

Changing the behavior of patients with periodontitis

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Success in periodontal treatment is highly dependent upon the ability and willingness of the patient to maintain good oral hygiene. This is achieved through a combination of personal care and seeking professional help. Assistance provided by dental professionals includes removing deposits of plaque or calcified bacterial material (calculus) that may prevent effective self-care, as well as dealing with any associated secondary aetiological factors, such as smoking or dietary control (19, 51). However, even with professional help, poor oral hygiene can lead to treatment failure in the longer term (10, 46, 61, 67, 71). Furthermore, Turner et al. (87) concluded that periodontal outcomes can be improved in chronic periodontitis patients by the sole use of oral hygiene.

Improving patients' adherence to oral hygiene instructions requires changing patients' behavior in terms of brushing, flossing and the use of additional oral hygiene techniques. There is a great need in dentistry for effective interventions to improve patients' adherence to oral hygiene instructions (92), particularly to improve the long-term treatment success in periodontal patients (8). However, this is potentially challenging, as the behaviors that require adherence to oral hygiene in patients with periodontal disease display many characteristics that have been shown to predict low adherence (35, 54). Specifically, the effects of behavior change are only manifest after several weeks, thus it does not provide immediate relief of symptoms. Furthermore, flossing and brushing may exacerbate symptoms initially, and the patient might experience bleeding and pain. Inflammatory periodontal diseases require patients to make permanent lifestyle changes, because they are chronic conditions. Johansson et al. (39) assessed adherence in a sample of 44 patients with moderate periodontitis, and found that less than half reported still using interdental cleaning aides at the end of 3 years. Similarly, Strack et al. (80) assessed adher-

ence to oral hygiene through patient interviews. This study reported that 30 days after receiving the oral hygiene instructions provided within the clinic, half of the patients (51%) were 'highly compliant', while 38% were 'moderately compliant' and 11% completely failed to adhere to the instructions.

There are a wide range of psychological models and theories that provide an important framework for increasing our understanding of the determinants of adherence to recommendations concerning health behaviors. Social cognition models in particular have been repeatedly applied to predict and explain behavior changes such as screening attendance, dieting and oral hygiene behavior (21). 'Social cognitions' are beliefs, thoughts and attitudes concerning behaviors that are believed to be related to whether or not a person undertakes a particular behavior. All these models share the common assumption that an individual's behavior is best understood by examining their attitudes and beliefs. The following models will be reviewed in relation to oral hygiene behaviors:

- health belief model.
- protection motivation theory.
- locus of control.
- social learning theory.
- theory of planned behavior.
- implementation intentions.
- stages of change model (or trans-theoretical model).

For each model, an outline of the constructs involved in the model and their relationships will be given. This will be followed by a review of research exploring the relationship between the theory and health-related behaviors, including oral health-related behaviors where possible. Finally, intervention studies based on targeting the cognitions in the model will be discussed for each model. Overall, the application of social cognition models to behavior change

interventions is still in its infancy, and so there are relatively few published intervention studies. A Cochrane review of interventions to enhance oral hygiene-related behaviors in patients with periodontal disease based on social cognition models identified only four studies (64).

Health belief model

The earliest version of the health belief model comprised two core dimensions: threat perception and behavioral evaluation. Threat perception encompassed two key beliefs, perceived susceptibility to the disease (a person's subjective perception of the risk of contracting the disease) and perceived severity (a person's subjective evaluation of the impact of the disease or consequences of the illness). Behavioral evaluation also consisted of two distinct sets of beliefs, perceived benefits (the subjective evaluation of the effectiveness of various actions available in reducing the threat) and perceived barriers (which describe a person's anticipated negative aspects of a particular behavior).

According to this model, the combination of high levels of susceptibility and severity increases motivation to act, whereas perceptions of benefits (fewer barriers) provide the preferred path of action. In 1977, the concept of a 'cue to action' was added to account for any stimuli that might trigger behavior. These cues can be internal, such as experiencing symptoms, or external, for example reading a health information leaflet or receiving a reminder from the doctor (15). This model is summarized in Fig. 1.

Janz & Becker (38) assessed the predictive validity of the four fundamental variables in the health belief model for a variety of health-related behaviors. The results were presented within three behavioral categories: preventive behaviors (where the primary purpose is to prevent a disease that the individual does not currently have; examples of such behaviors

include inoculation, screening attendance and self-examination), sick-role behavior (behaviors designed to ameliorate the effects of existing disease, such as diet, adherence to medication regimen and exercise), and clinic utilization (which included preventive and acute visits).

In studies assessing preventive behavior, 'susceptibility', 'benefits' and 'barriers' were most consistently associated with behavior, whereas the 'severity' construct seemed to be a much poorer predictor, producing significant results in only around one third of the studies. Turning to sick-role behaviors, the 'severity' construct becomes a much better predictor of behavior, producing the second highest significance ratio. The best predictor across all studies assessing sick-role behavior was the 'barriers' construct, which was significantly correlated with behavior in all of the studies that examined this relationship. Although 'benefits' was also consistently associated with behavioral outcomes, perceived susceptibility was a much weaker predictor for this type of behavior. The reviewers point out that this construct may have little relevance for people who are already diagnosed with an illness. Summarizing the three studies assessing clinic utilization proved more difficult as each one assessed a different type of clinic utilization. Nonetheless, the 'benefits' construct seemed to produce the most consistent results across those studies.

In order to assess the relative predictive validity of each of the four theoretical constructs, Janz & Becker (38) calculated the ratio of positive and statistically significant findings for each construct to the total number of studies in which the construct was tested. Across all 29 studies included in the review, the 'barriers' construct was the best predictor of behavior, as it was positively and significantly correlated with behavior in 91% of the studies, followed by 'benefits' (81%), 'susceptibility' (77%) and 'severity' (59%).

Harrison et al. (34) attempted to estimate the strength of relationships between health belief model variables and health-related behaviors across studies in a meta-analytic review that broadly followed the inclusion criteria of the original review by Janz & Becker (38). A total of 51 studies matched their inclusion criteria, 20 of which were included in the original review by Janz & Becker (38). This number was further reduced to 16 when studies that did not assess the reliability of the measures were excluded. Those 16 studies assessed a range of behavioral outcome variables, such as vaccination, doctor visits, self-examination, diet and pill taking.

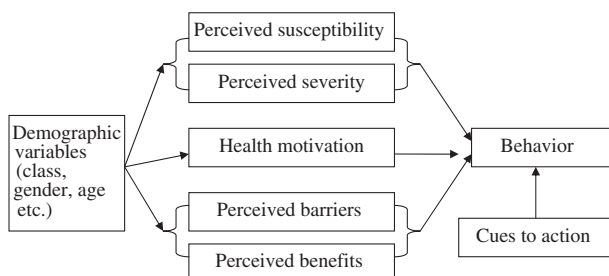


Fig. 1. The health belief model. Source: (2).

Seventeen effect sizes were calculated from the 16 studies, as one study analyzed two samples separately. Significant positive relationships between health belief model dimensions and behavioral outcomes were found. The results of this review indicate that a maximum of 10% of the variance of behavior can be accounted for by any of the four dimensions. However, as the authors point out, the combined effect of all four dimensions may be smaller or larger than the sum of all four individual dimensions (34).

Evidence of the ability of the health belief model constructs to predict adherence in patients with periodontal disease is equivocal. Three studies in this area have been published, all of which included measures of clinical status as proxy measures of adherence, rather than assessing oral hygiene behaviors directly. Kühner & Raetzke (42) examined the validity of the health belief model in 96 periodontal patients. Participants received a complete periodontal examination at their first visit to the clinic, and completed a measure assessing components of the health belief model. Following this visit, all participants received a diagnosis and oral hygiene instructions together with information about the relationship between oral hygiene and periodontal disease. Participants were assessed with respect to plaque control at the following visits and received feedback on their performance. The treatment performed at each visit varied according to patients' needs, but the total number of visits was limited to a total of four visits per patient. Changes in oral hygiene behavior were assessed through changes in bleeding on probing. Compliance was significantly correlated with four out of five items exploring 'motivation', two out of three items exploring 'seriousness' and two out of three assessing 'benefits', but none of the items exploring 'susceptibility', 'barriers' or 'dentist-patient relationship'. A further integrated-predictive variable was calculated, which assessed the combined predictive power of all significant variables. The results showed that the combination of these variables explained around a third of the variance in oral hygiene behavior.

Barker (14) used the health belief model as the basis for a study of the role of patients' health beliefs in compliance with preventive dental advice amongst 43 adult patients attending a secondary care dental service. Patients were seen twice, 1 month apart. Compliance was defined as any reduction in plaque or bleeding scores at the second visit. The perceived 'benefits' of treatment showed a significant correlation with compliance, and a combination of 'sus-

ceptibility' and 'benefits' beliefs was also found to be significantly related to compliance.

Rayant & Sheiham (62) used the gingival index (48) and the plaque index (48) as indicators of adherence in patients with periodontal disease. None of the factors in the health belief model were significantly associated with the periodontal status of these patients.

These three studies together suggest that the health belief model plays a small role in predicting the oral hygiene-related behavior of individuals with periodontal disease. Perhaps the most important variable is beliefs about the 'benefits' of oral hygiene. This has obvious implications for patient education.

Protection motivation theory

Rogers (66) originally formulated the protection motivation theory in an attempt to provide a theoretical framework that could help explain empirical data from previous studies on 'fear appeals' (behavior change communications based on creating fear within the target audience). This research was based on the fear-drive model, which proposes that fear is a driving force that motivates changes in behavior in order to avoid negative consequences. Research by Hovland et al. (37) suggested that a fear appeal contains three main stimulus variables: (i) the noxiousness of an event, (ii) the probability of occurrence if no protective behavior is adopted or existing behavior is not modified, and (iii) the efficacy of a recommended coping response in reducing or eliminating the noxious event.

Rogers (66) included these variables in the original formulation of the model, but further proposed that each stimulus variable initiates a corresponding cognitive response that motivates the individual to protect themselves from the threat (hence protection motivation theory). Rogers later expanded his theory in order to incorporate additional cognitive mediators, such as self-efficacy, response efficacy and perceptions of the rewards of mal-adaptive responses. This newer version of the model was organized into two parallel cognitive processes, threat appraisal and coping appraisal (see Fig. 2).

Threat appraisal focuses on the source of the threat and is the product of a cognitive response resulting from a persuasive communication identifying an event or illness as harmful and likely to occur, along with the belief that the recommended behavior is effective in preventing this negative event. As a result,

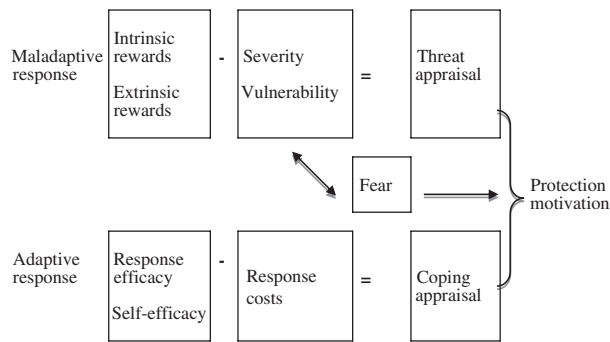


Fig. 2. Protection motivation theory. Source: (66).

the individual will be motivated to take action to protect themselves from the threat if the illness (in this case periodontal disease) is appraised as having negative consequences, being likely to occur and if the behavior (oral hygiene) can prevent the disease.

Coping appraisal focuses on the perceived coping resources available to the individual. If a person believes the recommended behavior is effective in reducing the threat (response efficacy) and also feels able to perform the recommended action (self-efficacy), then he or she is more likely to engage in the recommended behavior.

An early narrative review of studies applying the model (58) reported that, with regard to threat appraisal, 'severity' was found to be a good predictor of a range of behaviors, whereas 'vulnerability' was predictive of the intention to engage in a behavior. Within the coping appraisal process, response efficacy was found to be a good predictor of changes in intentions, while perceptions of self-efficacy predicted changes in preventive practices. In 2000, two meta-analytic reviews were published (28, 55) that provided a more quantitative understanding of the model variables. Floyd et al. (28) reviewed a total of 65 studies. Out of the 65 studies, 16 focused on only one of the variables of the model, whereas 49 studied multiple components of the theory. Sixteen of the 49 studies assessed intention and behavior, 22 only measured behavior, and 11 of the studies used intention to engage in the behavior as their only dependent variable. All studies were rated on nine points assessing their methodological quality, and each was given a score from 1 (poor) to 5 (excellent). The mean score for all studies combined was 4.2, indicating that on the whole the studies were of high quality. The heterogeneous effect sizes for this review ranged from 0.39 to 0.88, which represents small to medium effects. On the whole, effect sizes for coping appraisal variables were slightly larger than those for threat appraisal variables. The largest

effect size for a single variable in this review was for self-efficacy. In general, coping variables showed slightly stronger relationships with adaptive responses compared to threat variables, but the effect sizes for both coping and threat variables were still in the moderate range.

This pattern of results was largely confirmed in the review by Milne et al. (55), which contained a smaller number of studies due to more rigorous inclusion criteria. A total of 27 studies comprising 29 independent samples and a total of 7694 participants were included. Nineteen of the studies employed a cross-sectional study design, of which 11 measured intention only, five measured concurrent behavior only, and three measured both intention and concurrent behavior. Seven studies were longitudinal, six of which included measures of both intention and subsequent behavior, and one measured subsequent behavior but not intention. One longitudinal study measured intention, concurrent behavior and subsequent behavior. Most of the cross-sectional studies (14 of the 19) used samples from students. General population samples were used in seven studies, while another seven studies targeted specific groups. The relationship between the variables of the protection motivation theory and health-related intention is most consistently explained by coping variables. Although all of the model variables were significantly correlated with intention, the association between coping variables and intention was much stronger than the association between threat variables and intention.

To conclude, the protection motivation theory has informed a considerable amount of empirical research, and has repeatedly been shown to be significantly correlated with both intention and behavior, both in cross-sectional and longitudinal studies. However, to date, there are no published studies in which the protection motivation theory has been applied to oral hygiene. The main conclusion that can be drawn in relation to oral hygiene behaviors is probably the importance of self-efficacy beliefs in behavior change. This finding is replicated in research from other models.

Health locus of control

The term locus of control was introduced to describe a relatively stable set of beliefs held by a person about the perceived causes of events and situations. Locus of control was first postulated in relation to social learning models of behavior, which postulate that

behavior is a function of (i) the extent to which the individual believes the behavior will lead to a particular reward, and (ii) the extent to which the reward is valued. Rotter (68) also believed that social learning theory (see below) could be applied at a more general level, and that a distinction could be made between individuals with an internal locus of control (those who believe events are a consequence of their own actions) and individuals with an external locus of control (those who feel that events are unrelated to their own actions and steered by external factors instead). Rotter (68) developed the internal-external scale, which is the standard measure for assessing the generalized locus of control beliefs. Wallston et al. (90) later developed the health locus of control scale, which is a health-specific measure of the same construct.

Both these measures were based on the assumption that locus of control is a uni-dimensional construct, and consequently people were dichotomized into 'externals' or 'internals'. Hundreds of studies followed that compared the two, and, on the whole, an internal locus of control seemed to be beneficial to health, as internal individuals were more likely to engage in health-promoting behaviors compared to external individuals (83). This uni-dimensional conceptualization of the construct was later deemed inadequate, and a new approach for assessing locus of control was put forward. Levenson (45) developed the 'I, P and C scale', which differentiated between two types of external control beliefs. According to Levenson (45), external individuals could be further divided into those who feel events are influenced by powerful others, and those who believe events are contingent upon chance, luck or fate. Thus, according to this scale, people have one of the following three orientations: 'internal', 'powerful others' or 'chance'.

Based on Levenson's psychometric and theoretical expansion of the concept, Wallston et al. (90) developed the multi-dimensional health locus of control scale, which is now the most widely used measure of locus of control as applied to health behaviors.

In general, research has shown that the predictive ability of the locus of control construct increases as the behavior to which it refers is specified more exactly (44). There are a small number of studies that have explored the relationship between locus of control and oral hygiene behaviors. Two large-scale studies of the relationship between measures of dentally related locus of control and oral hygiene behavior and knowledge found only weak or insignificant relationships between these variables. Harris

et al. (33) found that locus of control was not significantly associated with dental knowledge or dental care practices in 200 adults without periodontal disease. Among 7770 health adolescents, Regis et al. (63) found low correlations between locus of control and toothbrushing frequency.

A number of studies have found a relationship between measures of locus of control and indices of periodontal disease. Knecht et al. (40) found a significant relationship between dental locus of control and a plaque index amongst diabetic patients. There was no relationship between plaque and a diabetes-related locus of control measure, demonstrating the importance of behavior-specific measures. Galgut et al. (29) investigated the relationship between the multi-dimensional health locus of control and the response of a group of 60 office workers to a plaque control programme. A significant correlation was found between the external multi-dimensional health locus of control dimension of 'powerful others' and improvements in some of the clinical criteria; a similar result was found for the 'internal' dimension of the multi-dimensional health locus of control. In contrast, there was minimal correlation between the external 'chance' dimension of the multi-dimensional health locus of control and the clinical results.

Wolfe et al. (94) assessed the relationship between oral hygiene behavior and locus of control (internal/external), self-efficacy and a further construct named 'oral health beliefs', which, according to the authors, focused 'on the role of thought in the regulation of behavior'. The sample consisted of 99 male veterans. As the outcome measure, Wolfe et al. (94) used the plaque index (48). Only external locus of control was significantly correlated with oral hygiene behavior. Given the introduction of the multi-dimensional locus of control scales around 15 years prior to their study, the authors' use of the earlier, uni-dimensional scale is somewhat surprising. Although it provided support for use of the locus of control construct in the study of oral hygiene behaviors, this study unfortunately failed to provide any information as to which type of external locus of control beliefs were correlated with behavior.

A later study by Borkowska et al. (16) failed to find any relationship between locus of control and oral hygiene behavior. This study examined the relationship between locus of control, health value, adherence intent, psychological mood and oral hygiene behavior in a longitudinal study with a repeated-measures design. Oral hygiene was assessed through bleeding on probing, plaque score and probing depth. Both psychological and clinical measurements

were taken at time 1 and time 2. At time 2, the only psychological variable (measured at time 1) significantly correlated with the clinical outcome measures was 'adherence intent', which was significantly negatively correlated with plaque score and bleeding score. The adherence intent scale consisted of four items that appeared to tap into several different theoretical constructs, such as intention ('I intend to follow the dentist's instructions'), self-efficacy ('I expect that it will be easy for me to follow the dentist's advice) and outcome expectancy ('I'm not sure the dentist's treatment will be worth the trouble it will take me'). Similarly, Odman et al. (56) found that locus of control showed no relationship with improvement in plaque scores or oral hygiene behavior following a 3-month oral hygiene instruction intervention in patients with moderate periodontal disease.

In conclusion, it appears that locus of control is correlated with clinical indices, but is not a strong predictor of oral health-related behavior. This may in part be due to the weaknesses of the various measures used, but it is also possible that an external locus of control is associated with seeking professional support for periodontal disease and in turn with improved plaque indices. Alternatively, it is possible that locus of control is susceptible to change following treatment. At least four studies have demonstrated changes in locus of control (from 'external' to 'internal') following standard periodontal treatment in patients with periodontal disease (11, 12, 75, 95).

Social learning theory

Bandura's social learning theory (13) postulates that behavior is learned through self-monitoring, skill training, modelling and visualization. According to this theory, behavior is mainly determined by incentives (personal values that an individual attaches to an outcome) and by the following three types of expectancies: situation outcome, action outcome and perceived self-efficacy. Situation outcome expectancies represent beliefs about the consequences of not engaging in a behavior. These include, among others, beliefs about the perceived threat of an illness. Action outcome expectancies are beliefs about whether or not the behavior will lead to the desired outcome. For example, the belief that flossing reduces the risk of periodontal disease is an action outcome expectancy. Self-efficacy describes the person's subjective evaluation about the ease or difficulty with which he or she

can undertake a given behavior. For example, a patient might feel that it would be easy or difficult to floss their teeth as recommended by the health professional. This theory further specifies a clear causal ordering among the three types of expectancies. Generally, action outcome expectancies are thought to mediate the effect of situation outcome expectancies on behavior, and are thought to determine behavior through their influence upon goals and intentions to engage in the behavior (74).

As with most other social cognition models, social learning theory also includes a motivational variable, which is thought to be the most immediate determinant of behavior. In this case, the variable is called goal formation, which represents self-incentives and information about what to do. This goal formation in turn is influenced by a person's sense of control, their expectancies about outcomes and socio-structural factors. According to this theory, behavior is a product of personal goals, outcome expectancies and self-efficacy beliefs. This model is summarized in Fig. 3.

Although all the above variables are part of the social cognitive theory, the construct of self-efficacy has quickly assumed the greatest importance in this theory. Many applications of this theory have solely focused on self-efficacy beliefs. Furthermore, this construct has been integrated into other social cognition models, and has often been used as a construct analogous to perceived behavioral control in the theory of planned behavior. Self-efficacy beliefs have been shown to predict sexual risk behaviors (76), physical exercise (24, 82), dieting behavior (70, 77), self-examination behaviors (7, 20) and adherence to medication regimens (81). A smaller number of studies that assessed these behaviors also included goals (41) or outcome expectancies (72).

Self-efficacy has also been shown to be an effective target in behavior change interventions. Luszczynska

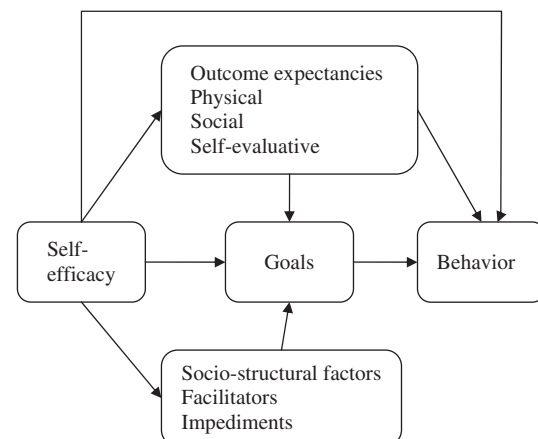


Fig. 3. Social learning theory. Source: (49).

et al. (50) found that an intervention aimed at enhancing self-efficacy beliefs produced a significant change in vegetable consumption at a 6-month follow-up.

For oral hygiene-related behaviors, Little et al. (47) adopted a social learning theory perspective when devising a group-based intervention for 107 patients aged 50–70 years with moderate to severe periodontal disease. All were members of a dental care programme run by a research organization. The control group received the usual dental care including periodontal maintenance therapy, and the intervention group additionally attended a series of five 90-minute group sessions. The group sessions provided feedback on bleeding on probing for each participant (provided by a dental hygienist), and participants in the experimental intervention group were also encouraged to define their problem in behavioral terms, set weekly targets and introduce cues to behavior change. The presence or absence of plaque was recorded using an adaptation of the Poshadley–Haley plaque index (57), and gingival bleeding was recorded using the Loe and Silness gingival index (48) but dichotomized into categories of ‘no bleeding’ and ‘bleeding’. Pocket depth and attachment loss were measured using a Florida probe. Self-reported toothbrushing and flossing were recorded, and patients were observed and rated on their skill in flossing and brushing. Measurements were taken at baseline and 4 months after baseline. Significant differences were found between the intervention and control groups for all measures, with the intervention group showing more favourable scores in all cases.

Within a social learning framework, Weinstein et al. (93) also conducted a small trial of 20 patients (11 women, 9 men) aged between 32 and 50 years and described as presenting with, ‘periodontal problems for which long term behavioral maintenance of oral hygiene routines were necessary as judged by a periodontist’. No further data regarding the clinical condition of patients were provided. The active intervention was based upon the principles of ‘operant and classical conditioning’. Equal numbers of participants (five per group) were assigned to one of four groups (two control groups and two experimental groups). The two control groups received instructions on oral hygiene and maintenance of their periodontal health, and the second control group was also required to telephone the periodontist twice a week, provide a self-assessed plaque score and receive feedback on their performance. The two experimental groups were both treated in the same

way as the second control group; in addition, the first experimental group visited their dentist twice a week and were given praise and feedback by the periodontist, and the second experimental group also received the praise and feedback, but were also given a check list to monitor their own behavior. Plaque scores were assessed at baseline, and 30 and 60 days later. There were no drop-outs. Significant decreases in plaque scores were noted over time, and the magnitude of the decline in plaque scores varied across the four groups. The greater the degree of intervention, the greater was the magnitude of the decline in plaque scores.

Within a similar theoretical framework, Stewart et al. (79) assigned 100 men aged 21–65 years attending a US Veterans Affairs outpatient clinic to one of four groups: intervention based on cognitive behavioral principles, an educational intervention (four 40-min presentations by a periodontist designed to increase knowledge of the causes of dental disease and techniques for intervention), an attention control group (a group who were given some contact with the research team but no active intervention, to control for the possible effect of simple attention from a researcher) and a control group. The control group received no intervention. The cognitive behavioral intervention was conducted by a psychologist and took place over two sessions that included cognitive restructuring, verbal reinforcement, use of cues to facilitate behavior, and problem solving to address barriers to behavior change. The attention control group attended two lectures on procedural aspects of dentistry. Three measures were assessed at baseline and at follow-up (5 weeks post-baseline, 2 weeks post-intervention): the Silness and Loe plaque index (48), self-reported brushing and self-reported flossing. At the end of the study only the comparison of the control group with the cognitive behavioral intervention group was significant for self-reported brushing. For self-reported flossing, there were significant differences between the control group and all three other groups. However, there were no differences between the attention control group, the educational intervention group and the cognitive behavioral intervention group. The cognitive behavioral intervention does not appear to offer any advantage over an attention control. Similarly, while the attention control group, the educational intervention group and the cognitive behavioral intervention group showed significant differences compared to the control group with respect to plaque scores, the cognitive behavioral intervention showed no advantage over the attention condition.

In summary, the social learning theory, in particular the self-efficacy construct, has been shown to be a very reliable predictor of health behavior change. There is some evidence that interventions based on this model can be effective in promoting behavior change.

Theory of planned behavior

The theory of planned behavior (4, 5) was preceded by and builds upon the theory of reasoned action (27). The latter was originally formulated in an attempt to explain the mediating processes between attitudes and behavior, which, according to this theory, is the intention to act. This theory also draws on the expectancy value model, and assumes that intentions are a product of careful deliberation of available information. Fishbein & Ajzen (27) further incorporated evidence from previous studies by developing the ‘principle of compatibility’, which states that the relationship between attitudes and behavior is greatest if both are measured to the same degree of specificity, especially with respect to the dimensions action, target, context and time. According to this principle, the relationship between attitudes and behavior is greatest if the behavioral statement corresponds with the target behavior in terms of these dimensions. Thus, specific behaviors are best predicted by specific attitudes, and general behaviors are best predicted by general attitudes. For instance, specific repeated single behaviors, such as flossing, require targeting of specific attitudes, rather than more general attitudes that may predict general behaviors such as healthy eating. Originally this theory was formulated to explain purely volitional behavior. Behaviors requiring resources that are not freely available, such as skills, time, money or opportunities, were not originally within the remit of this model. In order to account for behaviors that are not under complete volitional control, Ajzen (5) added the perceived behavioral control construct. This extension of the theory of reasoned action was named the theory of planned behavior.

The theory of planned behavior (Fig. 4) states that the intention to perform an action is the most immediate predictor of behavior. In turn, this intention is determined by attitudes towards the behavior, perceptions of personal control over the behavior and beliefs about social norms. The concept of ‘attitudes’ in this theory refers to a general evaluation of the positive and negative aspects of the behavior. For instance, a behavior might be evaluated as unpleas-

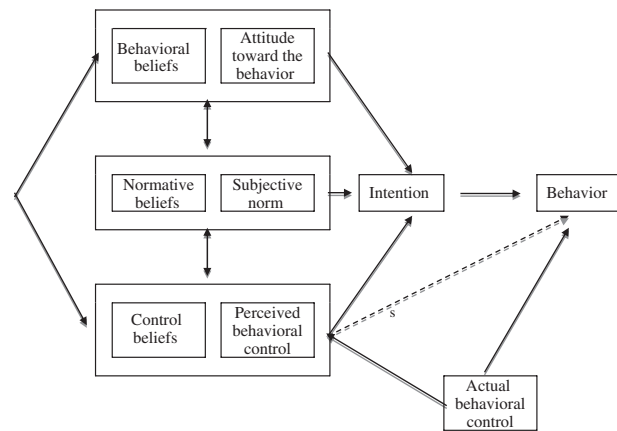


Fig. 4. The theory of planned behavior. Source: (6).

ant/pleasant, unwise/wise, bad/good, unnecessary/necessary and uncomfortable/comfortable. In general, positive attitudes are thought to predict positive intentions to perform the behavior. The subjective norm refers to the perceived social pressure to perform or not perform the behavior, and is usually assessed through two items in questionnaire measures of the construct: specifically, ‘Most people who are important to me think that it is important that I ...’ and ‘People who are important to me want me to ...’. Normative beliefs are measured using items such as ‘Those important to me think I should do X’, whereas motivation to comply is assessed through a further item, such as ‘It’s important to me to do what others think I should do’. According to this theory, an individual is more likely to engage in a behavior if he or she perceives that significant others endorse the behavior, and if this person wishes to conform to this pressure. Both attitudes and subjective norm are thought to be direct antecedents of intention. Therefore, intention is the mediating variable between attitudes/subjective norm and behavior. Perceived behavioral control describes the constraints as perceived by the individual. It is generally accepted that individuals are more disposed to engage in behaviors that they feel are achievable and under their personal control. The direct relationship between perceived behavioral control and behavior is thought to reflect the extent to which measures match actual control.

Generally, reviews of the theory of planned behavior have assessed the strength of associations between each of the theoretical constructs and intention and behavior, and have attempted to assess the amount of variance in intention and behavior that is explained by the model’s constructs. In addition, some authors have attempted to disentangle how different conceptualizations and measurements

of the construct affect the overall relationship between the variables, and some have investigated the success of the model when applied to behavior change interventions.

In 2001, Armitage & Conner (9) conducted a meta-analytic review of the theory of planned behavior in relation to observed and self-reported behavior. They located 161 articles comprising 185 independent empirical tests of the theory. Out of the 161 studies, 44 contained prospective measures of self-reported behavior, and 19 of the prospective studies employed objective measures of behavior. The reliability of the findings was assessed using Rosenthal's fail safe number (67). This number indicates the number of studies that would be required to nullify the present findings. All relationships in this review exceeded the required tolerance level. Across all behaviors, intention and perceived behavioral control accounted for 27% of the variance in behavioral outcomes, with a mean multiple correlation of 0.52. Overall, perceived behavior control adds a further 2% to the prediction of behavioral outcomes, over and above intention. Turning to the prediction of *intention* rather than behavioral outcomes, the authors found that 39% of the variance in intention was accounted for by the subjective norm, attitudes and perceived behavioral control variables. Assessed individually, the subjective norm variable was the weakest predictor of intention ($R^2 = 0.12$) compared to attitudes ($R^2 = 0.24$) and perceived behavioral control ($R^2 = 0.18$).

It seems possible that the outcome used in the study is important in determining how well the theory of planned behavior fits the data. Armitage & Conner (9) reported that theory of planned behavior variables accounted for 55% of the variance in self-reported behavior compared to only 44% in observed behavior. Although this difference is significant, the effect sizes for both outcomes were both within the medium to large range.

A further review performed by Godin & Kok (30) assessed application of the theory of planned behavior specifically to health behaviors, covering studies published between 1985 and 1996. They located a total of 56 studies (58 behavioral applications) that matched their inclusion criteria. Twenty-six of those studies included behavioral outcomes. The behaviors covered included: addictive behaviors, driving, attending screening, eating, exercising, HIV/AIDS risk behaviors and oral hygiene. Across all included studies, the mean correlations between intention and attitude, subjective norm and perceived behavioral control were 0.46, 0.34 and 0.46, respectively. For oral hygiene-related intentions, the

association between subjective norm and intention was particularly strong ($r = 0.42$). The reviewers concluded that, for health behaviors, approximately one third of the variation in behavior can be explained by the combined effect of intention and perceived behavioral control.

Exploring studies that examined the relationship between oral hygiene behavior and the theory of planned behavior in more detail, McCaul et al. (53) assessed self-efficacy in conjunction with the theory of reasoned action variables as applied to oral hygiene behavior. They found that self-efficacy beliefs further predicted brushing and flossing intention, but failed to add to the amount of variance explained for self-reported behavior. A similar study (86) assessed the combination of self-efficacy and theory of reasoned action variables in predicting oral hygiene behavior in a sample of periodontal patients, and found that self-efficacy added to the variance explained by the theory of reasoned action variables. While the combination of theory of reasoned action variables explained 46% of variance for self-reported brushing and 38% for flossing behaviors, adding self-efficacy raised the amount of variance explained to 51 and 66%, respectively. These findings were supported by later studies in periodontal patients (86) and diabetic patients (85).

Lavin & Groarke (43) recruited 199 university students to a study exploring the relationship between theory of planned behavior constructs and self-reported use of dental floss. The theory of planned behavior variables predicted 46% of the variance in intention and 29% of the variance in behavior. Similarly, McCaul et al. (52) found that theory of planned behavior variables predicted oral hygiene behavior in 219 undergraduate students.

Hardeman et al. (32) reviewed trials that used the theory of planned behavior in relation to recruiting individuals to an intervention and maintaining adherence, or in relation to changing cognitions and/or behavior as part of the intervention. For inclusion, the studies had to explicitly apply the theory of planned behavior. Studies that assessed the theory of planned behavior in conjunction with other models were also considered for inclusion. In total, 32 papers were identified that matched the authors' inclusion criteria, describing 24 distinct interventions, 21 of which specifically targeted health-related behaviors, such as sugar intake, smoking cessation, exercise, testicular self-examination and drink driving. The remaining interventions targeted behaviors such as signing up for a chemistry class, participation levels in project work and job seeking. Most of the

studies reviewed involved the use of university students, although some included at-risk or patient samples. Of the 24 interventions assessed for this review, only half of them based the design of the intervention on the model (the other half used the model to recruit participants), and those that did often selected individual components of the model, rather than the model as a whole. Further, descriptions of the intervention design and techniques employed were limited. Consequently, it was difficult for the reviewers to assess the effectiveness of theory of planned behavior-based interventions in changing targeted components, as these components were rarely explicitly stated. Studies of 13 interventions reported on change in behavior, and seven of those reported positive changes, with effect sizes ranging from very small to large. Of the studies that explicitly based their intervention design on the model, 33% found a positive association.

In summary, the theory of planned behavior has been tested in a large variety of settings and populations, and a further number of studies have tested application of this model to the design of behavior change interventions. The model has been found to explain around 20–30% of the variance in behavior and around 30–50% of the variance in intention. While the subjective norm variable is often found to be the weakest predictor of intention and behavior, this variable seemed to produce more promising correlations when applied to the study of oral hygiene behavior than for other types of behavior. However, this is a difficult construct to target for interventions. Studies combining the theory of reasoned action with self-efficacy confirmed the strong relationship between self-efficacy beliefs and oral hygiene-related behaviors.

Implementation intentions

All of the models discussed above are based on the common assumption that an individual's motivation to act is the most immediate predictor of behavior. Most social cognition models include some kind of motivation variable in their model, although it is conceptualized in a range of ways, for example intention in the theory of planned behavior and protection motivation in the protection motivation theory. The remaining parts of the models concentrate on the cognitive processes preceding this motivation to act. Subsequent research has primarily focused on factors that determine or strengthen intentions, assuming that intention strength is a good

predictor of behavior. Correspondingly, much of the literature on adherence assumes that a patient's lack of adherence is an indication of their lack of willingness or motivation to engage in the recommended behavior. Since the mid-1990s, however, a growing body of research has addressed the apparent gap between intention and behavior, indicating that this relationship may not always be as straightforward as formerly assumed. Motivation may be a necessary prerequisite for behavior but is not sufficient in itself to induce behavior change. Gollwitzer (31) distinguishes between goal intentions and implementation intentions. Whereas goal intentions are formed in the motivational phase, implementation intentions are important in the post-motivational (or volitional) phase to ensure the translation of intentions into action by linking the behavior to an anticipated situational context. More specifically, goal intentions are commitments to engage in a behavior (i.e. 'I intend to do X'), whereas implementation intentions are plans committing the individual as to when, where and how the behavior is to be implemented (i.e. 'I intend to do X whenever the situational conditions Y are met'). Implementation intentions promote the initiation and effective execution of a goal-directed activity by specifying a specific plan of where, when and how this activity should occur. In order to form an implementation intention, the individual must first identify a goal-directed behavior and anticipate a suitable situational context to initiate that behavior. For example, the individual might specify 'flossing' as the behavior and specify a suitable situation as 'in the bathroom in the evening after brushing my teeth'.

A recently published meta-analytic review (31) provided the first quantitative summary of research conducted into implementation intentions. Studies were included in this review if the implementation intentions formed by participants were assessed in relation to a goal-directed behavior, and if a statistical association between the formation of an implementation intention and behavioral outcome variable was reported or could be determined. A total of 63 studies comprising 94 independent tests were located that matched these inclusion criteria. The behavioral outcome variables assessed were classified into the following eight domains: consumer, environmental, anti-racist, pro-social, academic, personal, health and laboratory. The overall effect size of forming implementation intentions on goal achievement across all eight domains was $d = 0.65$ based on 8461 participants, which constitutes an effect size of medium to large magnitude. Assessing the relationship

between implementation intentions and health behaviors specifically, the review reported a medium effect size ($d = 0.59$) based on 23 studies involving 2861 participants. Overall, this review provides evidence that forming implementation intentions makes an important difference to whether or not people successfully translate their intentions into actions. This finding was robust across a variety of behavioral domains, study designs and outcome measures.

A search of Medline between 1985 and 2008 revealed two studies in which implementation intentions had been applied to oral hygiene-related behavior. Schutz et al. (73) found that planning was the only significant predictor of adherence to a daily regime of flossing in 157 university dental students. Sniehotta et al. (78) developed a brief intervention to enhance intention implementations in a group of university students. By asking participants to plan where and when they would floss their teeth, Sniehotta and colleagues were able to demonstrate an improvement in the proportion of participants who were flossing three times a week or more. To date, this method has not been applied to individuals with periodontal disease.

Stages of change model

The trans-theoretical model of behavior change, commonly referred to as the 'stages of change model' (59), describes how people modify their behavior over time. The 'stage' construct is central to the model and has a temporal dimension; unlike other models, the stages of change model perceives change as a process rather than an event. The five 'stages of change', summarized in Fig. 5, are 'pre-contemplation' (the individual has no intention to take action in the foreseeable future; many individuals in this stage are unaware of a problem), 'contemplation' (they are aware that a problem exists and intend to take action within the next 6 months), 'preparation' (they intend to take action within the next 30 days and/or have unsuccessfully taken action in the past year), 'action' (they have changed a behavior for <6 months) and 'maintenance' (the stage during which people work to prevent relapse and consolidate the gains achieved during action). For addictive behaviors such as smoking, this last stage extends from 6 months to an indeterminate period after the initial action (18). Individuals are seen to progress through each stage to achieve successful maintenance of a new behavior. However, these stages do not always occur in a linear pattern, and an individual may cycle from stage to

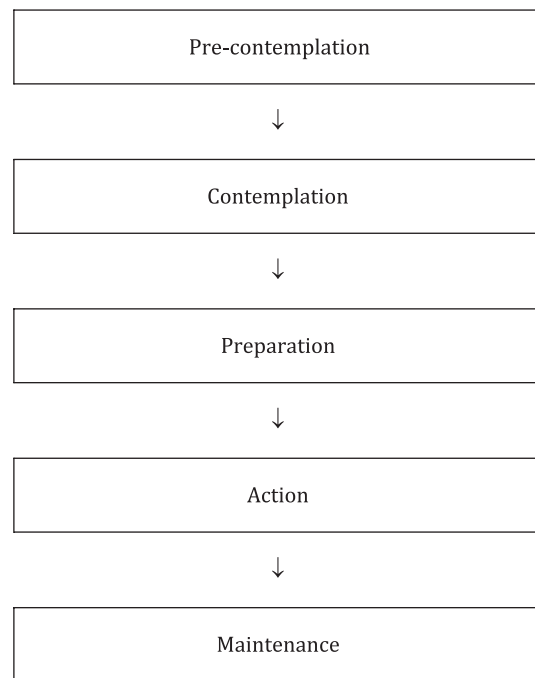


Fig. 5. Stages of change model. Source: (60).

stage and then back again, i.e. relapse, before achieving a long-term behavior change (84).

Transitions between the 'stages of change' are effected by a set of independent variables known as the 'processes of change', which are the activities and experiences that individuals engage in to progress through the stages. The ten 'processes of change' are divided into two broad categories: 'experimental (cognitive/affective) processes', which include activities related to thinking about changing behavior, for example, and 'behavioral processes', which are categorized as behaviors that are helpful in behavior change (60).

The model also incorporates a series of intervening or outcome variables. These include 'decisional balance', which is the result of weighing the advantages and disadvantages of behavior change, 'self-efficacy', which is the confidence that one can engage in health behavior across various challenging situations, and 'situational temptation', which is the temptation to engage in unhealthy behavior across various challenging situations (18).

Individuals in the preparation stage have been shown to have significantly different scores for 'self-efficacy' and 'process of change' compared to those in the pre-contemplation 'stage' (22), and the five cognitive/affective processes of change tend to occur in the earlier stages of change, whereas the five behavioral processes tend to occur in the later stages of change (26). These findings suggest that

Table 1. Summary of key studies exploring the relationship between psychological models of health-related behavior and the behavior and diseases status of patients with periodontal disease

Psychological model	Authors (reference)	Sample size	Study design	Periodontal disease and behavior measures	Psychological variables that correlated with disease outcome / behavior
Health belief model	Kuhner & Raetzke (42)	96	Cross-sectional survey	Bleeding on probing	Motivation Seriousness Benefits
	Barker (14)	43	Cross-sectional survey	Plaque score Bleeding score	Benefits Combined benefits + susceptibility score
	Rayant & Sheiham (62)	161	Cross-sectional survey	Gingival index	No significant relationships
Protection motivation theory			No studies		
Health locus of control	Knecht et al. (40)	149	Cross-sectional survey	Plaque index	Dental locus of control
	Galgut et al. (29)	60	Before and after study	Plaque level	Powerful others related to improved plaque Internal locus of control related to improved plaque External locus of control related to poor plaque control
	Wolfe et al. (96)	99	Cross-sectional survey	Plaque index	External locus of control
	Borkowska et al. (16)	47	Cross-sectional survey	Bleeding on probing Plaque score	No significant relationships
	Odman et al. (56)	22	Cross-sectional survey	Probing depth Plaque score	No significant relationships
	Little et al. (47)	107	Randomized controlled trial	Plaque index Gingival bleeding Pocket depth Attachment level	Intervention based on principles of social learning was superior to control
	Weinstein et al. (92)	20	Randomized controlled trial	Plaque score	Intervention based on principles of social learning was superior to control
Social learning theory	Stewart et al. (79)	100	Randomized controlled trial	Plaque index	Intervention based on principles of social learning was not significantly different to an attention control
Theory of planned behavior	McCaul et al. (52)	181	Cross-sectional survey	Self-reported oral hygiene behavior	Goal setting improved adherence

Table 1. *Continued*

Psychological model	Authors (reference)	Sample size	Study design	Periodontal disease and behavior measures	Psychological variables that correlated with disease outcome/behavior
Implementation intentions	Tedesco et al. (88)	39	Cross-sectional survey	Self-reported oral hygiene behavior	Theory of planned behavior predicted self-reported behavior Addition of self-efficacy significantly increased the explained variance
	Tedesco et al. (87)	166	Cross-sectional survey	Self-reported oral hygiene behavior	Theory of planned behavior predicted self-reported behavior Addition of self-efficacy significantly increased the explained variance
	No studies in patients with periodontal disease				
Stages of change	Stewart et al. (81)	117	Randomized controlled trial	Self-efficacy beliefs in relation to flossing and toothbrushing	Intervention based on stages of change model improved flossing self-efficacy beliefs in comparison to controls

individuals change their attitudes and intentions prior to actual behavior change (67).

The trans-theoretical model has been used extensively in research on smoking and smoking cessation. Cross-sectional studies have used the 'stages of change' algorithm to identify the distribution of current smokers within the various stages (23, 89, 91). The extent to which the variables in the trans-theoretical model predict an individual's movements between stages is equivocal. Some studies suggest that nearly all the processes of change increase when the individual moves from pre-contemplation to preparation (36) (see Fig. 5); however, others have found that the model offers limited predictive power (3, 25). The trans-theoretical model predicts that different types of interventions should be targeted at individuals within different stages of change; however, a systematic review of 23 studies found that there was limited evidence for the effectiveness of

stage-matched interventions in changing smoking behavior (65).

Only one published study has used the stages of change framework in an attempt to improve oral hygiene in patients with periodontitis. Stewart et al. (81) randomly assigned 117 male patients attending a US Veterans Affairs outpatients clinic who were eligible for comprehensive dental treatment to one of three arms of a trial: control, education and psychological intervention. The control group received no additional treatment or intervention other than 6-month recalls. Participants in the 'educational' intervention group received four 40-minute presentations by a periodontist that were designed to increase knowledge of the causes of dental disease and techniques for prevention. The 'psychological' intervention consisted of four 40-minute sessions with a clinical psychologist aimed at enhancing motivation to engage in oral health-related behavior and based

upon the stages of change model. However, the five stages of the model were reduced to two for the purposes of the study, but no empirical or theoretical justification for this change to the model was provided. Knowledge of dental health was assessed using a standardized questionnaire. Self-efficacy beliefs (beliefs about one's ability to undertake an activity) concerning toothbrushing and flossing were also assessed. Six participants dropped out between assignment to groups and the initial assessment. There were no further drop-outs. For dental knowledge, the control group showed no change pre- and post-intervention, whereas both intervention groups improved their dental knowledge significantly. There was no difference in dental knowledge at post-intervention between the educational and psychological intervention groups. All three groups showed higher scores on the measure of self-efficacy beliefs concerning flossing post-intervention; there was no difference in the post-intervention scores between the control and 'educational' groups, but the 'psychological' intervention group showed a significantly higher change in self-efficacy scores for flossing at post-intervention compared to the other two groups. However, the magnitude of the differences between groups was small. The data on perceived self-efficacy for toothbrushing were not analysed, due to ceiling effects in the data pre-intervention (i.e. the inability of data to show any improvement as the values have reached their maximum because the participants were convinced that they knew how to brush their teeth from the start).

In summary, there is clear evidence for the existence of the various 'stages of change', particularly in individuals who smoke, and that the processes of change identified within each stage are also prevalent; however, there is less convincing evidence that asking people to engage in the processes of change is related to behavior change or movement through the stages. What seems most probable is that the processes of change are effective targets for behavior change irrespective of the 'stage' that an individual is in.

Overall conclusions

Psychological models of behavior change have identified a great many thought processes that are related to oral hygiene behavior. Table 1 summarizes studies in this area. There has been much less research addressing whether changes in these thought processes can effect change in behavior. There are

several promising targets for interventions. The distinction between motivational and volitional stages appears to be important. Clinicians should distinguish between individuals who lack the motivation to change their oral hygiene behavior, and those who are so motivated but require support in planning and maintaining behavior change. Targets for motivational interventions that appear to be important are placing an emphasis on the benefits of behavior change and enhancing self-efficacy beliefs about oral hygiene behaviors. Specific interventions that could target self-efficacy are discussed by Abraham and Michie (1) and in the NHS Health Trainer Handbook '*Improving Health: Changing Behaviour*' produced by the British Psychological Society Health Psychology Team (17). For volitional interventions, planning where, when and how the individual will engage in the oral hygiene behavior appears to be a highly effective brief intervention.

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