THE PREMACK PRINCIPLE, SELF-MONITORING, AND THE MAINTENANCE OF PREVENTIVE DENTAL HEALTH BEHAVIOUR

by

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ABSTRACT

Preventive dental programs designed to reduce the incidence of gingivitis and periodontal disease have met with only limited success. The advent of behavioural technology offered a possible application to this problem. The present study examined the effects of two behavioural techniques, the Premack Principle and self-monitoring, on the maintenance of preventive dental health behaviour.

Experiment 1 attempted to determine the validity of the Premack Principle using both toothbrushing and flossing as instrumental and contingent responses. Twelve female students of a dental assisting instructional program were exposed to various baseline and contingency conditions of brushing and flossing, daily for 11 weeks, according to a single-subject reversal design. When access to the contingent response was prevented, six of the twelve subjects showed a reliable increase in instrumental responding. Compared to baseline performance, six of seven subjects and four of twelve subjects evidenced reinforcement effects due to a contingency which allowed unlimited and limited access, respectively, to the contingent response. However, increases in instrumental responding observed during these conditions failed to surpass those observed when access to contingent responding was prevented, in all but three subjects. These results would suggest that many observed increases in instrumental responding which are often cited as evidence supporting the Premack Principle may be due in fact simply to the unavailability of the contingent response. Additional theoretical implications of these findings were discussed.

Experiment 2 factorially compared two levels of the Premack Principle (contingency vs. no contingency between flossing and brushing)
with three levels of self-monitoring (no SM, SM-frequency, and SM-frequency plus evaluation). Ninety first and second year university student volunteers were assigned to one of six treatment groups. Instruction in brushing and flossing technique as well as application of the appropriate experimental manipulation was provided in two instructional sessions. Subjects' oral hygiene was assessed according to a gingival index and a plaque index before, one month following, and seven months following instruction. Repeated measures analysis of variance revealed only a significant Assessment effect. All treatment groups showed an equivalent large degree of improvement in oral hygiene from pre- to one month postinstruction. Improved plaque scores were maintained over the six-month follow-up period; gingival scores, however, were not. A no-treatment control group differed from the six treatment groups only at the one-month postinstructional assessment. These results show that instructions to implement a contingency between flossing and brushing, and different levels of self-monitoring, failed to augment the short-term gains in oral hygiene produced by instruction in brushing and flossing technique per se. None of the experimental components differentially contributed to maintenance.

A third and final experiment examined the effect of the Premack Principle on the maintenance of effective brushing and flossing within a private dental clinic. Thirty dental patients were alternately assigned to an experimental Premack Principle group or a control group. Subjects of both groups received two sessions of individualized instruction in oral hygiene techniques. Repeated measures analysis of variance showed only a significant Assessment effect, from pre-to three months postinstruction, only for plaque, but not gingival, scores. Instructions
to impose a contingency between flossing and brushing failed to produce an effect.

The results of this study demonstrated that neither self-monitoring nor instructions to impose a contingency between flossing and brushing contributed to the maintenance of effective oral hygiene behaviour. Self-management programs must become more concerned with the issue of maintenance, particularly following cessation of experimental or therapeutic contact. Implications for maintenance strategies were discussed.
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GLOSSARY\(^1\).

Some of the dental terminology which may be unfamiliar to the reader are defined here.

buccal. Adjacent to the cheek.

calculus. Tartar, the hard mineral deposit on teeth, formed from calcium phosphate and carbonate, and organic matter.

dental caries. Tooth decay, a disease of the calcified structures of the teeth, characterized by decalcification of the mineral components and dissolution of the organic matrix.

desquamation. Peeling off of the epithelial layer.

erythrosine dye. A red dye, used to stain bacterial plaque.

fluoride. A compound of fluorine with another element, which binds with tooth enamel to increase its resistance to the deleterious effects of dental caries.

gingiva(e). The fibrous tissue covered by mucous membrane that immediately surrounds a tooth.

gingival exudate. The outpouring of exudate from gingival tissues, particularly during gingival inflammation.

gingivitis. Any inflammation of the gingival tissue.

interproximal. Between the proximal surfaces of adjoining teeth.

intrasulcular. Within the shallow groove between the gingiva and the surface of the tooth, and extending around its circumference. Intrasulcular brushing pertains to plaque removal from this area.

lingual. Next to, or toward, the tongue.

mandible. Lower jawbone.

material alba. A soft white deposit which forms around the necks of the teeth; composed of food debris, dead tissue elements, and purulent matter; serves as a medium for bacterial growth in the development of plaque.

maxilla. Upper jawbone.

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1. from Boucher (1974).
neutrophil. A mature white blood cell.

Perio-aid. Instrument used in the present study to measure gingival integrity.

periodontal disease (periodontitis). Inflammation of the periodontal tissues resulting in destruction of the periodontal membrane and supporting alveolar bone; a chronic, progressive disease of the periodontium.

plaque. A sticky transparent substance that accumulates on the teeth; composed of mucin derived from saliva and of bacteria and their products.
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INTRODUCTION

Behavioural technology originally found application in the educational and mental health fields. Appropriate and inappropriate classroom behaviours, for example, could be increased and decreased via reinforcement and punishment, or extinction, procedures, respectively. Similarly behavioural intervention has been used to increase socially appropriate behaviours in mental health settings. More recently behavioural technology has found application in the treatment and prevention of physical disorders. The term "behavioural medicine" has been coined to describe this new approach (Schwartz and Weiss, 1977). Health professionals are becoming increasingly aware of the importance of appropriate lifestyle behaviours to the attainment of optimal physical (and mental) health. Excesses and deficiencies are apparent in lifestyle behaviours which detract from optimal physical health. Overeating and lack of exercise are obvious examples. Equally obvious is the need for the development and validation of new behavioural techniques for application to both accelerative and decelerative lifestyle behaviours.

The field of preventive dentistry presents an interesting avenue for the development and application of behavioural technology. Improvement in oral hygiene can be achieved by increasing requisite behaviours such as tooth brushing and flossing. The present study investigated the effects of two behavioural techniques, the Premack Principle and self-monitoring, within the context of a preventive dental program. The following chapters will review the relevant dental literature and the Premack Principle and self-monitoring literatures.
REVIEW OF THE DENTAL LITERATURE

Effects of Bacterial Plaque

Inadequate dental health care has been, and continues to be, a major social problem. The results of epidemiological studies illustrate the widespread prevalence of dental caries and periodontal disease. These are age-related diseases. Typically, dental caries exerts its most deleterious effects on children and adolescents; gingivitis and subsequent periodontal disease become increasingly prevalent in young adults. A recent, large, American survey found that the average number of decayed, missing, and filled teeth more than doubled from 4.0 to 8.7 in children from the age of 12 to 17 years. The most abrupt increase in the incidence of caries occurs between age 18 and 21 (Kelly and Harvey, 1974). A previous U.S. Public Health Service survey found that half of 32,000 six to 17-year-old students sampled had gingivitis (Kelly and Van Kirk, 1965). In Vancouver, 15 to 35 percent of children aged 5 to 19 years have been estimated to suffer periodontal disease requiring treatment (British Columbia Dental Health Survey, 1968). Estimates of periodontal disease are much higher for adults, as prevalence increases with age. Periodontal disease is the major cause of tooth loss past the age of 35 (American Dental Association, 1953). U.S. Public Health Service surveys have estimated that 75 percent of dentulous adults are affected by gingivitis or periodontal disease. This figure continues to rise with increasing age (Kelly and Van Kirk, 1965). The high prevalence of periodontal disease in adult populations has been well established throughout the entire world (Grant, Stern, and Everett, 1968; Greene, 1973).
Periodontal disease, if left untreated, will eventually result in destruction of the periodontium, and subsequent tooth loss. This condition is preceded by gingivitis, or inflammation of the gingiva, which results from irritation by the accumulation of bacterial plaque. The course of periodontal disease has been best observed experimentally in animals. Lindhe, Hamp, and Loe (1973) observed the long-term effects of plaque accumulation in beagles maintained on a diet of soft food. Over the first few days, plaque formed along the gingival margin of each tooth. There shortly followed a rapid increase in gingival exudate and the migration of neutrophils. After four to five weeks of plaque accumulation, clinical signs of gingivitis were observed, including alterations of gingival texture and colour, and an increased tendency to bleed. Finally, loss of connective tissue attachment, or periodontal destruction, became apparent after six to eight months. Periodontal destruction continued over the four-year period of a follow-up study (Lindhe, Hamp, and Loe, 1975). Control animals had plaque removed from their teeth daily, and maintained noninflammatory gingiva and a healthy periodontium over the same time period. Interestingly, the course of periodontal disease was not completely predictable: two of the experimental animals failed to show sub-gingival deposits, and did not evidence periodontal disease.

The course of gingivitis was first experimentally produced in humans by Loe, Theilade, and Jensen (1965). Twelve subjects with initially healthy gingiva ceased all oral hygiene for varying lengths of time. Three subjects developed gingivitis within 10 days. Gingivitis occurred in the other subjects between 15 and 21 days. On resumption of effective oral hygiene procedures, gingival inflammation was resolved in about one week. Additionally, plaque bacteriology went through three distinct stages, each associated with a corresponding stage of
gingivitis. Further bacteriology was associated with age, not thickness, of plaque. Theilade, Wright, Jensen, and Loe (1966) observed a reduction in gingival inflammation as early as one day following resumption of effective oral hygiene, following 21-day plaque accumulation. Gingival inflammation was closely related to plaque accumulation during this period.

There is little doubt that plaque accumulation will produce gingivitis, and that prevention of plaque accumulation will prevent gingivitis (Loe, 1970). While plaque is the primary etiological factor in gingivitis, and subsequently periodontal disease, its role in caries is less certain. It has been suggested that separate mechanisms, both associated with plaque metabolism, are responsible for gingivitis and caries (Lavelle, 1975). Chemical prevention of plaque formation in young adults resulted in a relatively lower Caries Index, even with frequent rinses of sucrose, compared to subjects who allowed plaque to accumulate (Loe, Fehr, and Schiott, 1972). Daily professional flossing of selected teeth in first grade children produced at least a 50 percent reduction in caries incidence, compared to contralateral unflossed teeth, over an eight-month, and a 20-month period (Wright, Banting, and Feasby, 1976, 1977).
Plaque Control Agents

It is apparent from these studies that control of plaque formation can prevent gingivitis and significantly reduce caries incidence. As plaque production is an ongoing process, optimal plaque control would involve disrupting its metabolism before accumulation can occur. Various chemotherapeutic agents, most notably chlorhexidine, have been tested. Twice daily rinsing with a chlorhexidine solution, for example, was found to prevent new plaque formation for 22 days (Loe et al., 1972). While this is a relatively new topic of investigation, recent work is encouraging. Chlorhexidine has been found to be effective in preventing the formation of new plaque, but not effective against existing subgingival plaque, for research periods up to two years (Axelsson, Lindhe, and Waseby, 1976; Nagle and Turnbull, 1978). Earlier reviews, while supporting the effectiveness of chlorhexidine, have also reported a variety of systemic side effects, including gingival soreness and desquamation, and staining of tooth surfaces. Also, chemotherapeutic plaque control agents have a limited spectrum of antibacterial activity. Finally, their long-term efficacy has not been evaluated (Mandel, 1972; Parsons, 1974).

Thus chemical plaque control remains a future, but not present, possibility as a viable public dental health measure. Additional measures have included retarding the growth and accumulation of plaque, and increasing tissue resistance to its deleterious effects. Plaque feeds on sucrose; restricting sucrose intake should therefore retard its accumulation. This in fact does occur, accompanied by a slower rate of caries activity (Loe et al., 1972). However, periodontal disease is rampant in many areas where sucrose intake is
low (Greene, 1973; Mandel, 1972). Plaque has even been observed to accumulate in animals which were tube-fed (Egelberg, 1965).

Assuming that plaque accumulation is inevitable, some attempts have been made to increase tooth and periodontal tissue resistance. Most success has been achieved with a reduction in caries produced by topical or systemic application of fluoride solutions. For example, semiannual topical application of fluoride paste resulted in a significant decrease in caries activity in children over a three-year period (Gish, Mercer, Stookey, and Dahl, 1975). A voluminous literature supports the contention that fluoridating the public water supply will produce about a 50 percent decrease in caries incidence (Davies, 1974).

Unfortunately, fluoride has no similar prophylactic effect on gingivitis (Birkeland, Jorkjend, and Fehr, 1973; Frandsen, McClendon, Chang, and Creighton, 1972). It is also doubtful whether the toxicity of plaque can be reduced nutritionally (Morhart and Fitzgerald, 1976), or whether periodontal tissue immunity to plaque can be increased nutritionally (Alfano, 1976).

The only reliable method of preventing gingivitis and periodontal disease is the regular mechanical removal of plaque from tooth surfaces. Contrary to popular belief, chewing coarsely textured food, such as apples, may produce a decrease in some oral debris, but will not remove accumulated plaque (Birkeland and Jorkjend, 1974; Wade, 1971). Some controversy exists as to the optimal frequency of plaque removal, both for the prevention of gingivitis and the prevention of caries. The evolution of bacterial toxicity through distinct stages associated with age would suggest optimal plaque removal just before toxicity exceeds tissue resistance, or every three to ten days (Arnim, 1971). Preventive programs which recommend plaque removal several times each
day for the prevention of gingivitis are empirically unfounded (Loe, 1971). Alexander (1970, cited in Kelner, Wohl, Deasy, and Formicola, 1974) found that brushing more frequently than once daily had no effect on gingival inflammation. Lang, Cumming, and Loe (1973) found that complete plaque removal every 48 hours maintained healthy gingiva as effectively as plaque removal every 12 hours, over a six-week period (in young adults with previously clean teeth and healthy gingiva). Increasing the interval to three days, however, resulted in a gradual increase in gingival inflammation (Kelner et al., 1974). Thus bi-daily plaque removal appears sufficient to prevent gingivitis, at least in healthy young adults over a short period of observation. Data from a long-term animal study corroborate this conclusion (Saxe, Greene, Bohannan, and Vermillion, 1967). Regarding caries prevention, the data are less clear. For example, many studies have attempted to relate frequency of brushing to a decrease in caries incidence, reporting small but usually insignificant results. Typically, children with good oral hygiene have a lower caries incidence, but the difference is small compared to children with poor oral hygiene (Andlaw, 1978). The lack of clear agreement in studies reviewed by Andlaw and earlier by Heifetz, Bagramian, Suomi, and Segreto (1973) is most likely due to the ineffective method of brushing employed by most subjects studied. Most frequency data are derived from self-report. There is usually no indication of efficacy of plaque removal. When plaque is removed daily, either professionally or under supervision, caries incidence is reduced (Wright et al., 1976, 1977), but this reduction may not be statistically (or clinically) significant (Horowitz, Suomi, Peterson, and Lyman, 1977; Horowitz, Suomi, Peterson, Voglesong, and Mathews, 1976).
At present, bi-daily plaque removal would appear to be sufficient for the prevention of gingivitis. The ontogenesis of plaque into a clinically recognizable substance over 24 hours would suggest the efficacy of its daily removal. The optimal frequency of plaque removal for caries prevention is not known (Heloe and Konig, 1978). There is also a paucity of information on the most effective technique for plaque removal (Suomi, 1971; Heifetz et al., 1973). Preventive programs have typically espoused brushing as the most effective technique for plaque removal, usually without empirical validation. Brushing has been found effective in removing plaque, and hence reducing gingivitis, buccally and lingually, but not as effective in removing plaque from interproximal tooth surfaces (Frandsen, Barbano, Suomi, Chang, and Houston, 1972; Lindhe and Koch, 1967). This is critical because plaque initially accumulates interproximally (McHugh, 1970). A high correlation has been observed between interproximal plaque accumulation and severity of gingivitis (Lang, Ostergaard, and Loe, 1972). As dental floss will effectively clean interproximal surfaces (Richardson, 1975), its use as an adjunct to brushing would seem appropriate. A recent study compared brushing and flossing with brushing alone, in subjects with an initially high incidence of sulcular bleeding. The addition of flossing significantly reduced the number of gingival bleeding sites after eight days (Carter, Barnes, Radentz, Levin, and Bhaskar, 1975).

It has been stated repeatedly that there is no current alternative to the control of gingivitis and periodontal disease by the regular removal of hard and soft deposits from the tooth surfaces (Greene, 1973). Hard deposits must be removed professionally. Soft deposits can best be removed by the appropriate personal use of a toothbrush and dental floss (McHugh, 1970). Gingivitis can be prevented by a
thorough daily removal of all soft deposits from all tooth surfaces (Lang et al., 1973).
Preventive programs designed to reduce the prevalence of dental disease have traditionally approached the problem by introducing the concept of preventive dental health to the community through several avenues, including mass media campaigns, educational campaigns in the school system, and instructional programs in dental clinics. Mass media campaigns have attempted to disseminate dental knowledge to both community and national populations. An example at the community level is the "Dr. Dial" program, a highly-touted program which used a combination of mass media and recorded messages in an attempt to increase public awareness of dental health (De Carlis, 1973; Weiss, Lee, and Williams, 1972). The campaign apparently succeeded with this goal, as a high level of community interest was demonstrated. In the original study, 14 percent of all dental visits were prompted by the program (Weiss et al., 1972). At the national level, the American Dental Association has sponsored television spot announcement campaigns designed for adult and child audiences. Unfortunately there has been no systematic evaluation of these campaigns (Thornton, 1974). The media have also been employed at the national level by commercial interests, to sell products purported to contribute to dental health. While some benefits of such advertising have been observed, such as the increased use of fluoridated dentifrice and the inferred increase in per capita frequency of brushing (Thornton, 1974), the public remains largely misinformed on matters of dental health. Recent surveys, for example, have estimated that 75 percent of adults and even a larger percentage of children, do not realize that plaque is implicated in dental disease (Epstein, Moore, and McPhail, 1974; Linn, 1976). Despite the exceedingly
high prevalence of periodontal disease, National Opinion Surveys conducted in the United States in 1959 and 1965 found that unlike caries, periodontal disease is not considered a personal threat by most people. Also, it is generally believed that satisfactory prevention can occur through regular brushing, in the absence of additional hygiene aids (Putnam, O'Shea, and Cohen, 1967). Such misconceptions are doubtlessly reinforced by the preponderance of advertising for breath sweeteners and toothpaste, which are of dubious value in the prevention of gingivitis and periodontal disease.
Preventive dental programs have existed in one form or another in school curricula for many years (Dollar and Sandell, 1961). Until recently, however, such programs have been supported more by intuition than by empirical data (Rayner and Cohen, 1971; Young, 1970). One program which has been advertised to be advantageous due to low cost and high effectiveness has been the "Toothkeeper" program. Dentists instruct teachers to instruct their students in all aspects of preventive dental health. Recent evaluations of this program have unfortunately failed to demonstrate its efficacy. Smith, Evans, Suomi, and Friedman (1975) and Stamm, Kuo, and Neil (1975) failed to observe significant dental improvement over no-treatment control subjects, at the end of the 16-week program. Graves, McNeal, Haefner, and Ware (1975) observed Toothkeeper subjects to improve slightly on gingival and plaque measures compared to subjects exposed to a traditional dental program. The plaque score, however, showed a less than 10 percent improvement throughout the program. Further, improvement for Toothkeeper subjects was not maintained over a 16-week follow-up. Possible reasons for the poor relative performance of the Toothkeeper program include lack of teacher preparation and lack of provision to transfer oral hygiene skills from school to home (Smith et al., 1975).

One of the earliest studies to validate empirically the effect of dental instruction was performed by Williford, Muhler, and Stookey (1967). High school students were given six lectures on dental health over a three-month period by a dentist. By the end of this period, their performance on the Simplified Oral Hygiene Index (OHI-S) (Greene and Vermillion, 1964), the Periodontal Index (Russell, 1956), the
Dental Health Test (Dental IQ), and self-reported frequency of brushing was significantly better than that of control subjects of a different school. Interestingly, experimental subjects continued to improve over the next three months in the absence of continued dental instruction. Podshadley and Schweikle (1970) found that a one-session lecture/demonstration in brushing given to grade three and four children resulted in slight improvement on the Patient Hygiene Performance (PHP) (Podshadley and Haley, 1968) index, over two-week, and four-month, follow-up periods. However, these scores did not differ significantly from those of a no-treatment control group. The authors concluded that measurement per se contributed to most of the change. Stolpe, Mecklenburg, and Lathrop (1971) presented an intensive 12-week brushing and flossing program to children in grades four, five, and six. The significant improvement in OHI-S scores achieved over the school year regressed during summer vacation to levels below the original scores. The net result over the follow-up period was an increase in dental knowledge, but no or negative changes in dental attitudes and behaviour. Anaise and Zilkah (1976) found that semimonthly booster instructional sessions maintained PHP scores in schoolchildren over a one-year period, regardless of initial instructional format. Control subjects improved over the first month, then regressed. It would be interesting to see whether treatment gains would have regressed following termination of the booster sessions.

Some success has been realized with regular supervision of oral hygiene, particularly when accompanied with reinforcement. Stacey, Abbott, and Jordan (1972) improved oral hygiene in children at a summer camp by means of demonstration, instruction, supervision, feedback, and reinforcement of improved brushing and flossing effectiveness.
Privileges served as reinforcers. Unfortunately there was no control group. Lattal (1969) successfully reinforced toothbrushing in children at a summer camp. Brushing was brought under contingent control of swimming in a reversal design employing eight subjects. In a long term study, children whose brushing was supervised at school for three years showed improvement on the Gingival Index (GI) (Loe and Silness, 1963) and Plaque Index (PII) (Silness and Loe, 1964) at each year end, compared to controls. However, these treatment gains regressed to levels of nonsignificance one year following cessation of supervision (Lindhe and Koch, 1967). It is possible that the supervised brushing of this study failed to provide for transfer from school to home. Horowitz et al. (1977) also failed to observe maintenance of improved plaque and gingival scores over summer vacation, following supervised brushing and flossing over two school years.

Supervision of children's oral hygiene behaviour appears to be effective so long as the supervision is in effect. It is disappointing that maintenance is not realized even following three years of supervision. Other programs have sought to facilitate maintenance with the inclusion of additional treatment components. Albertini, Boffa, and Kaplis (1973) provided what they considered an optimal environment for children to adopt preventive health behaviours. An extensive program which involved children at several conceptual levels of dental health focused on changing dental health behaviours of brushing and flossing, and not attitudes. While the program appeared successful at the end of its 12 week duration, no follow-up data were reported. Martens, Frazier, Hirt, Meskin, and Proshek (1973) differentially reinforced second grade subjects with tokens exchangeable for toys according to the degree of improvement in oral hygiene. Experimental subjects also
participated in dental learning projects. Finally, there was intensive individualized interaction with a dental hygienist. Compared to students exposed to the standard dental curriculum, this highly involving program produced significantly better modified PHP scores, both at project termination and at six month follow-up. Experimental subjects also evidenced a more effective brushing technique.

Albino, Juliano, and Slakter (1977) developed an extensive dental program, which included a variety of instructional and motivational techniques. Experimental subjects received annual dental prophylaxes and additional dental procedures supplemented with instruction in brushing in the first year. A parent-monitored behaviour modification program in which both brushing and flossing frequency and effectiveness were reinforced was added to a modified instructional program. In the third year, peer group leaders were assigned to small groups, which participated in a "belief consistency" program (Rokeach, 1971) designed to reduce inconsistencies between personal values and reported dental health behaviour. The groups also competed with each other for a prize given for the greatest collectively reduced plaque score. Finally, the parent-monitored behaviour modification program was continued through the third year. The experimental group was compared with two control groups, each of which received an annual prophylaxis and dental health lecture. One control group additionally received annual topical fluoride and sealant application. The experimental subjects evidenced slightly but significantly better plaque scores, but not gingival scores, only at the 30-month assessment period, at the end of the third school year. None of the gingival or plaque scores of the other semiannual assessments was significant, compared to control subjects. It is somewhat surprising that such an extensive program would fail
to show differences of greater magnitude. Additional analyses were performed on manipulations made in the third year of the program (Albino, Tedesco-Stratton and Greenberg, Note 1). Students who were classified as leaders according to sociometric measures participated in the home-based behaviour modification program. Postexperimental assessment revealed more oral hygiene improvement in these students, relative to non-leaders who did not participate in the behaviour modification program. It is not clear whether this program, or leadership status assigned to these students, contributed to these results. A more recent study (Albino, in press) compared two behaviour change techniques with traditional instruction and a no-treatment control. Seventh grade students served as subjects. Both an approach designed to reduce inconsistencies between expressed attitudes and actual oral hygiene behaviours and a cognitive behaviour rehearsal technique produced significant reductions in plaque, but not gingival, scores one week following treatment. Only subjects exposed to the belief consistency treatment continued to show improvement at six and twelve weeks following treatment, relative to control subjects. This approach does appear promising. However, as in many such studies, statistically significant group differences often represent differences of negligible clinical import.

The previous studies focused on changing children's behaviour to improve their oral health. When this is combined with frequent professional prophylaxis, excellent results have been reported (Axelsson et al., 1976). Schoolchildren exposed to this regimen showed a significantly reduced incidence of gingivitis and caries over a two-year period. Lindhe, Axelsson, and Tollskog (1975) instructed children and their parents in oral hygiene procedures. During the first two years of this program, children's teeth were professionally cleaned
every two weeks. The frequency of prophylaxis was decreased to every four or every eight weeks during the third year. Both experimental and control subjects brushed under supervision with 0.2 percent sodium fluoride once per month. The experimental program, combining instruction with regular prophylaxis with fluoride application resulted in virtual total elimination of gingivitis and carious lesions. Moreover, excellent oral hygiene standards were established and maintained. Similar results have been reported by Hamp, Lindhe, Fornell, Johansson and Karlsson (1978), who in addition found that regular rinsing with a fluoride solution will contribute to the prevention of caries, but this effect can be greatly enhanced by improved oral hygiene habits.

Most programs which have been designed to optimally prevent gingivitis and caries in children cannot be considered entirely successful. Regular supervision of effective oral hygiene behaviour is effective only so long as supervision is in effect. Oral hygiene skills developed in such programs typically fail to transfer from the school to the home environment (Haefner, 1972). Some attempts have been made to facilitate home transfer by the inclusion of parent participation. These programs have met with some success. Generally, programs which employ a diversity of intervention strategies seem most effective. The Karlstad program of oral hygiene instruction combined with frequent prophylaxis presents encouraging results, particularly when compared with typical remedial treatment, in terms of a cost-benefit perspective (Birkeland and Axelsson, 1976).
Plaque Control Programs: Clinical Settings

In addition to mass media campaigns and school programs, preventive dentistry has sought to exert an influence in the dental clinic. Preventive dentistry became a popular editorial topic in the early 1970's, accompanied by a plethora of "how-to" publications. Characteristically, such writing has not included supportive data. In response to the question: "Which efforts of the dentist have been shown to be effective in inducing preventive behaviours in the patient?", Corah recently replied: "I know of no evidence which demonstrates that dentists have any effect whatsoever." (1974, p. 227). Indeed, the dental literature had been characterized by an absence of evaluation of dental health programs (Burt, 1974). Fortunately this statement is less applicable today than it was several years ago.

One of the earliest preventive dental programs for adults was described by Lovdal, Arno, Schei, and Waerhaug (1961). Fourteen hundred Oslo factory workers were instructed in oral hygiene techniques. Every six months, or three months for those in greater need, subjects received additional instruction as well as professional supra- and subgingival prophylaxis. The 800 subjects who completed the five-year program showed a considerable reduction in gingivitis and tooth loss, compared with expected untreated outcomes. There was no control group. Improvement was positively related to subjects' efficiency of oral hygiene and compliance with instructions. More recently the effectiveness of a similar combined program of regular prophylaxis and instruction has been evaluated (Suomi, Greene, Vermillion, Doyle, Chang, and Leatherwood, 1971). Adult experimental subjects received complete prophylaxis and intensive instruction at two- to four-month intervals.
over three years. Control subjects received only an annual examination. At the end of three years, experimental subjects had cleaner teeth, less gingival inflammation, and a slower rate of apical migration of gingival attachment, compared to controls. A subsequent follow-up examination 32 months later revealed that the original treatment gains were to some extent maintained, although differences between the two groups on some of the indices were now smaller (Suomi, Leatherwood, and Chang, 1973). Such a program appears promising as a public health measure, provided that resources are available. The efficacy of a program combining regular prophylaxis with instruction receives further support from similar programs evaluated in school settings (Axelsson et al., 1976; Hamp et al., 1978; Lindhe et al., 1975). It is difficult to determine the relative contribution of prophylaxis and instruction to the relatively successful maintenance which has been reported in these studies. Possibly it is the interaction between the two factors which is most effective, but this has not been determined.

Much attention has recently been focused on the effect of various modes of instruction on changing oral hygiene behaviour. Durlak and Levine (1975) combined group instruction with individual feedback and evaluation in a program in which oral health improved over a five month follow-up. One important aspect of this program was the emphasis on self-diagnosis in the army outpatient subjects. No control group was employed. When the effects of individual versus group instructional formats were compared in a child dental program, no differences in oral hygiene measures were found. However, individual instruction led to more skill improvement in brushing technique (Anaise and Zilkah, 1976). Radentz, Barnes, Carter, Ailor, and Johnson (1973) found that one showing of video-taped flossing instruction to groups of army
dental patients improved flossing performance. Proficiency was further improved by the addition of one subsequent session of individual instruction (Radentz, Barnes, Kenigsberg, and Carter, 1975). In these two studies flossing proficiency was rated, not determined by its effectiveness in plaque removal. Kois, Kotch, Cormier, and Laster (1978) found that both live and video-taped instruction resulted in equal improvement in PHP scores over a five-week follow-up. Additionally, while subjects' initial dental I.Q., or dental knowledge evidenced by questionnaire data, had some predictive value for the final PHP scores, their initial plaque scores failed to predict final PHP scores. Probably even simpler than video-taped instruction is the use of a self-teaching manual. Zaki and Bandt (1974) reported two experiments which investigated the use of a manual developed at the University of Minnesota. In the first of these experiments, periodontal patients (following a professional prophylaxis) were given a tooth brush and dental floss and allowed to study the manual and practice plaque control skills. They showed significant improvement in PHP scores and a skill performance test score over a two-week period, relative to control subjects given the dental materials only. In the second study, a single session of individual instruction and feedback added slightly, but not statistically significantly, to the treatment gains produced by two sessions of exposure to the self-instructional manual. Improvement was measured in dental hygiene students one week following the last treatment session.

These studies have shown that dental hygiene performance can be improved with relatively minor intervention. Unfortunately most have only employed extremely short follow-up periods. Experience with school dental programs has shown that long-term maintenance is the exception rather than the rule, even after intensive intervention.
A brief program of plaque control instruction is not likely to prove effective over an extended period of time. For example, Legler, Gilmore, and Stuart (1971) reported a significant improvement in plaque, gingival and calculus measures 30 days following a program of chairside dental health instruction. Six months later, initial treatment gains had regressed to near pretreatment levels.

The use of fear appeals, evaluated in studies of attitude change, has also been investigated in the dental area. Janis and Feshback (1953) and Leventhal, Singer, and Jones (1965) found that fear appeals, when coupled with information providing instruction in avoiding feared consequences, leads to an expression of greater intent or attitude, to carry out the desired behaviour. In agreement with Janis and Feshback, Ramirez, Lasater, Anderson, Cameron, Connor, Davis, and Meon (1971) found that low fear messages produced the greatest change in intention to brush and self-reported frequency of brushing. Providing recommendations also increased intention to brush. The high fear message resulted in the greatest information retention. However, all groups improved equally on the behavioural measure of brushing effectiveness. Evans, Rozelle, Lasater, Dembroski, and Allen (1970) included a message which emphasized positive consequences of brushing, with other messages of fear appeals and recommendations. They found that positive communication, and not high fear appeal (Ramirez et al., 1971) produced greatest information retention. Both high fear and low fear messages resulted in greatest intention to brush. While all groups increased their reported frequency of brushing, positive communication and elaborate instruction produced the most oral hygiene improvement. Treatment gains in all groups regressed over the six-week post-communication period. The Evans et al. and Ramirez et al. studies show a discrepancy
between intention to behave, self-reported behaviour, and actual behaviour. It is apparent that the first two measures must be validated by the third, when the focus is on behaviour change. It is possible, however, that the reported discrepancy between reported and actual behaviour is exaggerated, as discrepant measures were used (i.e. frequency vs. effectiveness of brushing). More recently Evans, Rozelle, Noblitt, and Williams (1975) found that none of their manipulations, including fear messages, instructions, and feedback, was any more effective than repeated measurement per se in maintaining plaque scores over 10 weeks.

These reports have typically used didactic instruction as a vehicle for behaviour change. Recently additional techniques have been evaluated. Newcomb (1974) for example, found that dental students who had been instructed in effective oral hygiene procedures successfully served as models to improve oral hygiene scores of their peers, over six weeks. Several studies have evaluated the effects of disclosing for the presence of plaque. This procedure requires the application of a solution which renders visible any plaque remaining on the teeth following cleaning. It thus provides immediate feedback of the effectiveness of oral hygiene procedures. Cohen, Stoller, Chace, and Laster (1972) provided the first evidence that daily disclosing of plaque could significantly reduce plaque scores, even when subjects were not instructed in effective brushing techniques. In this study periodontal patients instructed to disclose for plaque and then brush showed relatively improved PII scores compared to control subjects instructed to brush only, over the six-week experimental period. Both groups equally improved their GI scores. Friedman, Evans, Paver, Bridges, and Burdine (1974) found that plaque disclosure was as effective as,
but no more so than other forms of instruction and feedback in improving PHP scores over an eight-week period. Barrickman and Penhall (1973) found that daily disclosing for plaque significantly added to the effect of instruction alone regarding PII scores. Subjects additionally allowed to graph their GI and PII scores at each of six weekly assessments showed the largest reduction in PII scores, over the six-week period. However, the study employed a very small number of college student volunteer subjects (ns of five and six). All groups showed similar reduction in their GI scores. Too few subjects were available for the 10-week follow-up, but it appears that gingival and plaque scores were regressing toward preassessment levels. Finally, a recent study has reported some promising results of greater patient involvement in their oral hygiene (Godin, 1976). Six periodontal patients taught plaque control procedures, including scaling their own teeth, and given optical devices for plaque disclosure were compared with six subjects who were taught plaque control procedures and who had their teeth professionally cleaned. No differences in gingival scores were observed at any assessment, nor in PHP scores after two-weeks of treatment, but the self-scaling group showed significantly better PHP scores at five months following treatment.

The effects of disclosing for plaque are equivocal. Regular disclosure for presence of plaque appears to be as effective as various instructional procedures on a number of indices of oral health. Monitoring the results of plaque disclosure may increase effectiveness. Adequate maintenance of these procedures has not been clearly demonstrated. Studies which show relative improvement in plaque indices but not gingival indices can not be said to have demonstrated clearly efficacious techniques. Oral hygiene program goals are typically expressed in terms of improving gingival health, thus preventing periodontal disease,
and not in terms of short-term episodic plaque removal.

As is apparent from this review, preventive dental programs have not enjoyed a large degree of success. Inappropriate measures of effectiveness have often been employed. Earlier studies, for example, focused on information retention, attitude change, and self-reported behaviour as dependent measures of program effectiveness. There is little evidence which clearly relates any of these factors to actual preventive dental health behaviour. For example, Evans et al. (1970) and Ramirez, Wershow, and Pelton (1969) found discrepancies between information retention, reported oral hygiene behaviour, and actual oral hygiene scores. There has been little or no relation reported between belief of caries susceptibility, or other dental attitudes, and frequency of visiting the dentist, or self-reported frequency of brushing (Bene, Novasky, and Geldart, 1974; Keleges, 1961, 1974). The patient typically fails to maintain appropriate dental behaviour even when convinced that such behaviour will eventually pay off (Van Zoost, 1975). However, Weigel and Amsterdam (1976) have recently observed an increased correlation between PHP scores and dental attitudes following oral hygiene instruction. There was an initial poor correlation, suggesting that subjects must have a knowledge of appropriate techniques to reduce the often reported discrepancy between attitudes and behaviour. Studies investigating patient personality characteristics have reported that patients who demonstrate an internal locus of control of reinforcement (Rotter, 1966) tend to show a greater orientation toward prevention (Ramirez et al., 1969), and to obtain regular checkups, but do not brush or floss more frequently (Williams, 1972) or show reduced plaque scores (Ayer, Barnes, and Macy, 1973) compared with externals. Measures of self-report have typically not been validated. In the medical literature, estimates
of compliance based on child patients or their mothers' reports of taking essential medication have been shown to be grossly inaccurate, when validated with urine tests (Gordis, Markowitz, and Lilienfeld, 1969). Also, the discrepancy between attitudes and behaviour has been documented in numerous studies in the medical literature, particularly in the area of cancer prevention programs (Green, 1970).

Many preventive dental programs have assumed that immediate change in oral hygiene attitudes, or behaviour, will be maintained. Many dentists have focused on the issue of maintenance by emphasizing the negative long-term consequences of incurring unnecessary pain and extensive dental treatment, or finally losing one's teeth, due to inadequate care. This may produce attitude change, but typically will not produce maintained behaviour change (Corah, 1974). Often aversive control is employed for immediate attitude or behaviour change, but this tends to promote avoidance of the dental practitioner. Gale (1972) reported that fear of the dentist's disapproval ranked third in a list of 25 fears which people have about the dental situation. Also, messages which emphasize the negative consequences of failing to improve oral hygiene habits have not been demonstrated to be any more effective than merely providing information on how to keep one's teeth clean (Evans et al., 1970; Ramirez et al., 1971). Unfortunately, whether emphasizing positive consequences of improved dental habits will maintain behaviour change is questionable. Of the few long-term studies which have been done, most produce improved oral cleanliness and gingival health which tend to be short-lived. Eventual regression to, and often beyond, pretreatment status is typical (See Shulman, 1974, and Suomi, 1971 for additional reviews).
Focusing on delayed consequences, whether positive or negative, is unlikely to contribute significantly to behaviour change. Immediate consequences are much more salient to the control of behaviour (Mahoney and Thoresen, 1974; Thoresen and Mahoney, 1974). Putnam et al. (1967) have suggested that preventive dental behaviour is difficult to promote because it fails to meet any immediate need. National Opinion Surveys of 1959 and 1965, for example, showed that, unlike caries, periodontal disease is not viewed as a personal threat by most people.

If any preventive dental procedure is likely to be effective, it must reinforce behaviour which is requisite to the maintenance of dental health, i.e., brushing and flossing. The use of naturally occurring reinforcers would seem best suited for the promotion of maintenance. For example, it is possible that one dental behaviour could serve to reinforce another, so that both would be maintained. Brushing is typically performed much more regularly than flossing (Linn, 1976; Young, 1970). As both activities are complementary for optimal oral health, maintenance of flossing may be established by using brushing as a reinforcer. A contingent arrangement between flossing and brushing is scarcely different from a normal contiguous arrangement, which would be expected to facilitate its implementation. This type of contingency, in which one behaviour reinforces another, has been researched in the behavioural literature as the Premack Principle.

An effective preventive dental procedure should also produce good generalizability from the training environment to the home environment. Oral hygiene performance is usually evaluated in the training environment. The dental patient could be trained to evaluate his own performance regularly at home, with subsequent intermittent professional evaluation. This could be accomplished by self-monitoring, which requires the
monitor to systematically observe and record his own behaviour. Self-monitoring provides an opportunity for the evaluation of a particular target behaviour, and seems appropriate for application to brushing and flossing. In addition to providing the monitor with performance feedback, self-monitoring records can also be evaluated by dental health professionals. The use of self-monitoring as a behaviour change technique has been the topic of much recent research, which will be described following a discussion of the Premack Principle.
PREVIEW OF THE BEHAVIOURAL LITERATURE

Premack Principle

It has been reported reliably in the experimental operant literature that a contingent relationship between responses of differing probability of occurrence is analogous to a response-reinforcement relationship. According to Premack, "For any pair of responses, the more probable one (contingent response) will reinforce the less probable one (instrumental response)" (1965, p. 132). This principle of behaviour has been called the differential-probability hypothesis, and is more commonly known as the Premack Principle.

Premack’s early work led him to question seriously the traditional assumption of trans-situationality of reinforcement, and later, punishment. For example, by experimentally manipulating the relative probability of running and drinking in rats, Premack (1971) showed that running could both reinforce and punish drinking. Premack suggested that reinforcement value may be predicted by assessing differential momentary response probability. This concept is critical to the Premack Principle. Momentary response probability may be assessed by calculating the ratio of the actual duration of responding to the possible duration of responding in a free-operant environment (Premack, 1971). In the case of running reinforcing drinking, for example, running occurred for a longer duration than drinking in a situation where both responses were equally possible. Reinforcement effects were obtained by arranging a contingency between drinking, the instrumental event, and running, the contingent event. Punishment occurred simply by reversing the probability ratio between these two responses, by means of imposing water deprivation.
The Premack Principle would appear to lend itself admirably to clinical application. Reinforcers derived from the client's behavioural repertoire could be contingently arranged to increase desired instrumental behaviour. Indeed, the classroom management and self-management literatures are replete with supposed application of the Premack Principle. For example, Homme, De Baca, Devine, Steinhorst, and Rickert (1963) have unsystematically observed that high probability behaviours such as running and screaming, which are traditionally punished, can successfully reinforce sitting and attending to the blackboard, in nursery school children. Hosie, Gentile, and Carroll (1974) successfully reinforced school children's report writing by contingent arrangement of a preferred activity, painting or clay modeling. Relative preference was determined by time spent in each activity during a free-time period. Contingent preferred activity produced both an increase in speed of report writing and a larger number of students completing the report, compared with the less preferred contingent activity. With institutionalized patients, a variety of behaviours has served as reinforcers, often through the medium of tokens (Ayllon and Azin, 1968). Mitchell and Stoffelmayr (1973) observed that low-frequency work behaviour, of two chronic schizophrenics resistant to traditional reinforcers, increased following the application of contingent sitting, which normally occurred at very high frequency. Within self-management programs, frequently occurring behaviours such as smoking, drinking, eating, washing, thinking, and urination have been employed as contingent events to reinforce increases or decreases in various behaviours congruent with subjects' goals. These studies are reviewed extensively by Danaher (1974), Johnson and Elson (Note 2), and Knapp (1976).
Despite extensive experimental validation of the principle in experimental animal studies (e.g., Premack, 1965, 1971), similar validation has not been observed conclusively in human application (Danaher, 1974; Knapp, 1976). This conclusion is based on methodological deficiencies inherent in attempts of human application. Premack (1965) specified several methodological constraints. The responses under consideration must be intrinsically maintained, that is, performed for their own sake and not for the subsequent presentation of another stimulus. Their relative momentary probability must be assessed within a free-operant environment. Their reinforcing value must be shown to be reversible, i.e., each of the paired responses must be shown to be capable of reinforcing the other, depending upon their relative momentary response probability. Finally, and perhaps most importantly, an increase in performance of the instrumental event must be accompanied by a decrease in performance of the contingent event, relative to baseline rates.

A survey of the applied literature invoking the Premack Principle shows that all of these constraints have been violated. For example, most application studies in the coverant (covert operant) control literature (e.g., Homme, 1965) reviewed by Danaher (1974) and Johnson and Elson (Note 2) have employed contingent responses that are extrinsically maintained. Also, response frequency and subjective preference have often been interchanged with momentary response probability. When attempts have been made to assess momentary response probability, they have often done so inappropriately by obtaining average response probability data. In application studies reviewed by Knapp (1976), no demonstration of reinforcer reversibility was made. Most important, according to Knapp, is the neglect to control for the increase in the instrumental event due simply to the removal of the opportunity to perform the contingent event.
The importance of including this control procedure is evident by the results of an experiment reported by Premack and Premack (1963), in which rats increased their normal daily food intake when deprived of the opportunity to run in an activity wheel. Only two studies have included this critical control, and their results were contradictory to each other.

In the first of these studies, Eisenberger, Karpman, and Trattner (1967) instructed college student subjects not to perform the more probable response (turning a wheel, for most subjects), during free opportunity to perform the less probable response (bar pressing). Compared to baseline rates, duration of low probability responding decreased. When wheel turning was made contingent on bar pressing, reinforcement effects were observed only with subjects whose baseline instrumental response rate was low, and whose contingent response rate was suppressed by the contingency. More recently, Robinson and Lewinsohn (1973) reinforced depressed subjects' low frequency verbal behaviour with the opportunity to emit high frequency depressive talk. While this contingency appeared to produce an increase in low frequency talk over baseline and control group rates, the difference was statistically similar to that observed in the deprivation control group, in which high frequency depressive talk was prevented.

It is not entirely certain, therefore, that positive Premack Principle results are actually due to the contingency in effect in applied studies. Simply depriving subjects of the opportunity to perform high probability behaviour resulted in a decrease in low probability behaviour in the Eisenberger et al. study and an increase in similar behaviour in the Robinson and Lewinsohn study. Clearly these discrepant findings warrant further investigation.
The large number of methodological shortcomings inherent in attempts of application of the Premack Principle exemplify the difficulty of strict adherence to Premack's original constraints. Perhaps most difficult to realize in practical application is the accurate assessment of momentary response probability. Premack (1971) has outlined three procedural problems likely to invalidate response duration as a measure of momentary probability. Responses may have a different rate of decay within a session. For example, fatigue may differentially affect two responses of differing physical requirement: Second, parameter values used during contingency sessions should equal those observed during baseline. Finally, response duration may distort the probability of those responses whose frequency is small but preference is large. Copulation may serve as an appropriate example of this situation.

Considering the difficulties involved, it is doubtful whether the original formulation of the Premack Principle could ever realize general applicability in clinical situations. A recent reformulation of the Premack Principle has suggested that the concept of momentary response probability, as well as being difficult to assess, is also unnecessary. Allison and Timberlake (1974) successfully reinforced rats' 0.4% saccharin licking with access to 0.3% saccharin. While 0.4% saccharin licking increased during the contingency, it was not clear whether this was truly a reinforcement effect since not all the available 0.3% solution was consumed. This issue was resolved and the results extended in a subsequent experiment when rats were required to lick 0.1% saccharin contingent on 0.4% saccharin licking. The weaker solution again served as the contingent response. In both experiments, rats preferred the 0.4% solution. Thus a contingent low probability response successfully reinforced an instrumental high probability response. Further, it was shown that reinforcement was not due simply to a restriction of the 0.1% solution.
There is additional evidence to question the validity of Premack's differential probability hypothesis. In the previously described study of Eisenberger, Karpman, and Trattner (1967), college student subjects increased their high probability wheel turning when contingent low probability bar pressed was reduced below operant rate. Marmaroff (1968, cited in Dunham, 1977) found that reinforcement occurred with rats' running and drinking, one reinforcing the other, only when the contingency imposed a reduction in the rate of contingent responding. This was the case when either response was made contingent on the other, regardless of relative probability. Also, Allison and Timberlake's (1974) results obtained with time held constant have been extended to a situation in which the amount of responding was held constant (Allison and Timberlake, 1975). In this study, rats' latency to respond instrumentally decreased when the contingency imposed an increased latency to respond contingently. Finally, Bauermeister and Schaeffer (1974) obtained a reversal of reinforcement relation within a single session. Three rats which were 23-hour water deprived initially preferred licking, then subsequently preferred running. In the first subsession, a run to lick contingency produced an increase in running with a concomitant decrease in licking. A similar reversal of results occurred in the second subsession, when running was contingent on licking. While these data were used to support the importance of accurate assessment of relative momentary response probability, they also present an additional example of reinforcement accompanied by a reduction in contingent response rate.

Premack (1965) recognized that an increment in instrumental responding is typically accompanied by a decrement in contingent responding. He further posited that contingent response reduction is necessary for reinforcement to occur. It now appears that contingent response reduction
may also be sufficient for the occurrence of reinforcement. This conclusion has given rise to the response deprivation hypothesis of reinforcement. Response deprivation occurs "if the animal, by performing its baseline amount of the instrumental response, is unable to obtain access to its baseline amount of the contingent response" (Timberlake and Allison, 1974, p. 152). Dunham (1977) has outlined a similar position, calling it the optimal duration hypothesis. This hypothesis involves two important properties of responding: burst duration, the amount of time spent responding once the subject enters that state, and interburst interval, the amount of time observed between successive bursts of responding. According to Dunham's optimal duration model, reinforcement will occur when the contingency imposes either a decrease in burst duration or an increase in interburst interval, of the contingent response. Similarly, punishment will result from an increase in burst duration or a decrease in interburst interval, of the contingent response. Although, according to Dunham (1977), supportive data are not yet available, the optimal duration model nevertheless offers an attempt to operationalize Premack's notion of "momentary probability", and thus more accurately specify conditions which will produce an increase, a decrease, and no change in instrumental behaviour.

Both the response deprivation hypothesis and the optimal duration hypothesis obviate the need to invoke the concept of differential momentary response probability as an explanation for reinforcement. Response deprivation or optimal duration would appear to be better suited to clinical application due to their relative ease of assessment, as well as their empirical utility. However, the optimal duration hypothesis is as yet lacking experimental verification. Also, the effects of simply restricting access to the contingent stimulus have not been adequately controlled in
studies purporting to support the response deprivation hypothesis. This critical control, discussed earlier, has been shown to produce increases, decreases, and no change in instrumental behaviour. Clearly this issue should be resolved.
Self-monitoring was initially used in the behavioural self-management literature as a convenient data collection device. It was particularly appropriate when the target behaviour occurred at very low frequency, or when the target behaviour was inaccessible to an external observer, such as with thoughts. However SM was occasionally observed to alter the frequency of the target behaviour, usually in a clinically favourable direction. For example, SM has been observed to produce increases in studying (Broden, Hall, and Mitts, 1971; Johnson and White, 1971), college students' performance in a programmed learning task (Mahoney, Moore, Wade, and Moura, 1973), oral class participation (Gottman and McFall, 1972), maternal attention to appropriate child behaviour (Herbert and Baer, 1972), number of study questions attempted by college students (Kazlo, 1976), and compliance with drug taking (Epstein and Masek, 1978). Similarly, SM has been shown to produce decreases in a variety of decelerative behaviours, including disruptive classroom behaviour (Broden, et al., 1971), face-touching (Lipinski, Black, Nelson, and Ciminero, 1975), and eating (Romanczyk, Tracey, Wilson, and Thorpe, 1973; Stuart, 1971). Additionally, the literature abounds with case studies demonstrating reactive effects of SM (see Nelson, 1977, for a recent review).

These observations of the reactivity of SM suggest that SM may prove more useful as a behavioural self-management technique than as a reliable measuring device. However, the literature also contains numerous examples of non-reactivity of SM. Ballard and Glynn (1975), for example, found that self-reinforcement (SR) increased children's writing behaviour, where SM did not. Greiner and Karoly (1976) found that neither SM nor SM combined with SR improved college students' study
behaviour more than training in a standard study method. When compared to additional self-management procedures, including relaxation training and environmental planning, SM failed to decrease frequency or severity of migraine headaches over a 60-week study (Mitchell and White, 1977). Sutherland, Amit, Golden, and Roseberger (1975) reported that SM had no effect on rate of smoking, independent of subjects' motivation to quit. Finally, weight control programs have reported discrepant results of SM. Stollak (1967) found that SM eating habits over eight weeks in the absence of experimenter contact failed to produce weight loss. Stollak obtained within- and between-group replications of this finding. When female subjects who had been members of TOPS (Take Off Pounds Sensibly) for the previous three months were instructed to self-monitor their daily weight, a slight group weight gain was obtained. Subsequent self-monitoring of both food and daily weight continued to produce weight gain (Hall, 1972). Mahoney, Moura, and Wade (1973) found that self-monitoring daily weight, and adaptive and nonadaptive eating habits and thoughts was ineffective in producing weight loss, compared to self-consequation. However, Mahoney (1974) found that self-monitoring daily weight and eating habits during a two-week baseline was reactive. Subsequent SM plus the addition of performance goals maintained this initial weight loss. There is additional evidence that SM will contribute to weight loss only when appropriate target behaviours are monitored. This issue will be discussed later.

Falling between the extremes of observations of reactivity and non-reactivity of SM is the observation that the effects of SM can attenuate following an initial period of reactivity. Stuart (1971) reported one of the earliest positive instances of reactivity of SM with weight loss, but this effect attenuated over time. Subjects self-monitored
their eating habits over a five-week baseline period, with an associated mean weight loss of 4.5 lb. Most weight was lost during the first week. Fixsen, Phillips, and Wolf (1972) found that both peer monitoring and SM produced initially reactive but transitory increases in delinquent boys' room cleaning behaviour. Self-reports of great improvement were obtained, but actual improvement was extremely short-lived. Similarly, Layne, Rickard, Jones and Lyman (1976) reported initial but short-lived improvement in "cleanup" in behaviour disturbed children.

At this point, it seems inappropriate to question whether SM is a reactive process... Little understanding of the variables underlying the reactivity of SM can be gained simply by enumerating positive and negative instances of reactivity (McFall, Note 3; Nelson, 1977). The variability of results of studies employing SM is perhaps best typified by a study performed by Zimmerman and Levitt (1975). They asked 14 therapists to instruct clients to self-monitor, via wrist counters, a variety of specific target behaviours for two weeks. Sixteen of 22 clients reported to have benefitted from SM, expressing either increased awareness, knowledge, or understanding about the target behaviour. Behaviour change occurred with eight of the 22 clients. Recent research has actively sought to delineate specific variables which may contribute to the reactivity of SM.

### Variables Contributing to the Reactivity of SM

**Nature of the monitored behaviour.** Some studies have demonstrated different degrees and directions of reactivity due to SM, depending on the target behaviour being monitored. Gottman and McFall (1972) instructed high school students to monitor either their instances of oral class participation or their instances of unfulfilled urges to
participate. Monitoring participation resulted in an increase in that behaviour; monitoring urges produced decreased participation. Similarly, Herbert and Baer (1972) found that maternal attention to appropriate child behaviour increased due to SM and instructions. When the target was inappropriate child behaviour, instructions and SM failed to produce a decrease in attention. Also, Nelson, Hay, Hay, and Carstens (1977) reported small increases in positive statements, and negligible decreases in negative statements, when teachers self-monitored positive or negative statements in class, in the absence of instructions to change. The importance of specificity of the monitored response was demonstrated by Johnson and White (1971), who observed college students' academic grades to improve significantly only when study behaviour was monitored. Self-monitoring of dating behaviour and no SM failed to produce a similar increase in grades. Peacock, Lyman, and Rickard (1978) found that SM was reactive only with easy room-cleaning tasks, and not more difficult tasks, performed by boys at a summer camp. Differing degrees of reactivity depending on the target behaviour were reported by Hayes and Cavior (1977), in what was reportedly the first study to demonstrate the effects of multiple response monitoring. Self-monitoring was increasingly reactive with verbalizations containing value judgments, verbal nonfluencies ("um", "ah", etc.), and most reactive with face touching. This would suggest the existence of a continuum of reactivity, possibly along the dimension of response specificity. Face touching may be more obviously discrete than verbalizations containing value judgments. Additionally, Hayes and Cavior found that monitoring one behaviour was more reactive than concurrently monitoring two or three.

Two studies compared the effects of self-monitoring cigarettes smoked with self-monitoring urges to smoke. McFall (1970) modeled smoking
at the beginning of each class during which students self-monitored. According to unobtrusive records kept by non-smoking class members, SM resulted in an increase in smoking in the SM-smoking group, and an insignificant decrease in smoking in the SM-urges group. None of the subjects had expressed a desire to reduce their smoking. Self-monitoring may have contributed to an increase in both monitored behaviours, if one assumes that the slight decrease in smoking evidenced by the SM-urges group was accompanied by an increase in the frequency of successfully resisted urges. These results have been criticized, however, as due to possible demand characteristics of the differential instructions (Orne, 1970). More recently Karoly and Doyle (1975) reported that SM-smoking and SM-urges were equally reactive in decreasing smoking in subjects who had expressed no desire to quit smoking. However, the self-monitored data of this study may have been inaccurate, as no reliability checks were performed.

Differential reactivity of target behaviours is perhaps most apparent in studies of weight control. Mahoney, Moura, and Wade (1973) asked overweight subjects to self-monitor daily weight and adaptive and maladaptive eating habits and thoughts. At the end of four weeks, these subjects lost slightly, though not significantly, more weight than control subjects. In a subsequent study, Mahoney (1974) found that self-monitoring of daily weight and eating habits (food quantity and quality, and situational determinants) during a two-week baseline phase produced equally significant weight loss in the three experimental groups performing this task. Similar results have been reported by Stuart (1971). When subjects self-monitored number of bites, with instructions to decrease this frequency, weight loss equalled that of subjects exposed to an
intensive self-management program (Hall, Hall, Hanson, and Borden, 1974). Joachim (1977) found that self-monitoring of daily food and drink intake was associated with weight loss in a mildly retarded female, whereas self-monitoring daily weight was ineffective. This case study has received empirical corroboration in studies which demonstrated the superiority of self-monitoring caloric intake over self-monitoring daily weight (Romanczyk, 1974), and over self-monitoring discriminative stimuli associated with eating (Green, 1978). Self-monitoring caloric intake was as effective as additional self-management procedures over a four-week training period. While a complete self-management program was most effective over a 12-week follow-up, SM continued to produce substantial weight loss (Romanczyk et al., 1973). These data suggest that SM is most reactive when the target behaviour is easily discriminable and relevant to the subject.

**Timing and schedule of self-monitoring.** Several studies have attempted to determine whether SM is differentially reactive when it is performed either before or after the target behaviour. Kanfer (1970a) has predicted that premonitoring a clinically relevant target behaviour would produce more change than postmonitoring, as the chain of events associated with that behaviour would be interrupted early, allowing for the emission of a more appropriate alternative. Cavior and Marabotto (1976) obtained partial support for this prediction. Self-monitoring videotaped verbal interaction before a test interaction was more reactive than monitoring during the test interaction, but only for verbal behaviour designated by the subjects as negative. Opposite results were obtained for positive verbal behaviour. Bellack, Rozensky, and Schwartz (1974) found that premonitoring food intake (description of food, stimuli
associated with eating) produced marginally more weight loss than post-monitoring, at six-week outcome and three-month follow-up. Rozensky (1974) reported similar results in a case of smoking cessation, based on self-report data, although the treatment sequence was confounded. Two studies, however, stand in disagreement with Kanfer's prediction. Green (1978) reported that pre- and postmonitoring produced no differential effect with either caloric intake or discriminative eating stimuli. Also, Nelson, Hay, and Koslow-Green (1977, cited in Nelson, 1977) found no differential effect of pre- or postmonitoring appropriate or inappropriate classroom verbalizations in young children.

If the schedule of SM affects behaviour in a manner similar to schedules of reinforcement (e.g., Ferster and Skinner, 1957), one would predict that continuous SM would produce greatest initial reactivity, while intermittent SM would produce greatest resistance to extinction. Only two studies have compared the effect of schedules of SM. Mahoney, Moore, Wade, and Moura (1973) reported longer time spent in a learning task due to continuous monitoring compared with recording every third correct response. However, no differences occurred in the other dependent measures of number of problems completed or accuracy of performance. Frederiksen, Epstein, and Kosevsky (1975) found that continuous SM produced greater smoking reduction than daily or weekly monitoring. Unfortunately continuous monitoring was also associated with the greatest degree of subject attrition, possibly due to the aversive nature of the task requirement. Further, initial differences were reduced to nonsignificance at six months follow-up.

Accuracy of self-monitoring. As SM was initially used as an assessment technique, accuracy was of major concern. As a therapeutic
device, accuracy of SM may be unimportant, or even irrelevant. Studies attempting to corroborate the accuracy of self-monitored data have reported varying discrepancies of reliability. Fortunately for clinical utilization of SM as a behaviour change technique, there has been unanimous observation that reactivity occurs independently of accuracy, or reliability. Reactivity of SM has been found to be unrelated to accuracy with face-touching (Lipinski and Nelson, 1974; Nelson, Lipinsky, and Black, 1975), verbal behaviour (Hayes and Cavior, 1977), maternal attention to child behaviour (Herbert and Baer, 1972), and children's classroom behaviour (Broden et al., 1971; Kaufman and O'Leary, 1972). In these studies self-monitored data were compared with external observations. The Hayes and Cavior study reported a considerably reduced frequency of nonfluencies due to SM despite a reliability estimate between self-recorders and observers of .00. Intensive training in SM and contingencies favouring increases in agreement between self-recorders and observers have produced increases in the accuracy of SM, but no concomitant change in reactivity (Bornstein, Mungas, Quevillon, Knivila, Miller, and Holombo, 1978; Fixsen et al., 1972; Lipinski et al., 1975; Nelson, Lipinsky, and Boykin, 1978).

Epstein, Miller, and Webster (1976) observed subjects' respiration rates to decrease quite dramatically during SM. When required to perform a concurrent reinforced task, percentage of SM errors more than doubled. Respiration, however, remained at the same low rate as during the SM-only condition, despite the increase in SM errors. It is apparent, then, that reactivity of SM is virtually unrelated to the accuracy of the self-recorded data.

**Instructions.** Early studies (e.g., McFall, 1970) have been criticized for possibly confounding the effects of SM by creating demand characteristics due to differential instructions (Orme, 1970). Even when experimental
instructions are held constant, subjects may create their own implicit expectations for behaviour change due to the experimental situation (Kazdin, 1974b). Herbert and Baer (1972), for example, confounded SM with instructions to change the frequency of the target behaviour in a particular direction. Nelson et al. (1977) found that instructions augmented the marginal changes in teachers' use of positive and negative classroom statements. Karoly and Doyle (1975) factorially compared self-monitoring urges to smoke versus self-monitoring completed cigarettes with high versus low expectancy that SM would produce a decrease in cigarette consumption. Subjects were college students who expressed no desire to quit smoking. Only the expectancy manipulation was significant.

While these studies suggest that SM may be reactive due to instructions, additional data would dispute this contention. Self-monitoring has been observed to produce consistent decreases in face-touching (a negatively valued behaviour) by college students, despite varying conditions of expectancy imparted to the subjects before monitoring (Nelson et al., 1975). These results have been extended to the target responses of eyeblinking (Hutzell, 1977) and use of first person pronouns (Nelson, Kapust, Dorsey, and Hayes, 1977, cited in Nelson, 1977). In this latter study, instructions to alter the rate of first person pronouns were effective only in the absence of SM. When subjects self-monitored, instructions had no effect. It appears, then, that instructions, expectations, or experimental demand may augment the reactivity of SM. However it is doubtful whether the reactivity of SM can be explained by these effects alone.

**Valence of the monitored behaviour.** The general observation of changes in self-monitored behaviours in a clinically desirable direction suggests that the valence of the monitored behaviour may contribute to
reactivity. Broden et al. (1971) reported an increase in appropriate study behaviour in one student and a decrease in inappropriate talking out in another. Single subject reversal (ABA) designs attributed behaviour change to SM. When two teachers were asked to monitor their frequency of positive and negative statements in class, a small increase and negligible decrease in these behaviours occurred, respectively, compared to baseline frequency (Nelson, Hay, Hay, and Carstens, 1977). Several studies have found that SM is only initially reactive with boys' room-cleaning (Fixsen et al., 1972; Layne et al., 1976; Peacock et al., 1978). If behaviour must be positively or negatively valued for change to occur, these results are consistent, as peer reports have determined that room-cleaning is neutrally valued (Peacock et al., 1978). When the valence of room-cleaning is increased by the imposition of a contingency, a predictable increase in this behaviour occurs (Layne et al., 1976).

Experimental manipulations extend the observations that the valence of SM contributes to reactivity. Cavior and Marabotto (1976) observed self-monitored verbal behaviours to change according to the valence attributed to them by the subjects themselves. A weak relationship between valence and reactivity was reported by Hayes and Cavior (1977), whose subjects self-monitored, in different combinations, face-touching, verbal nonfluencies, and value judgments. Relative valence was determined by subjects. Self-monitoring has also been observed to change behaviour in the predicted direction when different valences were assigned identical target behaviours, namely the use of first person pronouns (Kazdin, 1974a), and eyeblinking (Sieck and McFall, 1976). Finally, Nelson, Lipinsky, and Black (1976a) asked adult retarded subjects to self-monitor their rates of face-touching, object-touching, and talking. These
behaviours were depicted as undesirable, neutral, and desirable, respectively. Relative to base rates, these behaviours changed in the predicted direction, i.e., face-touching decreased, talking increased, and object-touching did not change.

**Subject motivation.** Related to the issue of valence is motivation for behaviour change. Early reports of reactivity due to SM were derived primarily from the clinical literature. Self-monitoring, or any clinical procedure for that matter, would be expected to contribute to behaviour change congruent to the client's goals. Indeed, there is no evidence that SM has contributed to behaviour change in a direction contrary to a client's, or subject's, motivation. McFall found that subjects of one study who were motivated to quit smoking decreased their smoking rate regardless of the SM procedure employed (McFall and Hammen, 1971), while in another study, self-monitoring number of cigarettes smoked actually increased frequency of smoking in unmotivated subjects (McFall, 1970). A more appropriate comparison was made by Lipinski et al. (1975), who induced an expectancy that SM would produce smoking reduction in subjects motivated and unmotivated to quit smoking. Only the motivated subjects reduced cigarette consumption. Unfortunately, in this study there was no corroboration of the self-report data upon which the conclusions were based. Such corroboration was provided, however, by Komaki and Dore-Boyce (1978), who observed that SM produced an increase in classroom participation only in those subjects highly desirous of such change. Further verification of the necessity of motivation for the reactivity of SM would be provided by experimenter manipulation of subject motivation.

**Consequences of SM: Performance Goals, Feedback, and Reinforcement.** Self-monitoring may be reactive due to its function of providing explicit
feedback regarding performance to the monitor. On the basis of knowledge
derived from such feedback, the monitor can compare current performance
with a performance goal, and then make necessary adjustments to reduce
the discrepancy. Performance which is consistent with the performance
goal may be reinforcing to the monitor (Kanfer, 1970, 1975). For example,
Richards (1975) found that self-monitoring the number of hours studied
and pages read on a cumulative graph produced a larger increase in studying
than other self-management procedures. Contrary to the results of
other weight control studies, Fisher, Green, Friedling, Levenkron, and
Porter (1976) reported that self-monitoring daily weight produced a
mean weight loss of 9.6 lb. (range 0-26 lb.) over an average 39 days in
11 subjects. This weight loss, comparable to that achieved by more extensive
programs, occurred when subjects monitored their daily weight on a graph
on which was drawn a diagonal representing goal performance, allowing
for daily comparison.

Some studies have attempted to isolate the relative contributions
of performance goals, feedback, and reinforcement to the reactivity of
SM. Mahoney, Moore, Wade, and Moura (1973) found that SM plus feedback
of correct responses in a programmed learning task resulted in longer
time spent at the task, and more correct math, but not verbal, responses.
Similarly Fink and Carnine (1975) found that feedback combined with
self-monitoring the number of arithmetic errors on a graph reduced errors;
feedback alone had no effect. When feedback combined with SM was compared
to SM alone, an incremental effect was observed in subjects' use of
first person pronouns in a sentence completion task (Kazdin, 1974a).
The addition of performance goals produced a similar increment. Richards,
McReynolds, Holt, and Sexton (1976) factorially compared two levels of
information feedback with three levels of self-administered consequences in an experimental study skills program. Neither condition enhanced the effectiveness of SM. However, subjects who were initially uninformed regarding time spent studying showed greater improvement than informed subjects. The authors suggested that the feedback conditions failed to add to reactivity of self-monitoring due to subjects' uncontrolled increasing attendance to feedback. Recently Richards, Anderson, and Baker (1978) reported that SM and external-monitoring produced a change in the use of first-person pronouns only when they provided information feedback. Feedback, then, appears to be an important function of SM, particularly when it provides information allowing for comparison of current performance with performance goals.

Reinforcement contingent on behaviour change has been shown to augment the reactivity of SM. Turkewitz, O'Leary, and Ironsmith (1975) demonstrated that tokens exchangeable for privileges could successfully shape and maintain children's evaluation and rating of both accelerative academic and decelerative disruptive behaviour. Lipinski et al. (1975) found reinforcement contingent on decreases in face-touching to produce decrements beyond those observed during SM. Similarly, when Nelson et al. (1976a) reinforced increases in adult retardates' accuracy of self-monitoring, the reactivity of two of three monitored behaviours increased. Postexperimental questioning revealed that subjects believed reinforcement to be contingent on changes in the target behaviours. A second experiment reported by these investigators demonstrated reinforced SM to produce more consistent behaviour change than a token economy program. It is not clear whether these subjects also believed that reinforcement was contingent on target behaviour change, and not on completion of self-monitoring records. Seymour and Stokes (1976) have suggested that
SM is ineffective when back-up reinforcers are not used. For example, Fixsen et al. (1972) found that SM, when not supported by reinforcement, failed to increase room-cleaning in pre-delinquent boys. Also, Santagrossi, O'Leary, Romanczyk, and Kaufman (1973) failed to observe a decrease in disruptive behaviour when contingent back-up reinforcers were not employed. Back-up reinforcement contingent on behaviour change has been shown to improve upon the reactivity of SM with disruptive behaviour (Kaufman and O'Leary, 1972), classroom behaviour (Glynn and Thomas, 1974), work and verbal behaviour (Seymour and Stokes, 1976; Sanson-Fisher, Seymour, Montgomery, and Stokes, 1978), and cleanup behaviour (Layne et al., 1976). Finally, public posting of self-monitoring records and praise have each been shown to contribute to increases in self-monitored compositional response rates in school children (Van Houten, Hill, and Parsons, 1975; Van Houten, Morrison, Jarvis, and McDonald, 1974).

Maintenance of SM Effects

To date, many studies have demonstrated the reactivity of SM. Unfortunately, as with the demonstration of many behavioural phenomena, follow-up studies are sorely lacking. The few that have been done have provided equivocal data. Rozensky (1974) described a successful case where self-monitoring antecedent to smoking produced and maintained abstinence over six months. Romanczyk et al. (1973) reported that self-monitoring caloric intake produced substantial weight loss over a 12-week follow-up period. However, Joachim (1977) has reported a case where weight loss due to self-monitoring daily weight plus food and drink intake was not maintained when SM was discontinued. Self-monitoring number of bites, plus instructions to decrease this number, produced weight loss persisting through three but not six months (Hall et al., 1974).
Frederiksen et al. (1975) found the initial reactivity of SM with smoking to attenuate over six months. Studies employing a single-subject reversal (ABA) design (e.g., Broden et al., 1971; Hutzell, 1977; Lipinski and Nelson, 1974) to demonstrate reactivity of SM have found behaviour change to persist only during the self-monitoring phase. However, Herbert and Baer (1972) used a reversal design to demonstrate increased maternal attention to appropriate child behaviour. Maternal attention failed to return to baseline following cessation of SM. While no additional follow-up data were provided, this behaviour may have come under control of increased appropriate child behaviour.

Some studies have produced generalization and maintenance of behaviour change by the creative combination of SM and various reinforcement procedures. Kaufman and O'Leary (1972) successfully taught children to self-evaluate appropriate behaviour as a means of maintaining a low rate of disruptive behaviour which was initially brought under the control of a token economy. Several studies have successfully faded tokens originally contingent on accurate and reactive SM (Sanson-Fisher et al., 1978; Seymour and Stokes, 1976; Turkewitz et al., 1975). Maletzky (1974) produced maintenance by fading the self-monitoring procedure. Broden et al. (1971) found that teacher praise maintained study behaviour which was initially increased by SM. Finally, Hall, Hall, Borden, and Hanson (1975) compared various follow-up procedures with subjects who had undergone a three-month weight control program. Subjects who mailed in self-monitoring records of daily weight and food intake at two-week intervals continued to lose at least as much weight as subjects exposed to biweekly therapy booster sessions, over a three-month follow-up. Both these groups compared favourably with subjects of a no-contact group, who gained weight since participating in the initial program.
Summary

Recent investigations of SM have moved beyond simple demonstrations of reactivity and are attending to the question: What are the conditions which contribute to the reactivity of SM? While the recent literature cannot yet provide unequivocal answers to this question, some contributing factors are becoming apparent. The nature of the target behaviour may differentially contribute to the reactive effects of SM. Accuracy of SM appears to be unrelated to reactivity. It is not known if absolute frequency of the target behaviour is related to reactivity. Data relevant to the timing of SM are inconclusive. Self-monitoring every response may be more reactive than intermittent monitoring, but again, the data are inconclusive. It is also unknown whether intermittent self-monitoring contributes to maintenance of behaviour change. The question of maintenance has been largely ignored. Although early studies have been criticized for possibly confounding the effects of SM with instructions or demand for behaviour change, more recent studies have demonstrated reactivity due to SM even following instructions designed to produce counterdemand. Expectancy is a doubtful contributor to the reactivity of SM. The only instruction which has reliably contributed to reactivity of SM is valence induction.

Self-monitoring has most consistently produced behaviour change in highly motivated individuals who record the occurrence of a target behaviour which is relevant to a performance goal. Reinforcement contingent on behaviour change can further enhance reactivity of SM. The current theoretical explanations of SM stress the importance of its consequences. Rachlin (1974) has suggested that SM provides the monitor with cues which help bridge the gap between immediate and delayed consequences. Monitoring
food intake, for example, may serve to cue the monitor to the negative long-range consequence of obesity. If this cue serves to supercede the immediate positive consequences which the monitor typically derives from eating, SM should in this case produce a decrease in food consumption. A similar but more mediational explanation has been proposed by Kanfer (1970, 1975), who has suggested that SM allows the monitor the opportunity to compare his own performance with a consensually- or self-defined performance goal. When a discrepancy exists, self-management begins a feedback loop which initiates adjustive behaviour to reduce the discrepancy. Kanfer's model of self-regulation includes three main components: self-monitoring, self-evaluation according to a criterion, and self-reinforcement for meeting that criterion. While it is difficult to separate these components experimentally, recent attempts to do so suggest that they may differentially contribute to successful behavioural self-management. Spates and Kanfer (1977) compared the relative contributions of self-monitoring, criterion-setting, and self-evaluation plus self-reinforcement to young children's performance on a simple learning task. The results of training in various combinations of these techniques suggest that criterion-setting is most effective. Training in the other techniques resulted in insignificant increments in performance over that produced by criterion-setting, suggesting their additive effect in the self-regulation of behaviour. However, self-monitoring in this situation consisted only of observing that a response had been made without regard for its appropriateness. Also, the study focused on differences resulting from prior training in techniques of self-regulation. No attempt was made to ensure that subjects actually employed these procedures.
EXPERIMENT 1

This experiment was performed within a laboratory setting to determine whether the Premack Principle (response deprivation hypothesis) could be experimentally validated with tooth brushing and flossing. Following baseline recording, access to one response was manipulated contingently with the performance of the other. Effects due simply to preventing the occurrence of the contingent response were controlled. In order to establish the validity of the Premack Principle, the instrumental event would have to increase in duration more during the contingency than during prevention of occurrence of the contingent event. It was expected that reinforcement would be accompanied by a decrease in duration of the contingent response. Should the response deprivation hypothesis prove to be valid, both brushing and flossing should be amenable to reinforcement effects, regardless of relative momentary response probability.
Method

Subjects

Twelve students of the Dental Assisting Program at Vancouver Vocational Institute volunteered to serve as subjects. The female students ranging in age from 17 to 40 years comprised the entire afternoon-evening class. Subjects had recently received instruction in brushing and flossing techniques. The experimental regimen occurred daily on weekdays during the period normally reserved for oral hygiene, immediately following dinner. Subjects were instructed not to practise oral hygiene at any other time during classroom hours. They were told before volunteering that the study was designed to determine normal time spent brushing and flossing under different conditions. Subjects were requested to brush and floss as normally as possible, under obvious experimental constraints. Subject consent forms (Appendix I) were signed prior to the first experimental session.

Procedure

A single-subject reversal design (Sidman, 1960) exposed subjects to various orders of the following conditions:

A: Baseline, free access to brushing and flossing. A toothbrush, toothpaste, and dental floss were available for subjects' use. Subjects were told that they were free to brush, floss, or do nothing, during the experimental session.

B: Contingent response deprivation control. Subjects were instructed not to engage in the response normally performed second, which was to later serve as the contingent event. Subjects were also free to do nothing if they wished. This condition allowed for comparison
with the contingency conditions, thus controlling for possible effects of response deprivation *per se* (e.g., Knapp, 1976).

C. Response contingency, unlimited access to contingent event.
Subjects were permitted access to the contingent event only when they had performed the instrumental event for the duration specified by the contingency. Instrumental and contingent events were those responses assigned subjects in B. Once the contingency was satisfied, subjects were free to perform the contingent event as long as they wished.

D. Response contingency, limited access to contingent event.
Following requisite instrumental performance, subjects were allowed limited access to the contingent event. Subjects were permitted to return to the instrumental event in order to earn more opportunity to perform the contingent event. The contingency arrangement required an increase in instrumental responding if baseline contingent responding was to be maintained. Comparison of C and D was expected to provide information on the importance of reduced contingent responding in reinforcement processes.

Subjects were exposed to experimental conditions in the order indicated in Table 1. Numerical subscripts of Conditions C and D indicate different contingency values (reinforcement criteria), which are more fully described in Table 2. With two exceptions, each condition was of two weeks (maximum 10 days) duration. The final return to baseline (Condition A) and Conditions C₁ and C₂ each lasted one week. In order to minimize disruption of subjects' normal order of brushing and flossing, the target, or instrumental event was that response normally performed first. For example, subject S1 normally flossed before brushing. In this case
flossing became the target response for the duration of the experiment. With one exception (S9), all subjects indicated a preference for brushing over flossing. If preference can be equated with relative momentary response probability, the present experiment provided a further test of reinforcer reversibility, as both brushing and flossing served as contingent events.

**Dependent Measures**

As this experiment was primarily interested in changes in duration of brushing and flossing, duration data comprised the main dependent measure. Subjects were arranged in pairs to consecutively record their partners' duration of brushing and flossing with a stopwatch. Each subject was responsible for her partner's adherence to the current experimental condition. Experimental constraints were accurately described to each subject at the beginning of each experimental condition.

All sessions were conducted in the same room, with the same subject pairs recording each other's data. Observers were substituted during occasional absences. Stopwatches were checked for accuracy at various stages throughout the experiment. Each observer was unobtrusively checked for accuracy of recording on several occasions.

Subjects were questioned before and after the experiment to determine their usual frequency of and relative preference for brushing and flossing. Subjects were also asked to describe their hypotheses concerning the experiment, and perceived reactions to each experimental condition (Appendix IV). At the conclusion of the study, subjects were provided with full information regarding experimental hypotheses.
Table 1
Summary of Experimental Procedure and Results,
Experiment 1

<table>
<thead>
<tr>
<th>Subject</th>
<th>Order (R1 - R2)</th>
<th>Conditions</th>
<th>Increase in RI During B</th>
<th>Increase in RI During C</th>
<th>Increase in RI During D</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>F - B</td>
<td>ABDADA</td>
<td>N</td>
<td></td>
<td>Y</td>
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<tr>
<td>S2</td>
<td>F - B</td>
<td>ABDA_{1}AD_{2}A</td>
<td>N</td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>S3</td>
<td>B - F</td>
<td>ABDA_{1}AD_{2}A</td>
<td>N</td>
<td></td>
<td>Y</td>
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<tr>
<td>S4</td>
<td>B - F</td>
<td>ABDA_{1}AD_{2}A</td>
<td>N</td>
<td></td>
<td>N</td>
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<tr>
<td>S5</td>
<td>B - F</td>
<td>ABAADA</td>
<td>Y</td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>S6</td>
<td>F - B</td>
<td>ACBADA</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
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<tr>
<td>S7</td>
<td>F - B</td>
<td>ACBADA</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>S8</td>
<td>F - B</td>
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<td>Y</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>S9</td>
<td>B - F</td>
<td>AC_{1}C_{2}BADA</td>
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<tr>
<td>S12</td>
<td>B - F</td>
<td>AC_{1}C_{2}BADA</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
</tbody>
</table>

1. Usual order of brushing (B) and flossing (F).
2. A: baseline.
   B: contingent response deprivation control.
   C: response contingency; unlimited access to contingent event.
   D: response contingency; limited access to contingent event.
3. Y: yes N: no
Table 2
Response Contingency Parameters, Experiment 1

<table>
<thead>
<tr>
<th>Subject</th>
<th>Condition (Instrumental: Contingent Response Contingency Criterion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>D(1'F:20&quot;B)\textsuperscript{1}.</td>
</tr>
<tr>
<td>S2</td>
<td>D\textsubscript{1}(1'F:15&quot;B) D\textsubscript{2}(1'F:10&quot;B)</td>
</tr>
<tr>
<td>S3, S4</td>
<td>D\textsubscript{1}(1'B:30&quot;F) D\textsubscript{2}(1'B:20&quot;F)</td>
</tr>
<tr>
<td>S5</td>
<td>D(1'B:15&quot;F)</td>
</tr>
<tr>
<td>S6</td>
<td>C(9'F:B)\textsuperscript{2} D(1'F:15&quot;B)</td>
</tr>
<tr>
<td>S7</td>
<td>C(7'F:B) D(1'F:10&quot;B)</td>
</tr>
<tr>
<td>S8</td>
<td>C(5'F:B) D(1'F:20&quot;B)</td>
</tr>
<tr>
<td>S9, S11, S12</td>
<td>C\textsubscript{1}(3'B:F) C\textsubscript{2}(4'B:F) D(1'B:20&quot;F)</td>
</tr>
<tr>
<td>S10</td>
<td>C\textsubscript{1}(4'B:F) C\textsubscript{2}(5'B:F) D(1'B:20&quot;F)</td>
</tr>
</tbody>
</table>

1\textsuperscript{1} E.g., subject S1 was allowed 20 seconds of brushing following each minute of flossing, during Condition D.

2. E.g., subject S6 was allowed unlimited access to brushing contingent on nine minutes of flossing.
Figure 1. Daily duration of brushing and flossing across experimental conditions.
Figure 1 (continued).
Figure 1 (continued).
Figure 1 (continued).
Accuracy of observation was within five seconds on all occasions in which reliability checks were made. Data collected on two occasions when the stopwatch stopped prematurely were discarded. In all other cases, missing observations were due to absence from class, or class cancellation.

Individual records of subjects' duration data are presented in Figure 1. Changes in duration of the target, or instrumental, event (Rl) during contingency and response deprivation control conditions are summarized in Table 1. An increase in Rl was only considered reliable if average response duration increased by at least 10 percent above the largest average baseline value. During the response deprivation control condition (B), six of the twelve subjects demonstrated a reliable increase in the target response. Increases were observed with both brushing and flossing, regardless of the order of experimental conditions. Of the seven subjects exposed to the response contingency condition with unlimited access to the contingent event (Condition C), six subjects increased their instrumental responding of both brushing and flossing relative to baseline rates. Subject S9 increased her duration of brushing to the value specified by the contingency, but also increased her baseline duration of brushing to approximately the same extent. Only four subjects reliably demonstrated increased instrumental responding during Condition D, when access to the contingent event was limited. The initial large increase in instrumental responding demonstrated by subject S3 was reduced during a more stringent contingency.

Compared with baseline performance, reinforcement effects were demonstrated by six of seven subjects in Condition C, and by four of twelve subjects in Condition D. However, reinforcement was only apparent
with subjects S1, S3, and S12, when target response increases due to contingent response deprivation were accounted for.

Knapp (1976) has criticized many attempted applications of the Premack Principle for their neglect to control for the observed increase in instrumental responding due simply to the removal of the opportunity to perform the contingent response. Data from the present study fail to resolve this issue satisfactorily. Previous studies (Eisenberger, Karpman, and Trattner, 1967; Robinson and Lewinsohn, 1973) have reported discrepant results due to contingent response deprivation. In the present study, half the subjects increased their instrumental responding when the opportunity to perform the contingent response was withheld. Three of these subjects (S5, S7, and S8) increased instrumental responding during the contingent response deprivation control condition in excess of their instrumental responding during either contingency condition.

The present experiment employed two different response contingency conditions: limited (Condition D) and unlimited (Condition C) access to the contingent event following requisite instrumental performance. All seven subjects exposed to Condition C increased their duration of instrumental responding to satisfy the contingency. During this contingency condition, unlimited contingent responding did not decrease below baseline, and in some cases even increased. Contingencies are more typically arranged as in Condition D, allowing only limited access to the contingent event. In each of the four cases of increased instrumental responding during this condition, contingent responding declined. This is consistent with previous observations of decreases in contingent responding during reinforcement. As the contingencies in Condition D required an increase over baseline in instrumental responding if baseline contingent responding was to be maintained,
most subjects simply reduced their duration of contingent responding. These subjects indicated following termination of the experiment that they responded to the increasingly stringent contingency by trying to increase their efficiency of contingent responding, rather than increasing their duration of instrumental responding. Subject S3, for example, evidenced a reinforcement effect during Condition D1. A subsequent and more stringent contingency imposed during Condition D2 produced decreases in both instrumental and contingent responding, reducing the previously observed reinforcement effect. In Condition C, however, subjects increased their duration of instrumental responding to meet the contingency requirement.

These data suggest that reinforcement processes attributed to the Premack Principle may in fact be due to the unavailability of the contingent response. Increases in instrumental responding evidenced by four subjects during Condition D were at least equalled by similar increases during Condition B by subjects S6 and S10. The contingency arrangement employed in Condition C, however, offers possible promise for applied utility. All subjects exposed to Condition C increased instrumental responding, both brushing and flossing, according to the contingency requirement. Condition C allowed unlimited access to the contingent event, once the contingency requirement had been met. This arrangement is more easily applicable to an applied situation than that of Condition D. For example, subjects could be asked to perform an instrumental response (e.g., flossing) before gaining unlimited access to a contingent response (e.g., brushing). Results of the present experiment suggest that such a contingency should produce increases in instrumental responding whether it is brushing or flossing. Experiments 2 and 3 attempted to determine whether the opportunity to brush could
serve as a contingent reinforcer of flossing, within experimental and clinical preventive dental programs.
EXPERIMENT 2

Many clinical and school dental programs have produced only short-lived changes in oral hygiene. The present experiment factorially compared the effects of different levels of SM with the Premack Principle on the maintenance of toothbrushing and flossing, over a one-month experimental period and a six-month follow-up period. Instruction per se was expected to be effective in the initiation, but not maintenance, of brushing and flossing. This has been found consistently in the dental literature. Similarly, the initially reactive effects of SM have often been found to attenuate following an initial period of reactivity. Self-monitoring which provides feedback relevant to performance goals has been shown to augment the reactive effects of SM alone. In the present experiment, evaluative SM, which provided performance feedback, was expected to maintain effective brushing and flossing. Finally, a contingency between flossing and brushing was expected to contribute to maintenance so long as subjects maintained the contingency. The factorial design of the experiment allowed for the evaluation of any interaction between application of the Premack Principle and SM.
Method

Subjects

One hundred and five volunteer subjects were solicited from first and second year psychology and nursing classrooms at the University of British Columbia. The experimenter explained that he was interested in assessing the effects of instructions on toothbrushing and flossing. Volunteers were accepted as subjects if they felt that their oral hygiene was in need of improvement, and if they agreed to attend two instructional sessions and three assessment sessions, the third occurring at the end of summer vacation. Additionally, subjects were telephoned for confirmation of their agreement to these criteria. All subjects signed subject consent and medical history forms (Appendices I, II, and III) prior to the first assessment session.

Instructional Sessions

During the week following the first assessment 90 subjects attended the first instructional session in groups of four to 12. Subjects were presented with a brief description of the effects of bacterial plaque and the benefits of effective daily plaque removal from all tooth surfaces. Statistics relevant to the prevalence of periodontal disease were provided. Subjects were then instructed in intrasulcular brushing (Bass, 1954, described in Wilkins, 1971) and flossing techniques. As well as didactic instruction and chalkboard illustration, instruction was also provided via modeling and feedback. Each subject was provided with an Odonto adult toothbrush, a 50-yard spool of Odonto unwaxed dental floss, a small Butler disposable mouth mirror, and 10 Butler "Red-cote" erythrosine dye tablets, with instructions for their use. Subjects practised intrasulcular brushing and flossing, and received individual guidance.
and feedback, for the remainder of the 45-minute session. Throughout this session, emphasis was placed on the positive nature of effective brushing and flossing. Subjects were encouraged to spend 15 minutes each day to thoroughly remove all plaque. As there is no evidence to suggest that toothpaste contributes to plaque removal, subjects were told that they could effectively remove plaque without using toothpaste. This would allow them to brush while performing some other passive task, such as watching television, in a location other than the bathroom. However, if subjects felt the need to continue using toothpaste, they were encouraged to do so.

For the second instructional session one week following the first, experimental subjects were assigned to one of six treatment conditions. Generally, subjects remained with their original group from the first instructional session. These groups were assigned to experimental conditions so that each experimental group contained 15 subjects. Two levels of the Premack Principle, presence and absence of a contingent relationship between flossing and brushing were factorially compared with 3 levels of SM: no self-monitoring, self-monitoring of frequency of brushing and flossing, and self-monitoring of frequency plus evaluation of brushing and flossing. Charts (Appendices V through VIII) were provided to subjects of the four self-monitoring groups.

During the second 45-minute instructional session oral hygiene procedures discussed in the first session were reviewed. Subjects then received instruction in employing the Premack Principle, or SM, where appropriate. Premack subjects (contingency) were instructed to perform the preferred response (e.g., brushing) only after performing the less preferred response (e.g., flossing) once per day. This method of response assignment seemed most appropriate for the present study, as previous
work has shown that the assessment of relative momentary response probability is unnecessary. Self-monitoring subjects were instructed to indicate the time of each occasion of brushing and flossing (SM-frequency). Subjects in the SM-frequency and evaluation condition were instructed additionally to evaluate the effectiveness of their oral hygiene, and to record these data, according to the semiweekly schedule indicated by the chart. At these times subjects were required to count and indicate the number of teeth on which plaque remained after cleaning, using erythrosine dye tablets as disclosing agents. They were then instructed to remove any remaining plaque from all teeth.

In addition to the six factorially compared groups, a seventh group (n = 15) was assigned as a waiting-list control. These subjects did not attend either instructional session. They were told at the first assessment that the instructional groups were full, but that instruction would be available in the near future.

Dependent Measures

As this study was primarily interested in evaluating the outcome of changes in oral hygiene behaviour, the Gingival Index (GI) (Loe and Silness, 1963) and Plaque Index (PLI) (Silness and Loe, 1964) comprised the main dependent measures. According to these indices, a score of 0, 1, 2, or 3 was assigned to the buccal, lingual, and both interproximal surfaces of each of six representative teeth: maxillary right first molar, maxillary right central incisor, maxillary left first premolar, mandibular left first molar, mandibular left central incisor, and mandibular right first premolar. If a designated tooth was missing, the first distal tooth was selected. A description of scoring criteria for the GI and PLI and the subject data form, are appended
Thus a composite score was derived for each subject by adding the scores assigned each of four surfaces of each of six teeth, then dividing by 24, for both the GI and the PII. Composite scores for these indices could fall between 0 and 3, increasing with increasing amounts of gingival inflammation and bacterial plaque.

The GI and the PII have been widely used and are reported to be both valid and reliable. Oliver, Holm-Pedersen, and Loe (1969) have shown that GI scores correlate highly with the amount of gingival exudation and histological measures of gingivitis. Gingival Index scores have also been shown to correlate highly with Russell's (1956) Periodontal Index scores (Loe and Silness, 1963). The PII, which considers differences in plaque thickness at the gingival margin, has been shown to correlate highly (r up to .995) with GI scores (Silness and Loe, 1964). Differences in plaque thickness at the gingival margin are strongly related to total area of plaque on the tooth surface (Lang, Ostergaard, and Loe, 1972). Also, unstained PII scores correlate highly with plaque weight (Loesche and Green, 1972). The six teeth typically measured, and used in the present study, have been found to be representative of the entire dentition (Ramfjord, 1974). When intra- and inter-rater reliability rates are reported, they tend to be in the range of 0.8. Intra-rater reliability tends to be higher than inter-rater reliability; both can be increased with training (Hazen, 1974; Mandel, 1974). Birkeland and Jorkjend (1975), for example, found no significant differences in GI or PII scores assigned subjects on consecutive days by the same trained examiner.

In the present study, a registered dental hygienist with six years' experience, blind to experimental conditions, evaluated subjects according
to the GI and the PII at the three assessment sessions. Subjects were examined individually, in a standard dental unit under quartz halogen illumination. Individual teeth were dried with compressed air, and the adjacent gingiva were probed with a "Perio-aid". The examiner was trained to a high degree of reliability before the study, and tested for reliability antecedent to and during the first assessment session.

In addition to GI and PII data, subjects were requested to answer questionnaires at the three assessment sessions (Appendices XI to XIII). The questions were designed to provide additional information about subjects' oral hygiene habits, knowledge, and attitudes.

There were three assessment sessions, occurring one week before the first instructional session, one month following the second instructional session, and six to seven months following the second assessment. Only four of the original waiting-list control group subjects returned for the second assessment. Many of the others who refused to return for this assessment expressed dissatisfaction at not having received instruction by this time. An additional 12 subjects were solicited from the same student population, for assignment to a no-treatment control group. These subjects were told that volunteers were needed for the assessment of normal oral hygiene in young adults. The request for volunteers did not imply that any treatment or instruction would be given. Due to temporal constraints, this new group of no-treatment control subjects was assessed six weeks and finally 14 weeks following the first assessment. These subjects responded to an abbreviated questionnaire, at the last two assessments (Appendix XIV).
Summary of Experimental Procedure (for the six experimental groups)

Assessment 1 - subject consent forms and medical history.
- GI-1, PII-1, and Questionnaire 1.

(1 week)

Instruction 1 - instruction in rationale and techniques for effective brushing and flossing.

(1 week)

Instruction 2 - assignment to experimental condition.
- review of brushing and flossing techniques.
- instruction in experimental techniques (Premack Principle and SM).

(4 weeks)

Assessment 2 - GI-2, PII-2, and Questionnaire 2.

(6 months)

Assessment 3 - GI-3, PII-3, and Questionnaire 3.

Following the final assessment, subjects were given a brief written description of the study (Appendix XV), and an opportunity to obtain final results.
Results

Examiner Reliability

Both inter- and intra-examiner reliability coefficients were calculated by dividing the number of agreements by the total number of observations. Following one session of training to score colour slides of anterior teeth, the hygienist who performed all assessments was tested for agreement with her previous scoring of colour slides, and with the scoring of a periodontist who participated in the training session. Reliability coefficients varied from .79 to .89. These are consistent with those reported in the literature. Inter-rater reliability rates improved (.90 to .95) when subjects were assessed during the first assessment session.

Preinstructional Measures

A one-way analysis of variance (ANOVA) performed on the plaque and gingival index scores of the seven experimental groups was nonsignificant. With one exception, one-way ANOVA and $\chi^2$ analyses of all subject characteristics indicated no significant group differences before the first instructional session. Experimental groups did differ on size of instructional group ($F(5,76) = 7.28, p < .001$), but instructional group size was not related to change in either dental index, at the two post-instructional assessments.

Postinstructional Measures

Subject Compliance. At one month postinstruction, 95 percent of Premack Principle subjects reported flossing before brushing, according
to the experimental requirement. Ninety-two percent of self-monitoring subjects returned charts at this time, of which 86 percent had been completed at least six days per week. Chi-square analysis revealed no significant differences in proportions of subject compliance. Subjects additionally reported equal instructional emphasis on the importance of daily brushing and flossing. Expectations for improvement were equivalent across experimental groups. Subject attrition at both postinstructional assessments was not significantly different across the six experimental groups. At the follow-up assessment, group size varied from 10 to 12 subjects. All 12 subjects of the no-treatment control group returned for each assessment.

**Dental Indices.** The experimental design included a factorial comparison of the Premack Principle with self-monitoring, as well as a comparison with a no-treatment control condition, across three assessments. To facilitate factorial analysis, a minimum number of cases was randomly discarded so that experimental group size was proportional across cells. Mean gingival and plaque index scores included in the statistical analysis are shown in Table 3 and Figure 2. Two separate repeated measures analyses of variance were performed on gingival and plaque index scores (see Table 4). The first analysis factorially compared two levels of the Premack Principle (PP) with three levels of SM across three assessments. Only the Assessment factor was significant ($p < .01$), for both dental indices. Neither between-group factor, nor any of their interactions was significant. Tukey post-hoc comparisons revealed that the largest difference occurred between the first two assessments, before and one month following instruction ($p < .01$). Gingival scores were also significantly different between one month and seven months postinstruction ($p < .01$), but not between pre- and seven months
Table 3

Mean Gingival and Plaque Index Scores, Experiment 2

<table>
<thead>
<tr>
<th>Condition</th>
<th>n</th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
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<td><strong>Gingival Index</strong></td>
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<td></td>
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<td></td>
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</tr>
<tr>
<td>No Contingency</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SM-none</td>
<td>10</td>
<td>1.183</td>
<td>.283</td>
<td>.596</td>
<td>.267</td>
<td>.946</td>
<td>.079</td>
</tr>
<tr>
<td>SM-frequency</td>
<td>10</td>
<td>1.046</td>
<td>.357</td>
<td>.658</td>
<td>.251</td>
<td>.992</td>
<td>.043</td>
</tr>
<tr>
<td>SM-frequency + evaluation</td>
<td>10</td>
<td>1.146</td>
<td>.346</td>
<td>.704</td>
<td>.277</td>
<td>1.017</td>
<td>.101</td>
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<tr>
<td>Contingency</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>SM-none</td>
<td>11</td>
<td>1.189</td>
<td>.171</td>
<td>.625</td>
<td>.211</td>
<td>.943</td>
<td>.135</td>
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<td>.712</td>
<td>.338</td>
<td>.970</td>
<td>.122</td>
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<tr>
<td>SM-frequency + evaluation</td>
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<td>1.148</td>
<td>.319</td>
<td>.625</td>
<td>.260</td>
<td>.909</td>
<td>.123</td>
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<tr>
<td>No-treatment Control(^1)</td>
<td>12</td>
<td>1.167</td>
<td>.199</td>
<td>1.069</td>
<td>.132</td>
<td>.972</td>
<td>.176</td>
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<tr>
<td><strong>Plaque Index</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>No Contingency</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SM-none</td>
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<td>1.258</td>
<td>.294</td>
<td>.254</td>
<td>.223</td>
<td>.592</td>
<td>.367</td>
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<tr>
<td>SM-frequency</td>
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<td>1.154</td>
<td>.411</td>
<td>.379</td>
<td>.247</td>
<td>.537</td>
<td>.228</td>
</tr>
<tr>
<td>SM-frequency + evaluation</td>
<td>10</td>
<td>1.167</td>
<td>.344</td>
<td>.300</td>
<td>.183</td>
<td>.437</td>
<td>.262</td>
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</tr>
<tr>
<td>SM-none</td>
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<td>.310</td>
<td>.235</td>
<td>.205</td>
<td>.511</td>
<td>.449</td>
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<td>SM-frequency</td>
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<td>.436</td>
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<td>.557</td>
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<td>.182</td>
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<td>.421</td>
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<td>.258</td>
<td>.847</td>
<td>.338</td>
<td>.660</td>
<td>.381</td>
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</tbody>
</table>

1. No-treatment control subjects were assessed six and 14 weeks following the first assessment.
Figure 2. Mean experimental and plaque index scores, Experiment 2.

Assessment months following instruction.

Plaque index vs. Gingival index.

Legend:
- □: Absent
- △: Present
- ■: Frequency
- □: Frequency evaluation
- ○: Self-monitoring

Contingency N.T.C.
Table 4
Repeated Measures Analysis of Variance Summary Table, Experiment 2

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
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<td><strong>PP By SM By Assessment</strong></td>
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<td></td>
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<tr>
<td><strong>Gingival Index</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>PP</td>
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<td>0.001</td>
<td>0.007</td>
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<tr>
<td>SM</td>
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<td>0.004</td>
<td>0.044</td>
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<tr>
<td>PP*SM</td>
<td>2</td>
<td>0.122</td>
<td>0.061</td>
<td>0.633</td>
</tr>
<tr>
<td>Error</td>
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<td>5.480</td>
<td>0.096</td>
<td></td>
</tr>
<tr>
<td>Assessment</td>
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<td>3.984</td>
<td>106.938**</td>
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<tr>
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<td>0.038</td>
<td>1.021</td>
</tr>
<tr>
<td>SM*Assessment</td>
<td>4</td>
<td>0.110</td>
<td>0.028</td>
<td>0.741</td>
</tr>
<tr>
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<td>0.043</td>
<td>0.011</td>
<td>0.289</td>
</tr>
<tr>
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<tr>
<td><strong>Plaque Index</strong></td>
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<td></td>
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<tr>
<td>PP</td>
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<td>0.034</td>
<td>0.034</td>
<td>0.209</td>
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<td>SM</td>
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<td>0.049</td>
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<tr>
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<tr>
<td>SM*Assessment</td>
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<tr>
<td><strong>Group by Assessment</strong></td>
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<tr>
<td><strong>Gingival Index</strong></td>
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</tr>
<tr>
<td>Group</td>
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<td>0.724</td>
<td>0.121</td>
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<tr>
<td>Error</td>
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<td>111.136**</td>
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<td>0.102</td>
<td>3.110**</td>
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<tr>
<td>Error</td>
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<tr>
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<td>MS</td>
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<td>4.409**</td>
</tr>
<tr>
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<td>8.429</td>
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</tbody>
</table>

**  p < .01
postinstruction. Plaque scores, however, did not differ significantly between the two postinstructional assessments. It appears, then, that improved PII scores were maintained over the follow-up interval, while similarly improved GI scores were not.

The second analysis compared the six treatment groups and the no-treatment control group, across assessments. Both the Assessment main effect and the Group by Assessment interaction were highly significant ($p < .01$), for both dental indices. Lack of treatment group differences in the factorial analysis would suggest that the inclusion of the no-treatment control group in the present analysis was responsible for the significant interaction. Scheffe comparisons between the experimental groups combined and the no-treatment control group were significant only at the one-month postinstructional assessment (GI: $F(6,57) = 33.256, p < .01$; PII: $F(6,57) = 30.613, p < .01$). Similar comparisons were not significant at the follow-up assessment. Tukey comparisons of no-treatment control group means also revealed significantly different PII scores between the first and last assessments; gingival scores, however, were not significantly different.

**Correlational Analyses.** The administration of questionnaires at each assessment allowed for correlational analysis of self-report data with dental outcome data of all experimental subjects. At the initial preinstructional assessment, self-reported frequency of flossing during the past 24 hours was inversely related to plaque index scores ($r_s(98) = -.24, p < .01$). However, frequency of flossing during the past week was not significantly related to plaque or gingival index scores. Self-reports of brushing frequency were not related to either dental index. At one month postinstruction, however, self-reported frequency of the past weekly and daily flossing was significantly inversely
related to both dental indices, when dental preinstructional scores were held constant ($-0.41 \leq r(89) \leq -0.49, p < .01$). Additionally, subjects who reported an increase in frequency of flossing and an increased daily duration of both flossing and brushing since instruction tended to have lower (better) plaque and gingival scores ($-0.35 \leq r_8 (89) \leq -0.45, p < .01$). At the follow-up assessment, seven months postinstruction, frequency of flossing was still inversely related to dental scores, controlling for the effects of preinstructional dental scores, although not as strongly ($-0.22 \leq r(72) \leq -0.31, p < .05$). When the one-month postinstructional dental scores were held constant, the follow-up scores were no longer related to self-reported frequency of flossing. At no assessment was frequency of brushing related to either dental index.

At the first assessment, only two questionnaire items related to preinstructional dental indices. There was a significant relationship between subjects' estimate of their dental health on a seven-point scale and their actual dental health as determined by the gingival ($r(83) = 0.25, p < .05$) and plaque ($r(84) = 0.37, p < .01$) indices. Also, subjects' estimate of the importance of toothbrushing in the maintenance of dental health was related to their initial gingival ($r(84) = 0.25, p < .05$) and plaque ($r(84) = 0.27, p < .01$) scores. Partial correlational analysis, holding the appropriate preinstructional dental scores constant, revealed only a significant relationship between preinstructional perceived importance of toothbrushing and gingival scores at the one month postinstructional assessment ($r(83) = 0.27, p < .01$). No other correlation between self-report measures and postinstructional dental indices was significant.

It is not surprising that frequency of brushing was unrelated to
either dental index at any assessment. Subjects were initially brushing at least twice per day, and maintained this frequency throughout the study. The postinstructional improvement in dental indices was accompanied by an increase in frequency of flossing (from two to about six times per week), but not brushing. Both brushing and flossing, however, apparently increased in duration. At the final assessment, experimental subjects reported flossing an average of four times during the previous week. Prior to receiving oral hygiene instruction in the present study, subjects showed some ability in estimating the state of their dental health. Those who recognized the importance of brushing tended to evidence better dental health. This relationship was maintained through one month postinstruction, but only with gingival index scores. No other indicator of subject knowledge, motivation, or health value, estimate, or locus of control was related to changes in dental indices following instruction.
Discussion

All treatment groups demonstrated striking improvement in oral hygiene, particularly on the plaque index, over the one-month post-instructional period. Only improved plaque scores were maintained over the follow-up period; gingival scores regressed toward preinstructional levels. In considering the question of maintenance, more weight must be given the gingival scores, as plaque accumulation can be eliminated in one concerted instance of brushing and flossing. Significant differences in gingival scores, however, are only observed following regular plaque removal, typically over at least one week (Loe, Theilade, and Jensen, 1965). In the present study, maintained improvement in plaque scores over the follow-up period indicate maintenance of only the knowledge of brushing and flossing techniques. A concomitant maintenance of gingival scores, which in fact did not occur, would provide stronger evidence for the maintenance of oral hygiene performance.

Only one of the original expectations was validated by the present results. Instruction in effective oral hygiene performance per se did indeed produce short-term behavioural change. Such change was equivalent to that produced by additional treatment components. The present data failed to shed any light on a putative effective component of self-monitoring. Previous research has suggested that self-monitoring must contain an evaluative component to produce behaviour change. Such an effect may have been masked in the present study by a possible ceiling effect created by the effectiveness of oral hygiene instruction. A self-imposed contingency between flossing and brushing also failed to augment other treatment effects. At no assessment was there a significant interaction between self-monitoring and the Premack Principle.
Comparison of the treatment conditions with the no-treatment control provided the most interesting outcome of this experiment. This group was included in the design to control for the effect of repeated assessment. Due to temporal constraints, these subjects were assessed two months following the second assessment, and therefore were not strictly comparable to the experimental subjects. Also, expectations for improvement due to oral hygiene instruction were not imparted to no-treatment control subjects, as they were to experimental treatment subjects. Nevertheless, no-treatment control subjects showed significantly improved plaque scores, but not gingival scores, between the first and third assessments. Evans, Roselle, Noblitt, and Williams (1975) reported that repeated measurement per se produced a decrease in plaque scores statistically equivalent to that produced by various persuasive communications up to 10 weeks following treatment. In the present experiment, group instruction in oral hygiene rationale and procedures produced clear improvement in gingival and plaque scores, relative to measurement per se, one month following instruction. At follow-up, however, which occurred for the no-treatment and treatment conditions at two and six months respectively following the second assessment, these differences were reduced to nonsignificance.
EXPERIMENT 3

Experiment 2 obtained data from subjects solicited from a university student population specifically for experimental purposes. Most people seek treatment, and hence receive preventive dental instruction, from private dental clinics. It is possible that private dental patients would respond differentially to an experimental manipulation such as the Premack Principle. The present experiment sought to determine this.
Method

Subjects

Thirty subjects selected from the new patient population of a private dental clinic were asked to participate in an experimental evaluation of oral hygiene instruction. Patients who evidenced prolonged periodontal disease were excluded from the study. All subjects were treated as typical dental patients. Prior to experimental participation, subjects verbally agreed to the request that their assessment data could be used for experimental purposes.

Procedure

Following an initial dental assessment, subjects were alternately assigned to the experimental Premack Principle group or the control group. Two instructional sessions, separated by up to one week, followed. During these sessions, the first of approximately 45 minutes, the second of 30 minutes duration, subjects were individually provided with a rationale and techniques for effective oral hygiene. Brushing and flossing techniques were identical to those taught in Experiment 2. In the present study, however, individual instruction by a certified dental assistant required each subject to show mastery of brushing and flossing technique, before dental treatment was provided.

During the two instructional sessions, subjects in the Premack group were instructed and subsequently agreed to brush, at least once per day, only following flossing. Subjects in both groups were told that flossing was equally important as brushing. The contingent order of these two behaviours was stressed only to Premack subjects. Control subjects did not receive instructions to brush and floss in a specific order.
Dependent Measures

Subjects were assessed immediately before instruction, and three months following instruction. During the interim period any necessary dental work was initiated, and in most cases, completed. Instruction and assessment was administered by one of three certified dental assistants. Gingival inflammation was evaluated according to the GI, administered as in Experiment 2. The PII was simplified so as to differentiate between simple presence and absence of plaque. A score of 0, indicating absence, or 1, indicating presence, of plaque was assigned to the same tooth surfaces as in Experiment 2. Additionally, subjects reported their frequency of brushing and flossing during the previous seven days and 24 hours, at the final assessment session. Assessment forms were similar to those used in Experiment 2.

Each dental assistant instructed and assessed approximately one-third of the subjects of each group. One of the dental assistants terminated employment and was replaced halfway through the study. Each assistant was requested to assess each subject only once, to ensure blindness to group membership. Unfortunately, due to practical constraints, some subjects were assessed by the same assistant at both assessment periods. Most, however, were not. Each assistant was briefly trained and tested for reliable administration of the dental indices before performing any assessment.
Results and Discussion

Reliability

Estimates of interobserver reliability were determined by dividing the number of agreements by the total number of observations, for each pair of observers. Reliability varied between .58 and .79, considerably lower than in Experiment 2. This may have been due in part to inadequate reliability training, or more likely to the lack of experience of dental assistants in the administration of oral hygiene indices.

Dental Indices

Mean GI and simplified P1I scores of the 12 control subjects and 10 Premack Principle subjects who returned for the three-month post-instructional assessment are shown in Figure 3 and Table 5. These data were analyzed according to repeated measures analysis of variance (see Table 6). The gingival scores of both groups showed a negligible nonsignificant decrease. Plaque scores, however, showed a much larger, significant decrease from pre- to three months postinstruction. Group differences, however, were nonsignificant, both for the Group factor and for the Group by Trials interaction. Only the main Trials effect for simplified P1I scores was significant.

These data would suggest that two sessions of individual oral hygiene instruction were effective in reducing simplified P1I but not GI scores in private dental clinic patients over a three-month period. The additional instruction to impose a contingency between flossing and brushing appeared to have little effect. Although the Group by Trials interaction of plaque scores approached significance ($p = .073$), the gingival data failed to corroborate this trend. A similar relative improvement in
### Table 5
Mean Gingival and Simplified Plaque Index Scores,
Experiment 3

<table>
<thead>
<tr>
<th>Condition</th>
<th>Preinstruction</th>
<th>Postinstruction</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Mean</td>
</tr>
<tr>
<td>Gingival Index</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Premack Principle</td>
<td>10</td>
<td>1.158</td>
</tr>
<tr>
<td>Control</td>
<td>12</td>
<td>1.278</td>
</tr>
<tr>
<td>Simplified Plaque Index</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Premack Principle</td>
<td>10</td>
<td>.892</td>
</tr>
<tr>
<td>Control</td>
<td>12</td>
<td>.878</td>
</tr>
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</table>
Figure 3. Mean gingival and plaque index scores, Experiment 3.
Table 6
Repeated Measures Analysis of Variance
Summary Table, Experiment 3

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gingival Index</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group</td>
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<td>1</td>
<td>.177</td>
<td>1.243</td>
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<tr>
<td>Error</td>
<td>2.850</td>
<td>20</td>
<td>.142</td>
<td></td>
</tr>
<tr>
<td>Trials</td>
<td>.023</td>
<td>1</td>
<td>.023</td>
<td>0.353</td>
</tr>
<tr>
<td>Group*Trial</td>
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<td>.001</td>
<td>0.011</td>
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<tr>
<td>Error</td>
<td>1.319</td>
<td>20</td>
<td>.066</td>
<td></td>
</tr>
<tr>
<td><strong>Simplified Plaque Index</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td>.111</td>
<td>1</td>
<td>.111</td>
<td>1.952</td>
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<tr>
<td>Error</td>
<td>1.133</td>
<td>20</td>
<td>.057</td>
<td></td>
</tr>
<tr>
<td>Trials</td>
<td>3.234</td>
<td>1</td>
<td>3.234</td>
<td>81.852**</td>
</tr>
<tr>
<td>Group*Trial</td>
<td>.142</td>
<td>1</td>
<td>.142</td>
<td>3.582</td>
</tr>
<tr>
<td>Error</td>
<td>.790</td>
<td>20</td>
<td>.040</td>
<td></td>
</tr>
</tbody>
</table>

** p < .01

** p < .01
plaque over gingival scores was observed in Experiment 2, suggesting maintained knowledge but not practice of oral hygiene techniques.

Subjects exposed to oral hygiene instruction in both studies reported flossing approximately four times during the week prior to the final assessment, just over half the recommended frequency. As in Experiment 2, subjects reported brushing about twice per day. In the present experiment, seven of the 10 Premack subjects reported that they routinely flossed before brushing, as predicted by the contingency requirement. Only four control subjects regularly flossed before brushing. This difference, however, was not significant (Fisher's exact test (one-tailed) = 0.115). The relatively high ratio of brushing to flossing evidenced by Premack subjects suggests that the contingency was virtually ignored, three months following instruction.
GENERAL DISCUSSION

The Premack Principle essentially posits that reinforcement occurs when a more probable response follows a less probable response, in a contingent arrangement. The results of Experiment 1 in the present study would suggest that the observed change in response duration may often, but not always, be due to contingent response deprivation. That is, simply preventing the occurrence of the contingent response, as is the case when a contingency is in effect, may account for the observed increase in the duration of the instrumental response. This notion, originally alluded to in an experiment by Premack and Premack (1963), and later elaborated by Knapp (1976), is also supported by data reported by Robinson and Lewinsohn (1973). Earlier, prevention of the contingent response was found not to be associated with an instrumental response increase (Eisenberger et al., 1967). Indeed, in the present study, prevention of the occurrence of the contingent response produced an increase in instrumental response duration in some subjects, and no change in others. This, then, is apparently not a universal phenomenon. Researchers planning to employ the Premack Principle as a behavioural technique should nevertheless be aware that any observed increase in instrumental responding may in fact be due to contingent response deprivation.

Experiment 1 also addressed the issue of the necessity of contingent response reduction for the occurrence of reinforcement. There has been unanimous agreement that reinforcement is typically accompanied by a reduction in contingent responding, compared to baseline performance. Some workers in this area (e.g., Dunham, 1977; Timberlake and Allison, 1974) would further argue that contingent response reduction is necessary
(and even sufficient) for the occurrence of reinforcement. However, reinforcement schedules employed in studies upon which these conclusions are based typically arrange for the alternation of instrumental and contingent responding. Such an arrangement corresponds with Condition D of Experiment 1. When the contingency allowed unlimited access to contingent responding following increased instrumental responding, relative to baseline, instrumental responding increased to meet the contingency requirement. This type of contingency arrangement would seem better suited to application to a self-management program, such as with the maintenance of toothbrushing and flossing, than the arrangement exemplified by Condition D. However, in the present experiment, the potential influence of experimenter demand (e.g., Orne, 1970) cannot be dismissed. Subjects were told that they were free not to perform the instrumental response according to the contingency requirement, and thus not be allowed access to the contingent response. Considering their (brief) history of brushing and flossing during the experimental time period, and the concurrent behaviour of their peers, it is not surprising that no subject availed herself of this alternative. It seems doubtful that such rigorous performance would be maintained without these supports, such as in the home environment.

One final point raised by the results of Experiment 1 concerns Premack's original notion of relative momentary response probability. A contingent increase in instrumental responding occurred with both brushing and flossing. All but one subject identified brushing as the preferred activity. If response duration is equated with probability, then this trend becomes reversed, with flossing the preferred activity. All but one subject engaged in flossing for a longer duration during
the initial baseline. As reinforcement occurred with either behaviour serving as the instrumental and contingent event, relative momentary response probability as a predictive or explanatory concept becomes redundant. Considering the results of Experiment 1 and those of recent studies reviewed by Dunham (1977) and Timberlake and Allison (1974), reinforcement would appear to be more accurately described by the response deprivation hypothesis. Dunham's (1977) optimal duration hypothesis, which adds the property of interburst interval to that of burst duration, needs to be more fully explored.

In Experiments 2 and 3, an attempt was made to promote maintenance of effective toothbrushing and flossing by the application of a contingency between these two behaviours. Experiment 2 also employed different levels of self-monitoring. Subjects in Experiment 2 were young university students; Experiment 3 utilized private dental patients as subjects. Instruction in the Premack Principle failed to contribute to maintenance in either experiment, beyond the effect of instruction in oral hygiene procedures per se. In Experiment 3, a Premack Principle by Trials interaction approached, but did not obtain, statistical significance, when the plaque scores were analyzed. Unfortunately the gingival scores did not show a similar trend. As has been previously discussed, gingival scores more accurately than plaque scores reflect a person's usual oral hygiene performance.

Despite the apparent utility of the Premack Principle in experimental situations, adaptability to a self-management program remains questionable. As Mahoney (1972) has pointed out, an application of the Premack Principle requires self-imposed deprivation of the contingent event, if reinforcement
is to occur. Skinner (1953) has made a distinction between "controlled" (instrumental) and "controlling" (contingent) responses. While the instrumental response may be controlled by the contingent response, the maintenance of the contingency must ultimately be controlled. To use toothbrushing and flossing in this example, contingent brushing may control flossing so long as the contingency is in effect. Once this control is weakened, reinforcement can no longer be expected to occur. Many self-management programs are sabotaged when the client increasingly engages in unearned contingent responding (Goldiamond, 1976). It seems plausible that the Premack Principle failed to show any clear maintenance effect in the present study due to subjects' failure to maintain the contingency between flossing and brushing. Thus while the technique may be effective, its successful implementation as a self-management strategy needs further examination.

In addition to the Premack Principle, Experiment 2 also examined self-monitoring as a possible self-management technique for preventive dental programs. Self-monitoring also failed to augment the effects of oral hygiene instruction alone. The results of previous studies in the self-monitoring literature would suggest that toothbrushing and flossing would be ideal reactive target responses. Both responses are highly specific, discrete, and easily measurable. As they relate to gingival health, both responses have a positive valence. Dental instruction was designed to produce strong expectations of positive outcome, and subjects indicated that this in fact occurred. Subjects also indicated a willingness to spend the necessary daily time to improve their oral health. Subjects who periodically evaluated and monitored their oral hygiene technique by means of plaque disclosing tablets were expected to demonstrate oral hygiene improvement at least equivalent to the other self-monitoring conditions. The scale used for evaluation, counting
the number of teeth on which plaque remained, was simple and allowed for observation of improvement. Other studies have shown that regular plaque disclosure is at least as effective as instruction and other forms of feedback, in reducing plaque scores over six to eight weeks (Barrickman and Penhall, 1973; Cohen et al., 1972; Friedman et al., 1974). The Friedman et al. study found plaque disclosure equally effective as instruction; the other two studies found that plaque disclosure improved on instruction, as determined by changes in plaque, but not gingival, scores. Barrickman and Penhall (1973) additionally reported that most improvement on plaque scores occurred when subjects graphed their weekly PII and GI data. This finding, however, was based on extremely small group sizes.

Studies in the self-monitoring literature in which feedback contributes to reactivity have already been described (Fink and Carnine, 1975; Kazdin, 1974a; Mahoney, Moore, Wade, and Moura, 1973). When SM provides information which allows for comparison of current performance with performance goals, reactivity is enhanced (Fisher et al., 1976; Richards, 1975; Richards et al., 1976, 1978). The Fisher et al. study provides the only example of weight loss due to self-monitoring daily weight. Subjects were able to compare their daily weight with goal weight which was indicated by a diagonal on their self-monitoring graph. In the present study, subjects in the self-monitoring frequency plus evaluation condition of Experiment 2 were not provided with explicit performance goals. All subjects who self-monitored frequency of brushing and flossing were asked to perform these activities once per day. It is possible that subjects who additionally evaluated their oral hygiene effectiveness would have shown greater improvement if a performance goal criterion had been arranged. Monitoring daily performance on a graph also presents an interesting possibility. This might better illustrate the cumulative
effect of criterion performance to the monitor.

The lack of clear treatment group differences at one month post-instruction may also be due to the powerful contribution of oral hygiene instruction. The treatment control group which received one group instructional session followed by one review session showed substantial improvement on both dental indices one month later. Experiment 2 employed university students who spend much of their time in didactic instruction, and thus might be expected to benefit most from this type of instructional format. Other subject samples, however, have shown short-term benefit from didactic instruction. Radentz et al. (1973) found that videotaped instruction produced equivalent improvement in flossing technique as individualized instruction, in army recruit subjects. A combination of these two modes of instruction, however, produced greatest improvement in flossing (Radentz et al., 1975). Williford et al. (1967) found that six lectures given by a dentist to high school students resulted in improved dental scores over the three-month experimental period. Treatment gains not only persisted but increased over a three-month follow-up period. Zaki and Bandt (1974) have even demonstrated improved plaque scores and oral hygiene performance in periodontal patients provided with an opportunity to study a self-teaching manual. It is apparent, particularly after examination of the one-month postinstructional results of Experiment 2 of the present study, that minimal intervention may be sufficient to initiate effective oral hygiene performance. It also seems likely that the evaluation of additional instructional techniques becomes exceedingly difficult against such greatly improved performance.

While instruction was expected to produce short-term gains, the additional treatment components of Experiment 2 were expected to produce significantly greater maintenance. Six months following the postinstructional
assessment, however, no clearly significant group differences were apparent. Even the no treatment control group was statistically equivalent to the treatment groups, although these subjects were assessed only two, and not six, months following the second assessment. This finding corroborates some previous research, regarding the effects of measurement per se. Podshadley and Schweikle (1970) found that repeated assessment produced as much improvement in plaque scores over a four-month interval as one session of instruction, in young public school children. Evans et al. (1975) reported similar results with junior high school students. These findings underline the importance of employing appropriate control groups, when evaluating any behaviour change technique. The continued improvement in no-treatment control subjects in Experiment 2 also illustrates the desirability of performing multiple assessments, in order for appropriate experimental comparison.

Until recently the question of durability of behavioural intervention has not been seriously entertained. Keeley, Schemberg, and Carbonell (1976), for example, found that most operant studies published during 1972 and 1973 contained insufficient follow-up data to evaluate maintenance. This trend has unfortunately persisted in the recent self-monitoring literature. There are, however, a number of studies which have examined this issue. Those described earlier have provided equivocal data. Some studies have demonstrated behaviour change to persist only during self-monitoring, while others have shown that behaviour change initially produced by self-monitoring is maintained for varying lengths of time. Hall et al. (1974) have discussed the importance of selecting an appropriate follow-up period. They found that weight loss due to self-monitoring was maintained over three, but not six, months. The majority of experimental evidence supports the contention that the effects of self-monitoring are ephemeral.
When self-monitored behaviour change has persisted, it has usually occurred due to the imposition of additional techniques. Fading of SM (Maletzky, 1974), or of tokens which were contingent on reactive SM (Sanson-Fisher et al., 1978; Seymour and Stokes, 1976; Turkewitz et al., 1975) has successfully produced maintenance. Teacher praise has been found to maintain students' study behaviour which was initially increased during SM (Broden et al., 1971). Finally, Hall and her colleagues have evaluated an interesting self-monitoring maintenance procedure. In the first study, subjects who had participated in a weight reduction program mailed in self-monitoring records at bimonthly intervals. These subjects improved on treatment gains at least as much as subjects who attended bimonthly booster sessions, over a three-month follow-up period. A no-contact group gained weight over this period (Hall et al., 1975). More recently, Hall, Bass, and Munroe (1978) found that subjects who mailed their self-monitoring records to the therapist every two weeks, and subjects who attended bimonthly booster sessions both maintained weight loss better than minimal-contact subjects over six months. However, at one-year follow-up, six months following the cessation of maintenance procedures, there were no significant differences between the three groups. Kingsley and Wilson (1977) also found weight gain to ensue following termination of successful booster sessions.

There is limited evidence, then, that SM will produce maintained behaviour change. There is even less evidence that behaviour change can be maintained by the Premack Principle. Additional procedures must be implemented to promote maintenance, following behaviour change originally produced by these techniques. Results of the dental studies reviewed earlier are consistent with this finding. One of the most successful treatment regimens has included oral hygiene instruction
and supervision combined with frequent professional prophylaxis and fluoride application. This type of program typically results in improved plaque and gingival scores and reduced caries incidence (Axelsson et al., 1976; Hamp et al., 1978; Lindhe et al., 1975). Unfortunately, consistent with many behavioural follow-up studies, improved oral health typically regresses to, and often beyond, pretreatment levels, once supervision is discontinued (Lindhe and Koch, 1967; Horowitz et al., 1977). Suomi et al. (1971), however, provided adult subjects with prophylaxis and instruction at two- to four-month intervals over three years. At a 32-month follow-up, experimental subjects evidenced better oral health than controls, although differences were less than at the end of the three-year treatment period (Suomi et al., 1973). Several other studies in the dental literature have reported promising follow-up data. Durlak and Levine (1975) reported that army outpatients' oral hygiene improved over a five-month follow-up interval following group instruction in oral hygiene and evaluation techniques, and individualized feedback. Subjects learned to evaluate their own performance gains. Unfortunately there was no control group. Martens et al. (1973) found that instruction, participation in dental learning projects, individualized interaction with a dental hygienist, and token reinforcement for improved oral hygiene resulted in better plaque scores, over a six-month follow-up, in second grade subjects. Control subjects were exposed to a standard dental curriculum. Finally, Godin (1976) found that six periodontal patients who were taught plaque control procedures, including scaling the hard deposits from their own teeth, and provided with optical devices for plaque disclosure, evidenced plaque and gingival scores equal to those of six control subjects who were taught plaque control procedures and had their teeth professionally cleaned. Experimental subjects continued to
improve their plaque scores, relative to control subjects, over the five-month follow-up interval. This finding has particularly interesting implications for maintenance, as removal of hard deposits from the teeth has traditionally fallen within the professional domain. These results suggest the importance of patient participation in treatment. Also, Weisenberg (1974) has suggested that dental practitioners might benefit from contract management to increase patient participation. Reduced fees, for example, may contingently increase patient adherence to a home-based plaque-control program.

On the basis of sparse follow-up data, there would appear to be at least two approaches to the maintenance of oral hygiene procedures. First, professional treatment can be supplemented with periodic "booster" sessions, providing the subject with regular contact with the treatment environment. Initial treatment gains appear to be maintained for the duration of this regimen. Compared to remedial treatment, this type of program which focuses on prevention of gingivitis and periodontal disease compares favourably from a cost-benefit perspective (Birkeland and Axelsson, 1976). Failure to maintain this kind of regimen, however, can result in the gradual deterioration of oral health. A second approach to maintenance of behaviour change involves generalization of treatment effects to the natural environment. The present study attempted to accomplish this by presenting the Premack Principle and self-monitoring as skills which subjects could employ on their own, long after initial instruction. Neither technique can be considered successful in the present study. There are, however, some studies which present provocative examples of successful generalization to the natural environment. Hunt and Azrin (1973) found that controlled social drinking as a treatment goal for alcoholics was more successful when family members were supportive,
and served to reinforce adherence to the treatment program. Stuart and Davis (1972) have suggested that family members might successfully reinforce appropriate eating behaviour in obese subjects. Their hypothesis has recently received empirical support. Brownell, Heckerman, Westlake, Hayes, and Monti (1978) found that obese subjects lost most weight at three and six month assessment sessions when their spouses agreed to participate in treatment and were trained in behavioural weight control techniques. The substantial weight losses achieved by these subjects were not realized by subjects whose spouses were uncooperative, or who were cooperative but not trained in the behavioural techniques. The importance of family involvement in medical treatment programs has also been discussed by Becker and Green (1975). Behaviour change programs, then, might produce more durable results by reorienting their focus from the transient treatment environment to the stable natural environment.
REFERENCE NOTES


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APPENDIX I

Subject Consent Form

Basic Rights and Privileges of Volunteer Subjects

Any person who volunteers to participate in experiments conducted by full or part-time members of the faculty of the Department of Psychology at the University of British Columbia, by their employees, or by the graduate and undergraduate students working under the direction of faculty members of the above named Department, is entitled to the following rights and privileges.

1. The subject may terminate and withdraw from the experiment at any time without being accountable for the reasons for such an action.

2. The subject shall be informed, prior to the beginning of an experiment, of the maximum length of time the experiment might take and of the general nature of the experiment.

3. The subject shall be informed, prior to the beginning of an experiment, of the nature and function of any mechanical and electric equipment which is to be used in the experiment. In cases where the subject is in direct contact with such equipment, he shall be informed of the safety measures designed to protect him from physical injury, regardless of how slight the possibility of such injury is.

4. The subject shall be informed prior to the beginning of an experiment, of the aspects of his behavior that are to be observed and recorded and how this is to be done.

5. Any behavioral record that is obtained during the course of the experiment is confidential. Any behavioral records that are made public through either journal papers or books, public addresses, research colloquia, or classroom presentations for teaching purposes, shall be anonymous.

6. The subject shall be offered, at the end of an experiment, a complete explanation of the purpose of the experiment, either orally by the experimenter or, at the option of the experimenter, in writing. The subject shall also have the opportunity to ask questions pertaining to the experiment and shall be entitled to have these questions answered.

7. The subject has the right to inform the Chairman of the Departmental Committee on Research with Human Subjects of any perceived violations of, or questions about, the aforementioned rights and privileges.

TITLE OF STUDY: ________________________________

DATE: ________________________________

I have read the above statement of my rights as a volunteer subject, understand the conditions of this experiment and am participating voluntarily.

SIGNED: ________________________________
APPENDIX II

Faculty of Dentistry Disclaimer

I understand that this study is being sponsored by the Department of Psychology as part of a PhD dissertation. Further, the Faculty of Dentistry assumes no responsibility for this study, other than providing facilities for the study's execution. My participation in this study does not entitle me to subsequent treatment or other services supplied by the Faculty of Dentistry.

Signed:

Date:
APPENDIX III

Medical History Form

Name: ____________________________

<table>
<thead>
<tr>
<th>Yes</th>
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1. Do you see a doctor regularly? Why? (Answer at foot of page).
2. Are you presently under treatment for any illness?
3. Are you taking medicines of any kind or have you taken medicines during the past six months (e.g. heart pills, insulin, cortisone)? What are they?
4. Do you take birth control pills?
5. Have you in the past had any major illness or operation?
6. Do you have heart disease (e.g. Rheumatic fever, congenital defect)?
7. Are you a diabetic?
8. Have you ever bled heavily or had any other difficulty after dental treatment?
9. Do you currently suffer any dental pain or discomfort?

Please elaborate on the above questions, where necessary:
APPENDIX IV

Postexperimental Questionnaire, Experiment 1

Name ________________________________

1. What do you think was the purpose of this study? How did this assumption affect your brushing and flossing?

2. When you were not allowed to brush, or floss, did you compensate for this by brushing or flossing longer, or by brushing or flossing longer or more often at home?

3. When you had to do one (e.g. brush) for a certain amount of time to be allowed to do the other (e.g. floss), did you tend to spend longer with the first, (e.g. brush) or try to do the second (e.g. floss) more efficiently?
4. Do you think that your brushing and flossing takes a longer or shorter time when someone is recording?

5. Do you think that there is any change in the amount of time you spend brushing and flossing, after participating in this study?

6. Additional comments?
APPENDIX V

Self-monitoring Chart: No-Contingency, SM - Frequency

Please indicate, each day, the times when you brushed and flossed your teeth.
Also, please bring this chart with you to the next assessment session in March.

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</table>

Name ____________________________
Please indicate, each day, the time when you brushed and flossed your teeth.
On the days specified (D), disclose for plaque after brushing and flossing, and
indicate the number of teeth on which plaque remains. Then remove this plaque.
Please bring this chart to the next dental assessment in March.

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</table>
APPENDIX VII

Self-monitoring Chart: Contingency, SM-Frequency

Please indicate, each day, the time and order of brushing and flossing. Remember that flossing must occur before brushing. Please bring this chart to the next dental assessment in March.

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</table>
APPENDIX VIII

Self-monitoring Chart: Contingency, SM-Frequency + Evaluation

Please indicate, each day, the time when you brushed and flossed your teeth. Remember, you can only brush after you have flossed. On the days specified (D), disclose for plaque after flossing and brushing, and indicate the number of teeth on which plaque remains. Then remove this plaque. Please bring this chart to the next dental assessment in March.

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<th>Sun</th>
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</table>
APPENDIX IX

Criteria for the Gingival Index (GI)\textsuperscript{1}:

0: Normal gingiva.
1: Mild inflammation - slight change in colour, slight oedema. No bleeding on probing.
2: Moderate inflammation - redness, oedema and glazing. Bleeding on probing.
3: Severe inflammation - marked redness and oedema. Ulceration. Tendency to spontaneous bleeding.

Criteria for the Plaque Index (PII)\textsuperscript{2}:

0: No plaque in the gingival area.
1: A film of plaque adhering to the free gingival margin and adjacent area of the tooth. The plaque may only be recognized by running a probe across the tooth surface.
2: Moderate accumulation of soft deposits within the gingival pocket, on the gingival margin and/or adjacent tooth surface, which can be seen by the naked eye.
3: Abundance of soft matter within the gingival pocket and/or on the gingival margin and adjacent tooth surface.

1. from Loe and Silness, 1963.
2. from Silness and Loe, 1964.
APPENDIX X

Subject Data Form

Subject:

<table>
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<th>Inflammation</th>
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<table>
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<th>Plaque</th>
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APPENDIX XI

Preinstructional Questionnaire, Experiment 2

UBC Dental Study

Name ________________________  Age ______
Address ________________________  Sex ______
Phone # ________________________

Please answer all the following questions. Confidentiality is guaranteed.
1. Have you ever received formal oral hygiene instruction? yes __ no __

2. When was the last time you visited a dental office? _____________

3. What was the reason for that visit?
   (a) toothache, or other pain ______
   (b) routine check-up ______
   (c) routine hygiene treatment ______
   (d) routine dental repair ______
   (e) specialized treatment (e.g. orthodontic, endodontic) ______
   (f) other (specify) ____________________________

4. Assuming that you had to do one or the other, would you rather brush or floss your teeth? __________________________

5. How many times in the last 7 days did you brush? _____ floss? _____

6. How many times in the last 24 hours did you brush? _____ floss? _____

7. When __________________________
   Where __________________________
   In what order ____________________
   do you normally brush and floss?

8. How long do you think it normally takes you to brush? _____
    floss? _____
9. How many others live in your household? _____

10. How many of these people regularly (at least once per day) brush? _____

floss? _____

11. How important is it for you to have good health?
   (please circle one number)
   
   extremely 1 2 3 4 5 6 not at all 7
   
12. How important is it for you to have healthy teeth and gums?
   
   extremely 1 2 3 4 5 6 not at all 7
   
13. How important is it for you to keep your teeth for the rest of your life?
   
   extremely 1 2 3 4 5 6 not at all 7
   
14. Do you think it is possible to keep your own teeth for the rest of your life?
   
   yes, definitely 1 2 3 4 5 6 definitely not 7
   
15. How important do you think regular brushing is for maintaining healthy teeth and gums?
   
   extremely 1 2 3 4 5 6 not at all 7
   
16. How important do you think regular flossing is for maintaining healthy teeth and gums?
   
   extremely 1 2 3 4 5 6 not at all 7
17. How important do you think your diet is to your dental health?

<table>
<thead>
<tr>
<th>Extremely</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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<tr>
<td>Not at all</td>
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18. To what extent is your dental health dependent on your own actions?

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<th>Totally</th>
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<tr>
<td>Not at all</td>
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19. To what extent is your physical health dependent on your own actions?

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20. How would you describe the present state of your physical health?

<table>
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<tr>
<th>Extremely good</th>
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<tbody>
<tr>
<td>Extremely poor</td>
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</table>

21. How would you describe the present state of your dental health?

<table>
<thead>
<tr>
<th>Extremely good</th>
<th>1</th>
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<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
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<tbody>
<tr>
<td>Extremely poor</td>
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22. Would you be willing to spend 15 minutes each day brushing and flossing your teeth, if it would improve your dental health?

<table>
<thead>
<tr>
<th>Yes, definitely</th>
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<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definitely not</td>
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23. Do you smoke? Yes ______ No ______

If yes, how much? ____________________

24. Do you regularly use a mouthwash, or breath sweetener? Yes ______

No ______
1. Since the first dental assessment in Jan./Feb., have you received professional oral hygiene treatment, either from a dentist or a hygienist? yes ______ no ______

2. How many times in the last 7 days did you brush? _____ floss? _____

3. How many times in the last 24 hours did you brush? _____ floss? _____

4. Since participating in this study, do you brush more often, less often, or the same number of times each day, as before? (Please circle one)

5. Do you floss more often, less often, or the same number of times each day?

6. Since participating in this study, do you brush for a longer, shorter, or the same period of time, each time you brush, as before?

7. Do you floss for a longer, shorter, or the same period of time, each time you floss?

8. Do you think it is possible to deep your own teeth for the rest of your life?
   (please circle one number)

   yes, definitely 1 2 3 4 5 6 7  definitely not

9. How important do you think regular brushing is for maintaining healthy teeth and gums?

   extremely 1 2 3 4 5 6 7  not at all
10. How important do you think regular flossing is for maintaining healthy teeth and gums?

11. To what extent is your dental health dependent on your own actions?

12. During the instructional sessions, how much emphasis do you feel was placed on the importance of daily brushing and flossing?

13. Do you think that your instructional group is expected to improve on the dental indices, more, less, or the same as the other groups?

14. If more, or less, why do you feel this way? ____________________

15. What, in your opinion, would be the best way to motivate effective brushing and flossing? ____________________

Thank you ENORMOUSLY for your participation. Good luck in your exams, and hope to see you in September.
APPENDIX XIII

Seven-month Postinstructional Questionnaire, Experiment 2
UBC Dental Study: Follow-up

Name __________________________

1. Have you received oral hygiene treatment since the last assessment? yes ____ no ____ If yes, when? ______________________

2. Since participating in this study, have your oral hygiene habits changed from before? yes ____ no ____ If yes, how? ______

________________________________________________________________________

In your opinion, what was responsible for this change? ______

________________________________________________________________________

3. How many times in the last 7 days did you brush? _____ floss? _____

4. How many times in the last 24 hours did you brush? _____ floss? _____

5. How many times in a typical week during the summer did you brush? _____ floss? _____

6. In what order do you normally brush and floss? ______________________

7. How important is it for you to have good health? (please circle one number)

<table>
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<tr>
<th>extremely</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>not at all</th>
</tr>
</thead>
</table>
8. How important is it for you to have healthy teeth and gums?
   extremely not at all
   1  2  3  4  5  6  7

9. How important is it for you to keep your teeth for the rest of your life?
   extremely not at all
   1  2  3  4  5  6  7

10. Do you think it is possible to keep your own teeth for the rest of your life?
    yes, definitely definitely not
    1  2  3  4  5  6  7

11. How important do you think regular brushing is for maintaining healthy teeth and gums?
    extremely not at all
    1  2  3  4  5  6  7

12. How important do you think regular flossing is for maintaining healthy teeth and gums?
    extremely not at all
    1  2  3  4  5  6  7

13. How important do you think your diet is to your dental health?
    extremely not at all
    1  2  3  4  5  6  7

14. To what extent is your dental health dependent on your own actions?
    totally not at all
    1  2  3  4  5  6  7
15. To what extent is your physical health dependent on your own actions?

| totally | 1 | 2 | 3 | 4 | 5 | 6 | 7 | not at all |

16. How would you describe the present state of your dental health?

| extremely good | 1 | 2 | 3 | 4 | 5 | 6 | 7 | extremely poor |

17. How would you describe the present state of your physical health?

| extremely good | 1 | 2 | 3 | 4 | 5 | 6 | 7 | extremely poor |

18. Do you smoke? yes ____ no ____ If yes, how much? ________

19. Do you regularly use a mouthwash, or breath sweetener? yes ____

no ____

20. Which brand of the following do you now use?

- toothbrush _______________________
- toothpaste _______________________
- dental floss _____________________
21. Approximately how long after the instructional sessions last spring did you maintain effective regular brushing and flossing?

- never brushed and flossed regularly
- 1 month
- 2 months
- 3 months
- 4 months
- 5 months
- still brushing and flossing regularly

22. What do you think was most effective in motivating effective oral hygiene habits?

23. What do you think should have been done, in addition to this program?
APPENDIX XIV

No-treatment Control Subjects’ Questionnaire, Experiment 2

UBC Dental Study

Name ____________________________

1. Have you received oral hygiene treatment since the first assessment in August? yes ______ no ______ If yes, when? ________________
   Were you also provided with brushing and flossing instruction at this time? yes ______ no ______

2. Since the August assessment, have your oral hygiene habits changed from before? yes ______ no ______ If yes, how? ________________

3. How many times in the last 7 days did you brush? ______ floss? ______

4. How many times in the last 24 hours did you brush? ______ floss? ______
Q: What was this study all about, anyhow?

A: I'm glad you asked that question. Let me start at the beginning.

Within the context of a dissertation, my interests were twofold: to contribute to the knowledge of mechanisms of behaviour change, and to develop a viable preventative dental health program. The present study sought therefore to compare the effects of two behavioural manipulations on the maintenance of brushing and flossing. (I really did the study because it was a requirement for the degree!)

The two behavioural manipulations were self-monitoring, and the arrangement of a contingency between flossing and brushing. Self-monitoring simply refers to the systematic observation of one's own behaviour. In this study, some subjects were asked to monitor the frequency of flossing and brushing, on a daily basis, for one month. Others were additionally asked, following flossing and brushing, to disclose for plaque twice weekly, according to a schedule, and then count and record the number of teeth on which plaque remained. They would subsequently remove this plaque. These subjects would be monitoring not only their frequency of flossing and brushing, but their efficiency of plaque removal as well. Presumably they would be evaluating the effectiveness of daily flossing and brushing.

The second manipulation required some subjects to impose a contingency between flossing and brushing, such that, once a day, they could only
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brush after they had flossed. There are behavioural data which suggest that a preferred activity can reinforce a less preferred activity, if the two are arranged contingently. According to previous relative frequency and self-reported preference, brushing is preferred to flossing. Thus brushing should, according to the theory, reinforce, or increase the probability of, flossing.

In addition to 6 treatment groups, there was a no-treatment control, to observe the effects of repeated measurement alone. All other subjects received instruction in brushing and flossing in the first session, and instruction according to treatment group in the second. Some subjects were exposed to only one manipulation; others to various combinations, according to this schematic:

<table>
<thead>
<tr>
<th>Self-monitoring</th>
<th>Frequency and Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Contingency</td>
<td></td>
</tr>
<tr>
<td>Contingency</td>
<td></td>
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</tbody>
</table>

n = 15

no treatment control

Self-monitoring, and contingent arrangement between brushing and flossing comprised the independent variables. The main dependent variables consisted of a gingival index and a plaque index. Four surfaces of each of six teeth were scored according to a 0-3 scale, 0 representing healthy gums, and no plaque, and 3 representing inflamed gums, and plaque extending well past the gingiva on the tooth surface. Scores on these indices were compared pre- and post-instruction, and at a 6 month follow-up interval.