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THE EFFECTS OF DENTAL HYGIENE
INFORMATION AND CONSEQUATION
ON PLAQUE CONTROL

by

Janel R. Warner

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment
of the
Degree of Master of Arts

Western Michigan University
Kalamazoo, Michigan
December 1973

ACKNOWLEDGMENTS

I would like to extend my appreciation to Dr. Jack Michael for the assistance he provided in the design of this study and for serving as the chairman of my thesis committee.

Warmest thanks go to Dr. Brad Huitema for his contributions in the preparation of this study, his encouragement, and for serving as a member of my committee. Thanks also to Dr. Fred Gault for serving as a member of my committee.

This research could not have been successful without the excellent assistance supplied by Marjorie Snow, dental hygiene instructor, Kalamazoo Valley Community College.

Special thanks for her support and effort in typing and retyping this manuscript goes to my mother.

Janel Rae Warner

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Western Michigan University, M.A., 1973
Psychology, general

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INTRODUCTION

The research described in the present paper is based upon a parsimonious analysis of behavior which utilizes principles that have been empirically determined. These principles as discussed by Ullmann and Krasner (1966) and Ulrich, Stachnik, and Mabry (1966) have suggested the wide applicability of behavior modification techniques, not only with animals, but with human subjects in diverse settings. One setting that has previously been left unexplored by proponents of behavior modification, which promises to be an area of growing concern, is that of dental hygiene.

The problem that the present study concerns itself with is educating children in the correct methods of dental hygiene behaviors, which includes brushing, flossing, and disclosing, and then providing sufficient motivation to maintain these behaviors in the children's daily repertoires.

Past research incorporating behavior modification techniques suggests that the presentation of reinforcement contingent upon appropriate dental behaviors should increase the probability of their occurrence. Programming reinforcement contingencies so that they occur daily should sufficiently motivate daily dental behavior. Therefore, a possible solution to the problem would be to educate the subjects in the correct methods of dental hygiene behaviors and to then program daily consequence for these behaviors by those in the best position to do so.

Dental caries (pathological process of localized destruction of supporting tooth tissues by microorganisms) is one of the most neglected health problems in this country today as determined by a survey of dentistry (1964). Children in the United States between the ages of ten and fourteen have over seventy-eight million unfilled cavities. The average child's expectancy is twelve cavities before age fourteen. A survey by Green (1972) shows that ninety-five percent of all Americans are attacked by caries.

Caries are produced when bacteria form colonies in the mouth where they thrive on the sugar residues from sweet foods. The bacteria manufacture acids which are entrapped by plaque and retained near the tooth surface. The tooth's vulnerability to decay determines the extent of damage the acids will cause.

In an attempt to achieve optimum dental health for all, the trend in dentistry, as seen by Petterson (1972), is shifting from curative to preventive techniques. At the present, dental systems are strained by the population's demands and future needs promise to overwhelm existing manpower and resources. The best solution to the problem would appear to be antecedent control of dental disease as evidenced in a study by Bagramian and Gockman (1973). They found that clear differences exist in patients who seek preventive services compared to those who do not.

With the new trend towards preventive dentistry, responsibility falls on the dental educator. The problem is a social, not a scientific one. The procedures of behavior modification utilize the appropriate social contingencies and can be effectively incorporated into any dental educator's repertoire.

A review of the literature shows that only one study incorporating behavior modification techniques and data collection has been published in the area of the development of dental hygiene behavior. This study by Lattal (1968) demonstrated an effective procedure for increasing toothbrushing responses by utilizing the Premack Principle. That principle, developed by Premack (1959), states that any behavior with a high frequency of occurrence can be used as a reinforcer for any behavior of a lower frequency. In the Lattal study, swimming privileges were used as reinforcers for toothbrushing responses.

Behavior modification procedures have been effectively utilized to shape appropriate patient behaviors in mentally retarded adults visiting the dentist for the first time. (Kohlenberg, et al., 1968). Dental schools throughout the country employ behavioral objectives within their curriculums and achieve high rates of success in the area of testing. (Shurley, et al., 1972; Kruper, 1972; and Kingston, 1970.)

Numerous projects have been conducted in classrooms using token economies simultaneously with the presentation of hygiene instruction, but little or no measurement or documentation was involved. Scheadel and McDaniel (1970) implemented such a program involving one-to-one relationships between hygienists and children in the classroom, backed up with a token economy. Data were not collected concerning plaque or decay.

The establishment of proper dental hygiene habits involves two aspects - dental hygiene instruction along with the ensuing development of effective dental behaviors, and the maintenance of those

behaviors. Hygiene instruction involves: a) techniques of brushing, flossing and disclosing; b) knowledge of superior brands of toothpaste, dental floss and toothbrushes; and c) proper nutrition instruction.

There are many acceptable methods of toothbrushing which all involve brushing from the roots toward the crown, brushing the inside and outside surfaces of each tooth at least ten times, and brushing immediately after eating. The most widely accepted method, as reported by Stoll (1960), is the Bass technique. Here, small circular strokes are placed on the inside and outside tooth surfaces with the brush resting half on the gum tissue and half on the tooth surface.

The effectiveness of brushing can be improved by using a toothpaste which contains an abrasive to help clean teeth, and stannous flouride to help strengthen tooth enamel. Toothbrushes should be soft in order to prevent gum tissue damage and should be allowed to dry thoroughly between use.

O'Rourke and Miner (1941) report that the proper method for flossing involves wrapping the floss several times around the middle fingers of each hand, inserting the floss in the spaces between the teeth, working the floss from the root to the crown, pulling forward and then working the floss in the same space from the root to the crown again only pulling backward. Unwaxed dental floss should be used at all times, since waxed floss leaves a wax residue on the tooth surface which negates the purpose of flossing. Flossing should occur once daily.

Disclosant tablets are vegetable dye solutions which tint the normally colorless plaque red. In this way a person can see exactly which surfaces of which teeth he is not cleaning properly and can concentrate on those areas.

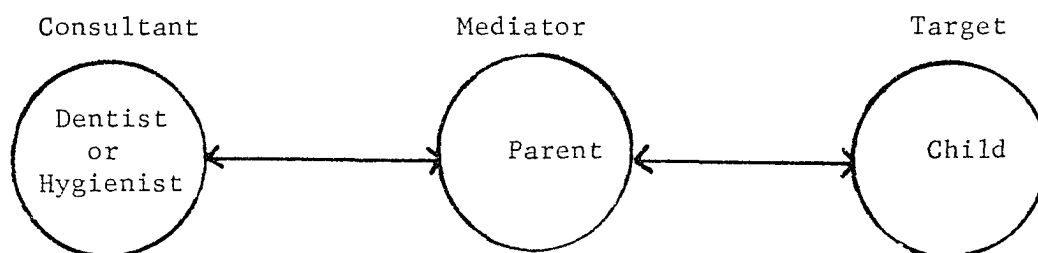
A proper diet which is adequate for general health is also adequate for dental health (Stoll, 1960). It is important to avoid candy, soft drinks and other sweets, potato chips and other foods with high carbohydrate content. For between-meal snacks, celery, carrots, apples and other fresh fruits and vegetables are preferable.

After a person has been given the instruction, successive approximations to the correct brushing, flossing, and nutritive responses must occur. Consequation for proper and improper responses must immediately follow the instruction.

The second aspect of dental hygiene involves the maintenance of correct responses. Traditionally, maintenance has been left solely to the individual with infrequent consequation being delivered by the dentist and/or dental maladies. With the shift towards preventive practices occurring, there comes the realization that more effective maintenance procedures must be developed.

To assure for the adequate maintenance of dental hygiene behaviors, sufficient reinforcement must be available to provide motivation for the behaviors. Dentists have in the past been eager to consequate appropriate dental behaviors yet have lacked the necessary control over their patients' reinforcers and consequently have been less than successful. Therefore, some means of gaining control of the reinforcers must be obtained.

In the case of young children who are just acquiring dental hygiene behaviors, the availability of many reinforcers is predominantly controlled by their parents. The development of a triadic model, (Tharp and Wetzel, 1969) as sketched below, would prove invaluable:



The Consultative Triad

Here we see the consultant providing the correct procedures and techniques, the mediator controlling the most powerful reinforcers, and the target whose behavior is to be modified. Applying the triadic model in a dental situation we have either the dentist or the hygienist acting as the consultant providing the necessary dental instruction and procedures, the parent monitoring and providing consequence for the behavior of the target, and the child developing effective dental hygiene habits. The maintenance of the mediator's behavior proves to be the weakest link in the chain. Means of maintaining that behavior might be in the form of a refund for the reduction of dental problems, home visits by the consultant, written correspondence or regular telephone calls.

A study by Hall (1968) showed that telephoning was an effective means of increasing school attendance in delinquent children. By means of regular telephone contact with the parents of the ab-

sentee children, school attendance was reinstated at a normal frequency. Generalizing to a dental setting, it can be hypothesized that regular telephone calls will sufficiently maintain parents' behavior of monitoring their children's dental behavior. Due to the demands upon dentists' time, it does not seem feasible for them to be responsible for the telephoning but hygienists should be able to allocate several hours each week to call the parents of children acquiring new dental habits.

Frequently, problems arise when explaining to parents the importance of their role as mediator. Many parents do not comprehend the correlation between healthy, deciduous teeth and healthy permanent teeth. Frequently, they are unaware that their children are not under the control of long-term contingencies as they are. Telling a child that, 'if he does not properly care for his teeth he will very likely have many cavities and fillings, spend much of his time and money in the dentist's office, and endure great pain and possibly periodontal disease', is not as effective as telling him that, 'if he brushes and flosses correctly tonight, Mom will be very happy and may just give him a treat'.

Parents must, therefore, come to understand that their children are not persistent or completely understanding of long-term concepts, and that they do function under the control of short-term contingencies. Therefore, short-term contingencies must be established until the dental behaviors are under good control in the child's repertoire. An explanation to the parents regarding the effectiveness

of parental approval and disapproval backed up by primary and secondary reinforcers must occur.

The purpose then of the present research is to assess the effectiveness of regular telephoning, in a triadic model situation, in maintaining daily consequence for dental behaviors, in order to achieve plaque reduction.

METHOD

Subjects

Nine boys and six girls enrolled in a regular fourth grade class at the Lincoln Elementary School of Kalamazoo, Michigan served as subjects. Fourth graders were chosen to serve as subjects since their baseline rate of flossing behavior is typically near or at zero, but the manual dexterity essential for proper flossing is present in their repertoires. The experimenter presented the plaque control project proposal to a board of administrators and to the Lincoln School principal and received written permission to proceed from both.

A cover letter seeking permission for children's participation in the project was drawn up and randomly distributed to 60 fourth graders. The letter, in part, follows:

"We would like to invite you and your child to participate in a dental health study being conducted by the school in conjunction with the Kalamazoo Valley Dental Hygiene School.

This study is being undertaken to develop effective preventive dental habits, through interactions between parents and their children and hygienists.

Participants in this program will receive at no cost, instruction in preventive dental hygiene and will have their teeth examined. A home visit by a hygienist will be arranged."

Since an insufficient number of permission slips were returned, 60 additional slips were distributed to the students. When

15 permission slips were returned, the subjects were randomly assigned to one of three treatment groups.

The classification of the 15 subjects by race, sex and socioeconomic level is presented in Table I. The socioeconomic level classification was based on ratings which were obtained by observing such variables as the neighborhood within which the subject's house was located, approximate value of the house, interior conditions and the number of cars belonging to the household. The ratings were made by the experimenter and the hygienist following the initial contact with the subjects in their homes.

The descriptive data on race, sex and socioeconomic level are presented here to indicate the heterogeneity of the subjects included in the study; these data were not utilized in the data analysis.

TABLE I

CLASSIFICATION OF
SUBJECTS BY RACE,
SEX AND SOCIOECONOMIC LEVEL

	<u>Group I</u>	<u>Group II</u>	<u>Group III</u>																
	Black White	Black White	Black White																
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L = Lower socioeconomic level
M = Middle socioeconomic level
H = High socioeconomic level

Hygienist Recruitment

With the intention of recruiting dental hygiene students as volunteers for the present study, the experimenter assisted in a class offered at the Kalamazoo Valley Community College, Oshtemo, Michigan which dealt with the elementary principles of behavior. The class was offered to freshman and senior hygienists. The class met three hours a day, five days per week, for three weeks. The text used was Behavior Modification Procedures for School Personnel by Sulzer and Mayer. Class activities included daily reading assignments, quizzes and lectures, several films, tours and guest lectures. Special emphasis was placed on the application of behavior modification techniques in the field of dental hygiene. The experimenter's role at this point was to grade daily quizzes and to assist during lecture. At the completion of the class, volunteers were called for to work on the plaque control project. Eight hygienists volunteered their assistance.

Independent Variable

The independent variable involved three degrees of instruction and consequence for appropriate dental behavior. It was hypothesized that the following rank order of effects would occur: Treatment I) Treatment II) Treatment III (Control). The complete description of the three treatments is presented in greater detail in a following section.

Dependent Variable

The dependent variable was the number of tooth surfaces which exhibited plaque following the use of a disclosant tablet as measured during the pre-test, and five to eight weeks later during the post-test. Naive hygienists, unaware of which group each subject belonged, recorded the data which were then analyzed by the experimenter.

General Procedure

The study was conducted in the homes of the subjects and in the nurse's office at the Lincoln Elementary School.

Subjects in the information and contingencies group and information only group each received a child's toothbrush, a tube of toothpaste, dental floss and several disclosant tablets. The parents of the subjects in the information and contingencies group were given two charts, one for each month during which the study was conducted. The charts included spaces for indicating daily whether or not the subject had brushed and flossed his teeth and what consequence or lack thereof the parent had presented.

The hygienists utilized wooden tongue depressors, mirrors, flashlights, disclosant tablets and plaque hemorrhage points (PHP) charts*. PHP charts display each of the five surfaces for the thirty-two teeth so that each surface with plaque can be designated.

* See Appendix A

Reliability

Although no reliability measure could be calculated for the dependent variable, another measure was recorded simultaneously for which a reliability coefficient could be obtained. It was not possible to obtain a reliability coefficient for the dependent variable, since it would have entailed two hygienists accompanying the experimenter to each subject's home which was not feasible nor possible to schedule. It was assumed that since the data collection of both measures occurred at the same time, by the same hygienist, that the reliability measures would not differ greatly. The other measure was the number of teeth each subject had as recorded by a hygienist during the pre-test and recorded by a different hygienist during the post-test. The reliability on this measure was computed, using two methods:

- a) the correlation between the number of teeth recorded during the pre-test and the number of teeth recorded during the post-test, and
- b) the percent of the subjects for which there was perfect agreement on the number of teeth for the pre-test and post-test.

The correlation coefficient was .72 and the percent of perfect agreement was .71. Although the calculated reliability coefficients were low, the blind procedure used by the hygienists during the post-test to collect data compensates for the low reliability.

Design

Three treatments were assigned to Groups I, II and III:

I. Subjects in the first group received dental hygiene information on brushing, flossing and disclosing techniques, and contingencies for the daily maintenance of these techniques were programmed by means of regular telephone contact with the parents of the subjects.

II. Subjects in the second group received dental hygiene information on brushing, flossing and disclosing techniques only.

III. Subjects in the control group received no dental instruction or contingencies.

Group I: Information and Contingencies

Pre-Test. Prior to the initiation of the treatment condition, the hygienists telephoned the parent(s) of the subjects and arranged for a visit by the hygienist and the experimenter. At the designated time the hygienist and experimenter arrived at the subject's home, both clothed in proper hygienist uniforms. It was assumed that parents would respond more favorably to the experimenter in the guise of a hygienist than a psychologist. Therefore, the experimenter visited the subjects' homes and school in the attire of a dental hygienist.

The subject was given a disclosant tablet to chew and the number of tooth surfaces displaying plaque was recorded by the hygienist. The subject was then given a toothbrush and instructed in

the Bass technique of toothbrushing. Unwaxed dental floss and instruction on the correct method of flossing were then given to the subject. Finally, disclosant tablets and PHP charts were given to the subject to allow for the recording of his own hygiene behavior. The subject and the hygienist then went into the bathroom to practice brushing and flossing the teeth. During their absence, the experimenter explained the importance of establishing short-term contingencies for dental hygiene behavior to the parent. Information regarding the use of positive schedules, daily inquiry regarding the hygiene behavior, parental approval and/or back-up reinforcers were passed on to the parents. Charts for recording daily dental behavior were given to the parents and their use explained. Instruction for proper toothbrushing and flossing was given so that parents could offer assistance if the subjects required it. When the subjects returned, the hygienist explained to the parents and subjects the correct dietary habits for caries reduction and provided referral advice in regard to any outstanding dental problems they may have had. Finally, the hygienist arranged a time during which she could telephone the parents, and occasionally the subjects, to see if the hygiene behavior was being maintained and whether there were any problems or questions.

Phase I. Phase I was begun immediately after the pre-test and lasted approximately two months. During this time, parental consequence was given daily for the subjects' hygiene behavior. Hygienists telephoned the parents and subjects alternately, one to two times a week during the first month and once every two weeks during

the second month in order to maintain the parents' behavior. The experimenter telephoned the hygienists once a week to maintain their telephoning behavior.

Post-Test. On the final day of the experiment, the number of tooth surfaces displaying plaque out of the total number of tooth surfaces was once again recorded.

Group II: Information Only

Pre-Test. As with Group I, the hygienists telephoned the parents of the subjects and arranged for a home visit by the hygienist and experimenter. At the designated time the hygienist and experimenter arrived at the subject's home, both clothed in hygienist's uniforms. The subject was given a disclosant tablet to chew and the number of tooth surfaces displaying plaque was recorded by the hygienist. The subject was given a toothbrush, unwaxed dental floss, disclosant tablets and instructed in their proper use. The subject's parents were given the same instruction simultaneously so that they could offer assistance if the subjects required it. The hygienist then explained to the parents and subjects the correct dietary habits for caries reduction and provided referral advice in regard to any outstanding dental problems they may have had.

Phase I. Phase I was begun immediately after the pre-test and lasted approximately two months. No contact between the subjects and hygienists occurred. The treatment condition involved no contingencies or consequence but merely the passage of time.

Post-Test. On the final day of the experiment, once again the number of tooth surfaces displaying plaque out of the total number of tooth surfaces was recorded.

Group III: Control Group

Pre-Test. The pre-test consisted of the recording of the number of tooth surfaces displaying plaque out of the total number of tooth surfaces. It was conducted in the nurse's office at the Lincoln School. No instructions in plaque control fundamentals were given and no toothbrushes or floss were distributed.

Phase I. Phase I was begun immediately after the pre-test and involved no contingencies on the subjects' behavior and no contact between the subjects and the hygienists. The treatment condition, therefore, involved no contingencies or consequence but merely the passage of time.

Post-Test. On the final day of the experiment, once again the recording of the number of tooth surfaces displaying plaque out of the total number of tooth surfaces occurred.

RESULTS

The pre-test, post-test, difference and mean difference scores for all three groups are presented in Table II. When these data are analyzed using Dunnett's test on the control versus treatment comparisons, the control versus the information and contingencies group is significant at the .05 level of confidence, see Table III.

While the control versus the information only group comparison is not significant, it can be seen in Table IV that the trend of the difference scores is in the direction that would be predicted on the basis of a logical consideration concerning the effectiveness of the treatment conditions. A regression analysis of the relationship between the difference scores and the treatment level, classified as Group I, II or III, reveals a significant linear trend occurring along these group means, see Table V.

TABLE II

PRE-TEST, POST-TEST, DIFFERENCE AND MEAN
DIFFERENCE SCORES FOR THE NUMBER OF
TOOTH SURFACES EXHIBITING PLAQUE

	<u>Pre-Test</u>	<u>Post-Test</u>	<u>Difference</u>	<u>Mean Difference</u>
Group I	17	4	13	19.8
Information and Contingencies	91	85	6	
	18	9	9	
	67	5	62	
	28	19	9	
Group II	41	16	25	11.8
Information Only	40	19	21	
	33	28	5	
	108	96	12	
	36	40	-4	
Group III	12	8	4	-9.2
Control	42	60	-18	
	54	86	-32	
	31	25	6	
	64	70	-6	

TABLE III

DUNNETT'S TESTS ON THE CONTROL
VERSUS TREATMENT COMPARISONS

<u>Comparison</u>	<u>Differences</u>	<u>Dunnett's Test Statistic</u>
Control vs. Information Only Group I vs. Group II	$11.8 - (-9.2) = 21$	1.86
Control vs. Information and Contingencies Group I vs. Group III	$19.8 - (-9.2) = 29$	2.57*

*Significant at .05 level of confidence

TABLE IV

PRE-POST DIFFERENCE SCORES

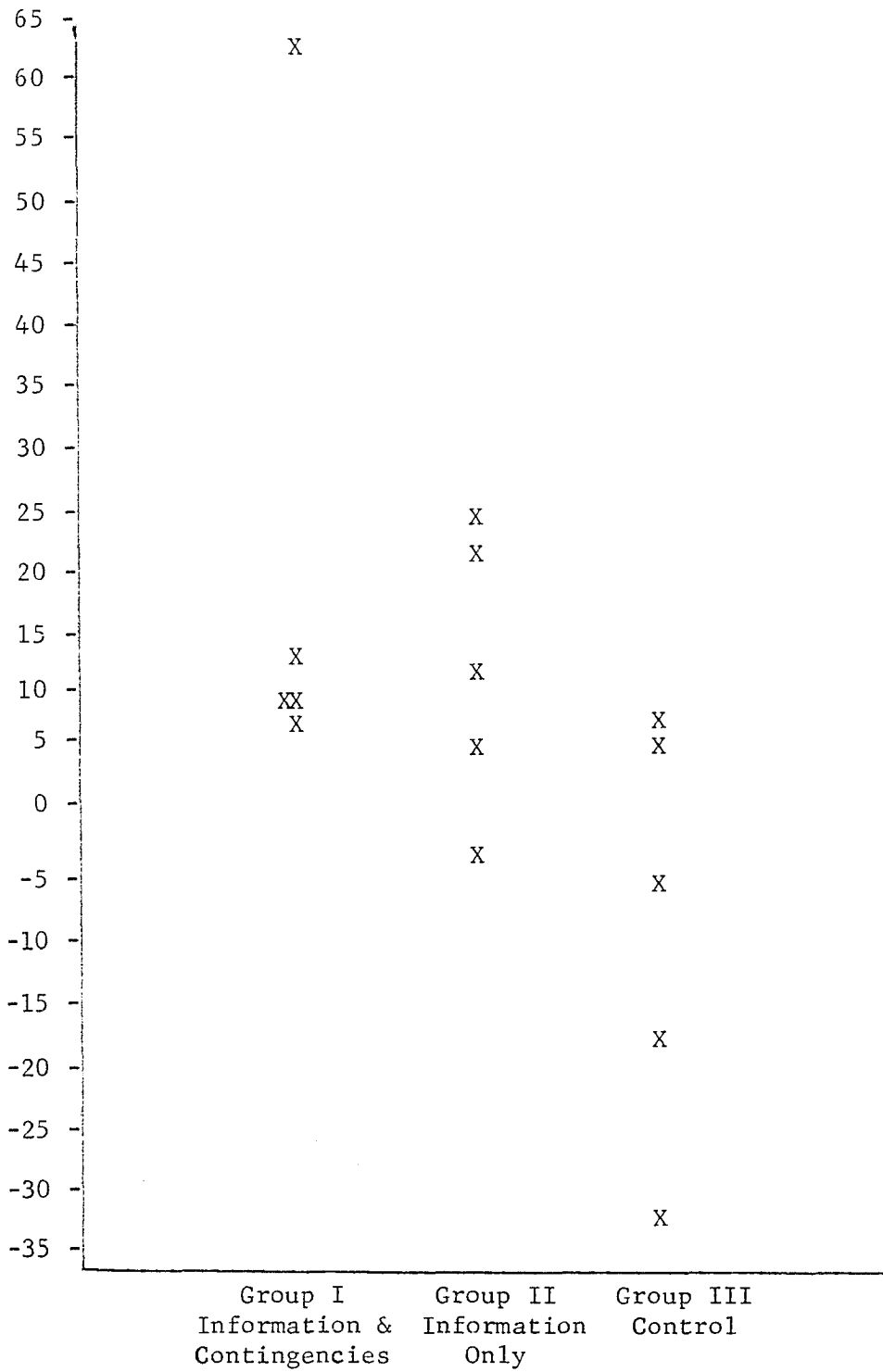


TABLE V

REGRESSION ANALYSIS OF
DIFFERENCE SCORES AND TREATMENT
LEVELS

<u>Source of Variation</u>	<u>SS</u>	<u>df</u>	<u>MS</u>	<u>F</u>
Regression	2102.50	1	2102.50	6.903*
Residuals	3959.23	13	304.556	
Total	6061.73	14		

*Significant at the .025 level of confidence

DISCUSSION

The results of Dunnett's test on the control versus the information and contingencies group comparison indicated a significant difference. These are the results which were hypothesized, that educating the subjects in the correct methods of dental hygiene behaviors and programming ensuing daily consequence for these behaviors, would result in a significant amount of plaque reduction.

In an attempt to determine if there was a relationship between the difference scores and the treatment levels, a regression analysis was computed. The results of that analysis confirm the hypothesized rank order of effects. That is, the amount of plaque reduction was greatest for the group receiving both information and contingencies, was less for the group receiving information only and was actually increased for the control group. This increase in the amount of plaque for the control group was not unexpected. Since subjects in the control group received no dental hygiene information or contingencies, and there was no consequent change in their dental behavior, plaque continued to accumulate and build up on their teeth over the passage of time. Informal verbal reports from the subjects in the control group were that no changes in their dental hygiene habits had occurred since the initial contact with the experimenter and hygienist.

The effectiveness of the contingencies opposed to the information only, is not completely clear in the results, particularly

upon elimination of one subject. It appears, then, that the contingencies were not strong enough to make a significant difference, although presentation of the information did cause a substantial plaque reduction.

The implications of these results when applied to the area of preventive dentistry can be significant to those in the dental profession. Here is a way to maintain effective dental hygiene behavior in their patients, young or old. Through regular telephone contact between hygienists and their patients, or the parents of their patients, effective motivation can be maintained. Biweekly, weekly or bimonthly schedules of telephoning can be arranged. Primary and/or secondary reinforcers in various forms may be utilized for increased effectiveness. Several modifications could be introduced according to the specifications of the particular dentist's office so long as the basic presentation of the correct dental hygiene information occurred and was accompanied with effective contingencies for maintenance of hygiene behaviors.

Suggestions for Further Research

A replication of the present study could be improved by the inclusion of another measurement, that being to ascertain the condition of hemorrhage points. Hemorrhage points are specific areas on the gums where conditions such as the presence or absence of bleeding, coloration, and the firmness and strength of the gums determine whether or not enduring hygiene habits have proceeded. The data on hemorrhage

points can be easily indicated on the plaque control charts. Inclusion of data on the hemorrhage points involves a more thorough examination by the hygienist, additional time and instruments must be employed, and special lighting as found in dentists' offices must be used.

The use of a new form of disclosant which would increase the accuracy with which the plaque is displayed is a liquid rather than a chewable tablet. Frank Kihn, D.D.S., professor of dentistry at the University of Maryland, reports that the liquid form is more uniform in its disclosing properties since the tablets disclose as a function of chewing. If the tablet is not chewed thoroughly, is chewed on one side of the mouth, or is not swished around on the teeth sufficiently, the measurement of plaque is inaccurate.

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APPENDIX A

PLAQUE HEMORRHAGE POINT CHART

PATIENT'S NAME
STUDENT'S NAME

AREAS

PLAQUE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	MAX
HEM																	
HEM																	
PLAQUE	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	MAND

DATE _____

AREAS

PLAQUE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	MAX
HEM																	
HEM																	
PLAQUE	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	MAND