 through 6). Teachers were asked to volunteer for the program, then randomly were assigned with their classes to one of four experimental groups (n = 15, 16, 13, 13). Four control groups were randomly chosen from the balance of the school population of grades 4 through 6 (n = 18, 21, 14, 20).

Procedure

All students in Washington Elementary School were pre-tested to measure their plaque level, then given a lecture on the value of proper tooth care and instructed individually in proper brushing techniques. The four treatment groups were then presented the prompts of a toothbrush rack hung in the classroom (with each student having his or her own brush) and an announcement by their respective teachers of a daily "toothbrushing time" (generally 5 to 10 minutes after lunch period). There were no contingencies placed on the toothbrushing at this point.

After two weeks, the four treatment groups were randomly assigned to a multiple baseline design whereby one group was placed on a token economy plus prompts every two weeks. The token economy was designed such that weekly row monitors (selected by their teachers) would award one token for each day that a student brushed his/her teeth during the assigned time. Reinforcement criteria for toothbrushing consisted of

the presence of the toothbrush in the mouth for a minimum of two to three minutes. The token was a "happy face" stamped on an index card that had been given to each student. In addition, tokens awarded to students were recorded by the teacher on a master chart.

Throughout the experiment dental hygiene students from Kalamazoo Valley Community College were randomly assigned to check plaque concentrations. Each child rinsed his/her mouth with disclosing fluid and plaque concentrations were noted and recorded by hygienists on PHP (personal hygiene performance) forms. Plaque scores were the number of tooth surfaces with plaque visible (with five surfaces per tooth, four sides and top, and a full mouth of thirty-two teeth, plaque scores can conceivably vary from 0 to 160).

These plaque-check days were randomly determined each week. Any student showing a decrease in plaque level from the week before was given two tokens, while a maintenance of the previous week's plaque level was awarded one token. Tokens could be exchanged in a student-operated store on a weekly basis.

During eight weeks, three of the experimental classes (n = 15, 16, 13) received the token economy while the fourth class (n = 13) received only prompts. This was done to control for any effects of the prompts only versus prompts and token economy combined. At the end of the eight weeks, a final post-check was taken on the plaque level of all experimental and control subjects.

RESULTS

Figure 1 shows mean plaque scores for each treatment group over time, and the mean plaque scores for each control group on pre- and post-tests. (See Figure 1.)

The overall differences in gain scores (pre minus post scores) between the four control and four treatment groups proved highly significant. As can be seen in Table I, this difference was significant beyond a 0.001 level. (See Table I.) Supporting this is a one-way analysis of variance for gain scores for control groups (see Table II) which shows a .072 probability of the results being due to chance, whereas the same analysis for treatment groups yielded a lower probability (.001) (see Table III). Mean gain scores in Table II show only one control group decreased plaque levels (1.50), and the rest increased. This control group is small compared to mean gain scores of treatment groups (36.5, 5.0, 41.3, 39.8) (see Table III).

Using an analysis of co-variance to look at the difference in gain scores between the four treatment groups, it can be seen that the general trend was a reduction of plaque level as a function of time spent on the token economy (see Table IV). Treatment group 1 which was on token economy longest showed the greatest mean decrease (40.2) in plaque level, while treatment group 4 which used only prompts showed the least mean decrease.

Figure 1: Mean plaque scored for all groups on succeeding weeks. Start of token economy for each treatment group is indicated by a thicker line. Control group mean scores are marked as "x's" for pre- and post-check weeks only.

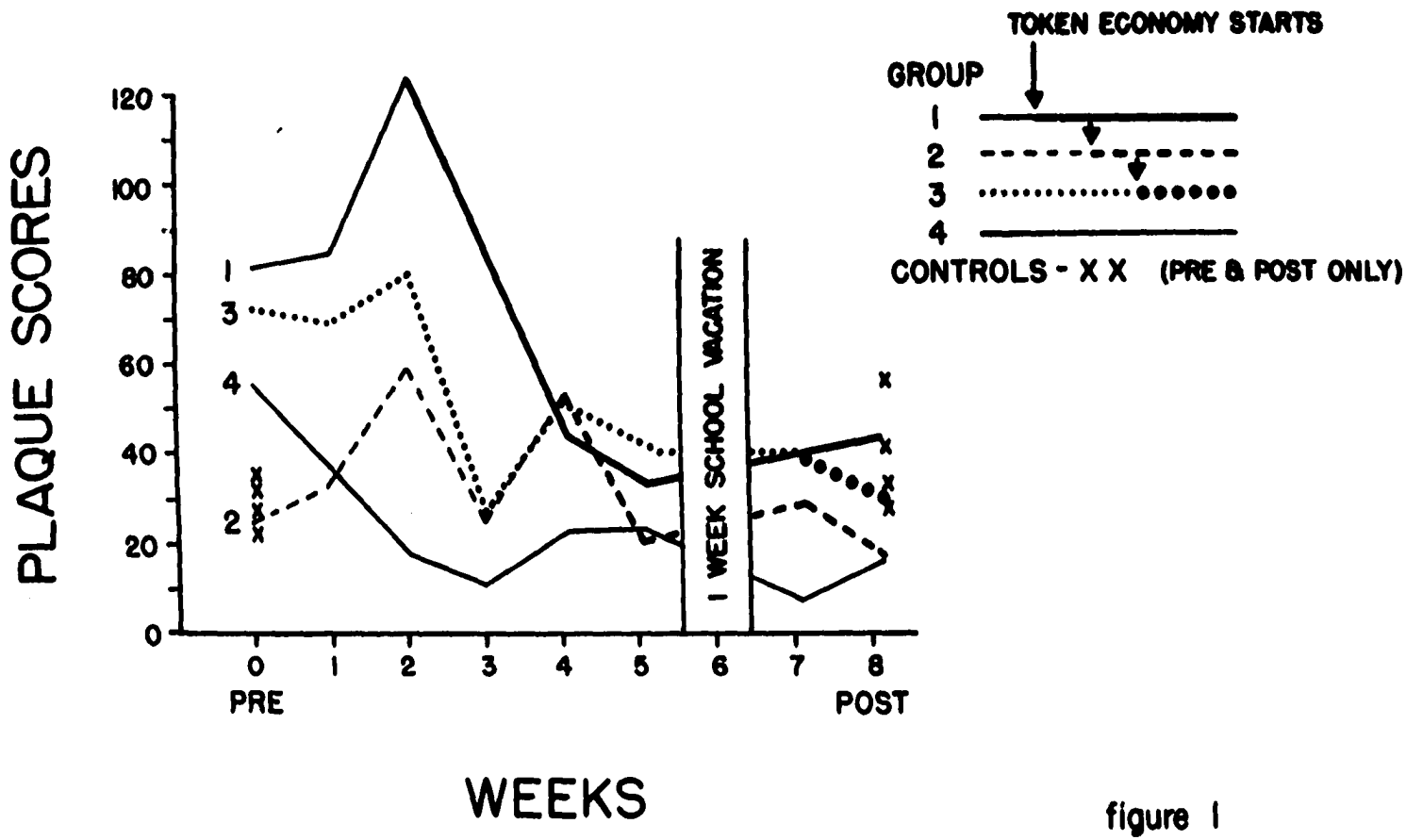

figure 1

Table I: One-way analysis of variance showing significance of overall differences in gain scores between control and treatment groups.

TABLE I

One-Way Analysis of Variance Showing
Significance of Overall Difference in Gain Scores
Between Control and Treatment Groups

Source	Sum of Sq.	D.F.	Mean Sq.	F	Prob.
Between	54759.062	1	54759.062	53.68	<0.001
Within	130578.239	128	1020.142		
Total	185337.301	129			

Group	Size	Means
1 (Treatment)	57	29.5263
2 (Control)	73	-11.8356

Table II: One-way analysis of variance showing significance of overall difference in gain scores for control groups.

TABLE 11

One-Way Analysis of Variance Showing
Significance of Overall Difference in Gain Scores
for Control Groups

Source	D.F.	Sum of Sq.	Mean Sq.	F	Prob.
Groups	3	7807.895	2602.632	2.442	0.072
Error	69	73552.133	1065.973		
Total	72	81360.027			

Group	Size	Means
1	18	-22.444
2	21	-20.476
3	14	1.50
4	20	- 2.550

Table III: One-way analysis of variance showing significance of overall difference in gain scores for treatment groups.

TABLE III

One-Way Analysis of Variance Showing
Significance of Overall Difference in Gain Scores
for Treatment Groups

Source	Sum of Sq.	D.F.	Mean Sq.	F	Prob.
Between	13550.01560	3	4516.67188	6.71	0.001
Within	35668.19480	53	672.98481		
Total	49218.21050	56			

Group	Size	Means
1	15	36.5333
2	16	5.0
3	13	41.3076
4	13	39.8461

Table IV: **One-way analysis of co-variance showing significance of overall differences in gain scores between the four treatment groups.**

TABLE IV

One-Way Analysis of Co-Variance Showing Significance of Overall Differences in Gain Scores Between the Four Treatment Groups

Source	Sum of Sq.	D.F.	Mean Sq.	F	Prob.
Between adjusted treatments	3770.279	3	1257.0	5.46	.002
Error	11974.47	52	230.3		
Total	15744.75	55			

Treat	Size	Unadjusted Mean	Adjusted Mean
1	15	42.0	40.2
2	16	18.8	21.4
3	13	28.8	27.7
4	13	15.2	15.3

DISCUSSION

The results indicated that implementation of a token economy plus prompts was more effective in reducing plaque than use of prompts only; and, that prompts plus weekly checks was more effective than use of lectures only. The mean increase in plaque level of the four control groups is consistent with the findings of Evans et al. (1979) and Imam (1974). Educational lectures and hygienic recommendations appear to be relatively ineffective in controlling and maintaining dental care habits in children.

Contrary to hypothesized results, Group 2 which was on token economy longer than Group 3 showed a smaller mean decrease in plaque level. This discrepancy could be related to any number of factors inherent in human research in natural settings. For example, teachers participating in treatment groups volunteered their classes and were not randomly chosen so they already had varying degrees of personal investment (e.g., during staff meetings, teacher #2 constantly expressed scepticism about token economies).

A further contaminating factor was that children in all groups talked with each other about what was happening in their respective classes. For example, after one class went on token economy, the other children started asking teachers when they would also. The sudden drop in plaque scores exhibited by the other three treatment groups when the first group started on a token economy might be related to these expectations (see Figure 1).

The hygienists themselves introduced still more variables. For example, they controlled positive reinforcement (tokens) by what plaque scores they recorded, and their own personalities may have been additionally reinforcing or punishing to the children. This is further complicated by the fact that the hygienists interacted with treatment group children weekly and only interacted with the control group children during pre- and post-tests.

Despite these complications, this study has shown the use of a token economy to be effective in reinforcing toothbrushing behavior and subsequent plaque reduction. When compared to other possible methods of behavior modification, it is not apparent that a token economy is the most effective procedure in terms of response cost (time, effort, expense). For example, the toothbrushing behavior of eight boys at a summer camp was maintained at a high level when the behavior was required as a prerequisite for the opportunity to swim (contingency management) (Lattel, 1969). It also remains to be shown whether the use of a token economy system to reinforce the designated behavior (toothbrushing) will result in the children internalizing responsibility for care of their teeth. As stated by Alessi[1] the purpose of a token economy should be a means to an end rather than an end in itself.

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[1]Alessi, G. J. Token economy: How to start it. Working Paper, Western Michigan University, 1973.

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