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Applying psychological theory to evidence-based clinical practice: Identifying factors predictive of taking intra-oral radiographs

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Abstract

This study applies psychological theory to the implementation of evidence-based clinical practice. The first objective was to see if variables from psychological frameworks (developed to understand, predict and influence behaviour) could predict an evidence-based clinical behaviour. The second objective was to develop a scientific rationale to design or choose an implementation intervention.

Variables from the Theory of Planned Behaviour, Social Cognitive Theory, Self-Regulation Model, Operant conditioning, Implementation Intentions and the Precaution Adoption Process were measured, with data collection by postal survey. The primary outcome was the number of intra oral radiographs taken per course of treatment collected from a central fee claims database. Participants were 214 Scottish General Dental Practitioners.

At the theory level, the Theory of Planned Behaviour explained 13% variance in the number of radiographs taken, Social Cognitive Theory explained 7%, Operant Conditioning explained 8%, Implementation Intentions explained 11%. Self-regulation and Stage theory did not predict significant variance in radiographs taken. Perceived behavioural control, action planning and risk perception explained 16% of the variance in number of radiographs taken ($F(3,160) = 11.33$, $p<.001$). Knowledge did not predict number of radiographs taken.

The results suggest an intervention targeting predictive psychological variables could increase the implementation of this evidence-based practice; influencing knowledge is unlikely to. Measures which predicted number of radiographs taken also predicted intention to take radiographs, and intention accounted for significant variance in behaviour (Adjusted $R^2 = 5\%$: $F (1, 166) = 10.28$, $p<.01$), suggesting intention may be a possible proxy for behavioural data when testing an intervention prior to a service-level trial. Since psychological frameworks incorporate methodologies to measure and change component variables, taking a theory-based approach enabled the creation of a replicable methodology for identifying factors predictive of clinical behaviour and for the design and choice of interventions to modify practice as new evidence emerges.

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Introduction

Evidence-based practice encompasses integrating current best evidence from research with clinical practice and policy. However, studies in the USA and the Netherlands suggest that about 30 to 40% of the patients do not receive care according to current scientific evidence and about 20 to 25% of care provided is not needed or potentially harmful (Grol, 2001; Schuster, McGlynn, & Brook, 1998).

Usual methods for encouraging the implementation of evidence-based practice are to disseminate guidelines and educational materials, deliver education courses, and audit and feedback exercises. However, systematic reviews of implementation interventions have shown that these methods of increasing knowledge and skills have a variable success rate, often failing to achieve changes across a variety of clinical behaviours (Grimshaw et al 2001; Grimshaw et al, 2004). Indeed, the considerable body of implementation research promoting the uptake of research findings has provided only limited information to form the basis of a scientific rationale for the development or choice of interventions to predictably influence clinical practice.

A wide range of factors may influence health care delivery, including resource constraints, organisational policy, and patient preferences. However, their effects on clinical practice tend to be mediated through the actions of individual clinicians. The uptake of clinical research, the implementation of knowledge and the delivery of evidence based health care, can all be viewed as forms of clinician behaviour. Ultimately, it is the individual health care professional who interprets patient preferences or decides to follow (or not) organisation protocols. Identifying factors predictive of clinicians' behaviour that are amenable to change may guide the design and choice of interventions with the greatest likelihood of success.

Psychological models have been developed to understand, predict and influence individual behaviour, albeit applications to date have largely been to the behaviour of patients and the public, (Norman & Conner 1993; Hounsa et al., 1993; Conner & Norman, 1996; Hardeman et al, 2002). Recent investigations have been exploring the possibility of applying these models to clinicians' behaviour. Walker et al. (2001) used the Theory of Planned Behaviour (Ajzen 1991) to investigate amongst general medical practitioners those factors associated with prescribing antibiotics for patients presenting with a sore throat. The study showed that attitudinal and control beliefs were important predictors of intention to prescribe. The authors suggested that targeting these beliefs should influence motivation to follow evidence-based prescribing practice. Bonetti & Johnston (2001) used psychological models to further an understanding of why audit and feedback and a computer assisted learning package did not influence the extraction of third molars, despite successfully influencing knowledge of the evidence-base relating to third molars. They measured psychological factors derived from the Theory of Planned Behaviour and Social Cognitive Theory (Bandura, 1998) and found attitudinal and control beliefs predicted the outcome behaviour, but were not influenced by the interventions.

They suggested that an intervention which specifically targeted these predictive beliefs may be more successful in influencing third molar evidence-based practice. In another study, psychological models were used to design a very simple intervention based on theoretical approaches to action planning, which successfully influenced dentists' intention to implement evidence-based practice for third molar management (Bonetti et al, 2003). Bonetti et al (2005) also applied the Theory of Planned Behaviour and Social Cognitive Theory to further an understanding of how different interventions achieved their effects on GP referral behaviour. They identified control beliefs as possible psychological mediators of clinical decision-making in relation to taking lumbar spine x-rays.

The present study, as part of a larger project (Walker et al., 2003), examined the predictive power of factors from a range of psychological models. Variables were drawn from the Theory of Planned Behaviour, Social Cognitive Theory, Operant Conditioning (Blackman, 1974), Implementation Intentions (Gollwitzer, 1993), Self-regulation Model (Leventhal, Nerenz, & Steele, 1984), and an adaptation of the Transtheoretical and Precaution Adoption Process models (Prochaska & DiClemente, 1983; Weinstein, 1988; Weinstein, Rothman & Sutton, 1998). These specific theories, described in detail elsewhere (Walker et al., 2003), were chosen because they vary in their emphasis. Some focus on motivation, proposing that motivation determines behaviour, and therefore the best predictors of behaviour are factors that predict or determine motivation (e.g. Theory of Planned Behaviour). Some place more emphasis on factors that are necessary to predict behaviour in people who are already motivated to change (e.g. Implementation Intentions). Others propose that individuals are at different stages in the progress toward behaviour change and that predictors of behaviour may be different for individuals at different stages (e.g. Precaution Adoption Process). The specific models used in this study were chosen for three additional reasons. First, they have been rigorously evaluated with patients or with healthy individuals. Second, they allow us to examine the influence on clinical behaviour of perceived external factors, such as patient preferences and organisational barriers and facilitators. Third, they all explain behaviour in terms of variables that are amenable to change.

The objective of this study was to use these theories to identify factors predictive of an evidence-based clinical behaviour. The setting and behaviour selected was dentists in the community taking intra-oral radiographs. Intra-oral radiographs have been shown to detect clinically important numbers of lesions which would remain hidden from clinical examination and should significantly contribute to patient health outcomes by allowing better informed treatment decisions. (Pendlebury & Pitts, 1998). Guidelines relating to the prevention of dental caries recommend bitewing radiographs as an essential adjunct to a first clinical examination (SIGN 47, 2000). Nevertheless, comparison of data from the English and Scottish Dental

Practice Boards has shown that dentists in Scotland take fewer than optimal intra-oral radiographs (Pitts & Fyffe, 1991).

Behavioural intention, a theoretically derived measure, was included as a secondary outcome, because there is considerable evidence supporting intention as a consistent predictor of subsequent health-related behaviour (Ajzen, 1991; Randall & Wolff, 1994; Connor & Norman, 1996). Furthermore, the relationships between knowledge, intention and behaviour were also assessed in order to integrate the results of this study into the current implementation literature.

Method

Design and Participants

This was a cross-sectional study. Participants were General Dental Practitioners (GDPs) across Scotland. Data collection was by postal survey and from itemised records of courses of treatment for NHS patients across Scotland from the central fee claims database (MIDAS) at the Scottish Dental Practice Board. This system has internal checking systems which ensure that claims are a reliable index of the actual clinical behaviour.

Outcome measures

Behaviour

The primary outcome was the number of intra oral radiographs taken per course of treatment. This was calculated as the total number of radiographs claimed divided by the total number of courses of treatment expressed as a percentage.

Behavioural Intention

Three items assessed dentists' intention to take radiographs: *'I intend to take radiographs of most patients as part of their management'; 'I aim to take radiographs as part of patient management*'; *When a patient has caries, I have in mind to take a radiograph'* (rated on a 7-point scale from '*Strongly Disagree'* to '*Strongly Agree'*). Responses were summed, with higher scores reflecting greater intention to take a radiograph.

Predictive measures

Table 1 provides a summary of the predictive measures used in this study (see also Walker, 2003). Theoretically derived measures follow the operationalisation protocols of Ajzen (1991), Bandura (1997, 2000), Connor & Sparks (1996), and Francis et al. (2004). Unless otherwise stated, all questionnaire items were rated on a 7-point scale from *Strongly Disagree* to *Strongly Agree*.

In formulating the TPB questions, every effort was made to maintain correspondence between the questionnaire items and the behaviour specified in the outcome measures, while at the same time

asking questions that were acceptable to respondents in our pilot studies. Thus, the 'TACT' principle was observed: the 'Target' was the patient; the 'Action' was 'taking a radiograph'; 'Context' (management of the patient) and 'Time' (during a course of treatment) were specified in the introduction to the questionnaire. While not achieving perfect correspondence, this specification of the 'TACT' principle is reasonably similar to the outcome TACT.

Procedure

A preliminary study was conducted to inform the development of the postal questionnaire. Semi-structured interviews took place in the practices of sixteen dentists, randomly identified from the Scottish Dental Practice Board Research Register and Scottish Health Board lists. Responses were coded into belief domains (behavioural, normative, control) which were then used, in conjunction with the literature, to create the items measuring variables from the psychological theories. Given the number of predictor variables, a power calculation suggested that a minimum sample of 200 dentists was required to detect an effect size of 0.40 with alpha of 0.05, 95% power.

550 dentists were selected from the Scottish Dental Board practice list by an independent statistician, using a list of random sampling numbers. Dentists were sent an invitation pack (letter of invitation, questionnaire consisting of psychological and demographic measures and a consent form to allow access to their fee claims data from MIDAS, as well as a reply-paid envelope). Three postal reminders were sent to non-responders at 2 weeks, 4 weeks and 6 weeks from the first mailing. Routinely collected data on fee claims for treatment, used to generate the primary outcome measure, were gathered for a 12 month period to control for seasonal variations.

Statistical Analysis

Data were analysed using SPSSPC (Norusis, 1993). Theoretical measures were tested for acceptable internal consistency. If the criterion value (0.60) was not reached, items were dropped from the variable measures until the maximum possible Cronbach alpha was achieved. The relationship between predictive and outcome variables were examined using ANOVA for stage theories and correlation for other variables. Multiple regression analyses were used to examine the predictive value of each of the theoretical models and to investigate the combined predictive value of all significantly predictive variables.

The study was approved by the South East Multi-Centre Research Ethics Committee.

Results

The study population

Of the 214 GDPs who agreed to participate (40% response rate), 66% were male; 14% were dental trainers, their median list size was 3000 (interquartile range (IQR) from 2000 to 5,500), their median number

of years qualified was 17 (IQR 10 to 24), the median number of ½ day sessions worked per week was 9 (IQR 8 to 10). There were no significant differences between participant and non-participant NHS dentists in Scotland in the number of radiographs taken as a proportion of total claims per month ($t(1, 2106) = -1.55$, $p = 0.120$).

Predicting the taking of intra-oral radiographs

The results of the correlation analyses are reported in Table 2. The variables which significantly predicted the number of radiographs taken were behavioural intention, perceived behavioural control, risk perception, self-efficacy, action planning, anticipated consequences, habit, and illness representations (consequences of caries). From the stage model, whether or not a dentist has not yet thought about changing, has made a decision to change the number of radiographs they take (in either direction) or whether they believe they have already acted to change the number of radiographs they take (in either direction) did not predict the number of radiographs actually taken ($F(5, 162) = 0.76$, $p = 0.578$). Knowledge did not predict the number of radiographs taken.

When all variables which significantly predicted behaviour were entered into a stepwise regression analysis, only action planning, perceived behavioural control and risk perception entered the equation, explaining 16% of the variance in the number of radiographs taken (Table 4).

Table 2 reports the results of the regression analyses for the theoretical frameworks. The Theory of Planned Behaviour explained 13% and Social Cognitive Theory explained 7% variance in behaviour. Implementation Intentions explained 11% of the variance and Operant Conditioning explained 8% of the variance in behaviour. The Self-regulation Model did not predict significant variance in behaviour.

Predicting dentists' intention to take intra-oral radiographs

The variables which predicted behavioural intention to take radiographs were attitude, perceived behavioural control, risk perception, outcome expectancies, self-efficacy, anticipated consequences of the behaviour, habit, experienced consequences, illness representations (identity of caries, control of caries, and emotional response to caries), and knowledge (Table 3). Behavioural stage was not predictive ($F(6, 206) = 2.03$, $p = 0.063$).

When all variables which significantly predicted behavioural intention were entered into stepwise regression analyses, habit, risk perception, self-efficacy, outcome expectancies and control over caries explained 53% of the variance ($F(5,190) = 44.58$, $p < .001$, see Table 4).

Table 3 reports the results analysed by theoretical framework. The Theory of Planned Behaviour explained 28%, Social Cognitive Theory explained 39%, Implementation Intentions explained 28%, Operant

Conditioning explained 43%. Self-regulation model did not explain significant variance in behavioural intention.

Behavioural intention significantly predicted behaviour ($r=0.25$, $p<.01$), explaining 5% of the variance ($F(1, 166) = 10.28$, $p<.01$).

Discussion

Variables from psychological frameworks predicted the clinical behaviour of taking intra-oral radiographs. The relationships between behaviour and the theoretical components were also in line with the expectations of the theories. The greater the general intention to take radiographs, the more positive the anticipated consequences of taking radiographs, or the more automatically radiographs are considered as a management option, the more radiographs are taken. Dentists take more radiographs if experienced consequences have been positively reinforcing or if they perceive their standard method of managing patients includes taking radiographs. If the consequences of having caries are perceived as high, then dentists take more radiographs. Dentists take less radiographs if they feel they have more control, that is, the easier they find managing patients without a radiograph, and the more confident they are that they can manage patients without a radiograph.

Since encouraging the implementation of any evidence-based practice generally entails various methods of increasing knowledge, knowledge was also included as a predictive variable in this study. The knowledge measure included items about both the how and the why of intra-oral radiographs. However, the number of items correct was not related to the number of radiographs taken. This implies that the usual form of implementation intervention which specifically targets knowledge is unlikely to be successful in influencing this behaviour.

This is a cross-sectional study so the causal aspects of the theories remain untested in this population, but it is promising for the utility of applying psychological theory to changing clinical practice that the variables are acting as the theories suggest. The stepwise regression analyses revealed the main variables driving the number of radiographs dentists take are perceived behavioural control (Theory of Planned Behaviour), risk perception (Social Cognitive Theory) and action planning (Implementation Intentions), i.e. dentists who take more radiographs are confident that taking radiographs is up to them, believe it is risky for patients if they do not take radiographs and include taking radiographs in a standard plan for patient management. These results suggest that an intervention which specifically targets these motivational and action elements should have the greatest likelihood of success in influencing the implementation of this evidence-based practice. For example, commentaries which emphasise the role of

radiographs in reducing the risk of caries or other dental disease might target risk perception, whereas action planning might be facilitated by encouraging dentists to incorporate prompts in routine patient data collection.

One of the main strengths of this study is that the primary outcome was behavioural. Additionally, this study examined the relationship between psychological variables and dentists' intention to take radiographs. Motivational and action elements also accounted for variance in intention. Furthermore, intention to take radiographs predicted significant variance in the number of radiographs taken. The results suggest that intention may be able to act as a proxy for behavioural data when testing an intervention prior to implementation in a service-level trial Bonetti et al, 2005).

At the theory level, while the Theory of Planned Behaviour, Social Cognitive Theory, Operant Conditioning and Implementation Intentions all predicted significant variance in intention to take radiographs and the number of radiographs taken, Stage did not predict behaviour or behavioural intention. The usual approaches to measuring behavioural stage in the literature were used in this study, but a more complex approach may be more informative in terms of the number and the nature of the stages when applied to clinical behaviour.

The self-regulation model also did not predict significant variance in behaviour or behavioural intention. Why the self-regulation model does not appear to be working is open to discussion, since both theoretical and measurement explanations are possible. The internal reliability of the measures for this theory were consistently poor. The measures in this study were derived from a standardized measure developed for the point of view of the patient and for conditions such as diabetes and stroke. It may be that the items were not adequately adapted for the point of view of the clinician or to caries. Theoretically, representations of someone else's 'illness' may not influence the individual dentist's 'self-regulation'. In exploring this model, the current study has taken it beyond its normal field of application, but we argued that the model, and the models on which it was founded, suggest that coping actions would be taken to resolve discrepancies from some standard. It is also possible that illness representations per se simply do not drive clinical behaviour, that is, dentists' perceptions about caries as a disease in and of itself does not influence their decision to radiograph. This interpretation was supported by anecdotal evidence during the preliminary study interviews, however, more work is required to address the issue of whether the lack of predictive power for this model is either measure, theory or behaviour related.

The stepwise regression models (Table 4) explained more variance in the number of radiographs taken, and in behavioural intention, than did any single model. This may indicate that clinical behaviour requires a more sophisticated explanatory model than those used here, one which incorporates motivational and action elements. Future research needs to explore whether psychological theories, as well as variables

derived from these theories, can be consistently predictive across a range of clinical behaviours before a rationale can be developed for choosing theory or theoretical components to apply in implementation research. Recent work by Michie et al (2005) takes a step forward in this area. They examined theoretical components and attempted to make theory more accessible to implementation researchers. The current study investigated several of the 12 theoretical domains identified by Michie et al, and at least four domains had significant co-efficients in the stepwise regression model. Nevertheless, the models as they now stand still provide the ways and means of influencing the variables identified in the stepwise models for this specific behaviour.

Operationalising the constructs with theoretical purity was a challenge. The preliminary study revealed that it was difficult to ask clinicians about their control over taking radiographs - an essential component of some frameworks. Even when barriers to performing the behaviour were acknowledged, participating dentists believed that they had absolute control over taking radiographs since they "pressed the button". This meant some items had to be worded in terms of not doing the behaviour (managing without a radiograph) in the postal questionnaire. This created some concern that *not taking radiographs* may be a behaviour in itself or represent a range of alternative behaviours rather than being just a negative reflection of taking radiographs. However, pragmatically it was not possible to measure control variables any other way, and the results did show the theoretically expected relationships. The results also accounted for similar amounts of variation in behavioural intention to those found in previous studies (Armitage & Connor, 2001).

One final issue is that the response rate was not as high as for many studies. This may be due to the length of the questionnaire and our request to access behavioural data from a data base which is used to generate payment and is therefore highly confidential. However, support for the representativeness of our sample was provided by the analysis showing the average number of radiographs per dentist in our study was similar to the average number of radiographs taken per dentist in all Scotland. Thus the study was not restricted to a sample of keen, evidence-compliant dentists.

Conclusion

This study provides evidence that psychological models can be useful in understanding and predicting clinical practice requiring clinicians' behaviour change. Since psychological frameworks incorporate methodologies to measure and change component variables, taking a theory-based approach enabled the creation of a replicable methodology for identifying factors predictive of clinical behaviour and for the design and choice of interventions to modify practice as new evidence emerges. The results of this study suggest that an intervention which specifically targets the role of radiographs in reducing risk to patients and which encourages dentists to plan in more detail when they will take radiographs as part of patient management

(e.g. through persuasive statements delivered via a letter or during a professional development course), may increase the implementation of evidence-based practice.

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Table 1. Summary of the predictive measures used in the PRIME study

Theory of Planned Behaviour *(Ajzen, 1991)*

Variables (number of items)	***Example Item(s)***
Behavioural intention (3)	*I intend to take radiographs of most patients as part of their management.*
Attitude Direct (2); Indirect[a] (12 behavioural beliefs (bb) multiplied by 12 outcome evaluations (oe). The score was the mean of the summed multiplicatives.)	Direct: *In general, the possible harm to the patient of an intra-oral radiograph is outweighed by its benefits;* Indirect: *In general, taking a radiograph would reassure the patient (bb)* ***x*** *reassuring the patient is (oe: un/important)*
Subjective Norm[b] Indirect (5 normative beliefs (nb) multiplied by 5 motivation to comply items (mtc). The score was the mean of the summed multiplicatives).	*I feel under pressure from colleagues /training course teachers/guidelines, the Dental Practice Board/patients) to take radiographs (nb)* ***x*** *How motivated are you to do what colleagues think you should (mtc: very much/not at all)*
Perceived Behavioural Control Direct (4); Indirect/power (12)[c]	Direct: *Whether I take radiographs is entirely up to me* Indirect: *I find it easy to manage without a radiograph if the patient is pregnant*

Social Cognitive Theory *(Bandura,1998)*

Risk Perception (2)	*It is highly likely that patients will be worse off if I do not take a radiograph*
Outcome Expectancies Self (2x2), Behaviour (12x12). The score was the mean of the summed multiplicatives.	Self: *If I take a radiograph, then I will think of myself as a caring dentist* **x** *Thinking of myself as a caring dentist is (Un/Important)* Behaviour: *See Attitude (Theory of Planned Behaviour)*
Self Efficacy General: Generalized Self-Efficacy Scale (Schwarzer, 1992) (10: 4 point scale, *not at all true/exactly true*); Specific (12)	General*: I can always manage to solve difficult problems if I try hard enough* (Specific: *Without a radiograph, how confident are you in your ability to make a diagnosis of caries*

Implementation Intentions *(Gollwitzer, 1993)*

Action planning (1)	*Currently, my standard method of managing caries does not include taking a radiograph;*
Operant conditioning *(Blackman, 1974)*	
Anticipated consequences (2)	*If I routinely take radiographs then on balance, my life will be easier in the long run*
Evidence of habit (2)	*When I see a patient, I automatically consider taking a radiograph*
Experienced (rewarding and punishing) consequences (4: *more likely to radiograph (score=1); less likely (score=-1); unchanged/not sure/never occurred (score=0)*). Scores were summed.	*Think about the last time you took a radiograph and felt pleased/sorry:* *Think about the last time you decided not to take a radiograph and felt pleased/sorry that you had not done so':*
Self-regulation Model[d] *(Leventhal et al., 1984)*	
Perceived identity (3)	*Caries is a condition with symptoms generally of an intense nature*
Perceived cause (5)	*Caries is caused by poor oral hygiene*
Perceived controllability (7)	*What the patient does can determine whether caries reverses or progresses, What I do can determine whether the patient's caries reverses*
Perceived duration (4)	*Caries is a condition which is likely to be permanent rather than temporary*
Perceived consequences (4)	*Caries does not have much effect on a patient's life*
Coherence (2)	*I have a clear picture or understanding of caries*
Emotional response (4)	*Seeing patients with caries does not worry me*
Stage *(Prochaska & DiClemente, 1983; Weinstein, 1988; Weinstein, Rothman & Sutton, 1998)*	
Current stage of change. A single statement is ticked to indicate the behavioural stage	Which of these sentences *most* characterises you at the moment? Unmotivated (3): *I have not yet thought about changing the number of radiographs I take* Motivated (2): *I have decided that I will take more/less radiographs* Action (2)*: I have already done something about increasing/decreasing the number of radiographs I take*
Other Measures	

Knowledge (5) *(True/False/Not Sure)*	*Bitewing radiographs are useful for showing recurrent caries at the buccal surface*
Demographic	*post code, gender, time qualified, number of other dentists in practice, trainer status, hours per week, list size*

[a] All indirect measures consist of specific belief items identified in the preliminary study as salient to the taking of radiographs.

[b] These individuals and groups were identified in the preliminary study as influential in the decision to take a radiograph

[c] An indirect measure of perceived behavioural control usually would be the sum of a set of multiplicatives (control beliefs x power of each belief to inhibit/enhance behaviour). However, the preliminary study demonstrated that it proved problematic to ask clinicians meaningful questions which used the word 'control' as clinicians tended to describe themselves as having complete control over the final decision to perform the behaviour. Support for measuring perceived behavioural control using only questions as to the ease or difficulty of performing the outcome behaviour was derived from a metanalysis which suggested that perceived ease/difficulty items were sensitive predictors of behavioural intention and behaviour (Trafimow et al., 2002).

[d] Illness representation measures were derived from the Revised Illness Perception Questionnaire (Moss-Morris, R., Weinman, J., Petrie, K. J., Horne, R., Cameron, L.D., & Buick, D. 2002)

Table 2. Predicting the taking of intra-oral radiographs: Descriptive statistics, correlation and multiple regression analyses

Theoretical Framework	*Predictive Variables*	*Alpha*	*Mean (SD)*	*r*	*p*	*B*	*Beta*	*p*	*R2(adj)*	*df*	*F*	*p*
	Attitude direct	0.40	11.7 (2.0)	0.06	ns							
Theory of	Attitude indirect	0.75	361.4 (63.9)	0.11	ns							
Planned	Subjective Norm	0.83	53.4 (31.7)	-0.11	ns							
Behaviour	Intention [a]	0.73	14.3 (3.8)	0.24	**	0.38	0.16	*				
	PBC direct	0.76	9.9 (4.0)	0.21	**	0.42	0.19	**				
	PBC indirect	0.84	49.1 (10.4)	0.31	***	0.19	0.21	*	0.13	3 162	9.20	***
	Risk perception	0.51	9.2 (2.6)	0.26	***	0.72	0.21	*				
Social Cognitive	Outcome expectancies	0.75	52.4 (23.0)	0.09	ns	-0.03	-0.07	ns				
Theory	Self efficacy	0.83	45.2 (9.2)	0.23	**	0.18	0.18	*				
	Generalised self efficacy	0.87	30.0 (3.7)	-0.06	ns	-0.10	-0.04	ns	0.07	4 162	4.22	**
Implementation Intentions	Action Planning	-	5.4 (1.6)	0.34	***	1.89	0.34	***	0.11	1 166	21.54	***
Operant	Anticipated consequences	0.51	9.3 (2.6)	0.25	***	0.74	0.21	*				
Conditioning	Evidence of habit	0.62	7.6 (2.7)	0.22	**	0.39	0.12	ns				
	Experienced consequences	0.46	0.40 (1.06)	0.12	ns	0.63	0.08	ns	0.08	3 161	5.44	***
	Identity of condition	0.21	2.01 (0.4)	0.03	ns	-0.78	-0.03	ns				
Self-Regulation	Duration	0.44	18.7 (4.0)	-0.01	ns	-0.05	-0.02	ns				
Model	Control	0.46	39.0 (5.0)	-0.39	ns	-0.02	-0.03	ns				

	Cause	0.28	21.6 (3.4)	0.08 ns	0.32	0.12 ns			
	Consequence	0.53	15.5 (3.1)	0.15 *	0.56	0.20 *			
	Coherence	0.64	4.3 (1.8)	-0.05 ns	-0.14	-0.03 ns			
	Emotional Response	0.70	12.9 (4.8)	-0.04 ns	-0.15	-1.08 ns	0.00	7 157	1.03 ns
Stage Model	Behavioural Stage [b]	-							
Other	Knowledge	0.20	4.4 (0.8)	0.07 ns	0.130	0.010 ns	0.00	1 165	0.76 ns

ns = not significant at the p<.05 level; *p<.05; ** p<.01; ***p<.001.

[a] Only intention and perceived behavioural control measures are entered into this regression equation as only these variables are the proximal predictors of behaviour in this model.

Alpha = Cronbach's Alpha

r = Pearson product moment correlation coefficient

B = Regression coefficient for predictor variables included in the final regression model

Beta = Standardised regression coefficients

- = single statement measure

[b] The stages were distributed as follows: 143 (67%) were unmotivated, 18 (8%) were motivated/taking more radiographs; 1 (0.5%) were motivated/taking less; 42 (20%) were action/taking more; 4 (2%) were action/taking less. See 'Predicting what dentists do' for the results of the ANOVA analysis.

Table 3. Predicting intention to take intra-oral radiographs: Correlation and multiple regression analyses

Outcome: Behavioural Intention

Theoretical Framework	*Predictive Variables*	*r*	*p*	*B*	*Beta*	*p*	*R2(adj)*	*df*		*F*	*p*
	Attitude direct	0.14	*	0.31	0.17	**					
	Attitude indirect	0.14	*	0.01	0.13	*					
Theory of Planned	Subjective Norm	-0.03	ns	0.00	0.03	ns					
Behaviour	PBC direct	-0.03	ns	-0.13	-0.14	ns					
	PBC power	0.32	***	0.15	0.43	***	0.28	5	205	17.07	***
	Risk perception	0.51	***	0.51	0.34	***					
Social Cognitive	Outcome expectancies	0.41	***	0.03	0.17	**					
Theory	Self efficacy	0.48	***	0.13	0.31	***					
	Generalised self efficacy	0.04	ns	0.07	0.07	ns	0.39	4	206	34.22	***
Implementation	Action Planning	0.53	***	0.23	0.32	***	0.28	1	211	83.75	***
Intentions											
Operant Conditioning	Anticipated consequences	0.51	***	0.49	0.33	***					
	Evidence of habit	0.59	***	0.60	0.44	***					
	Experienced consequences	0.15	*	0.15	0.04	ns	0.43	3	206	54.01	***
	Identity of condition	0.16	*	1.19	0.13	ns					
	Duration	0.02	ns	-0.02	-0.02	ns					
	Control	0.15	*	0.09	0.11	ns					
Self-Regulation Model	Cause	0.09	ns	0.05	0.04	ns					

	Consequence	0.13 ns	0.08	0.07 ns				
	Coherence	0.02 ns	0.03	0.01 ns				
	Emotional Response	0.14 *	-0.07	0.09 ns	0.03	7	202	1.99 ns
Stage Model	Behavioural Stage [b]							
Other	Knowledge	0.21 **	1.01	0.21 **	0.04	1	210	10.04 **

ns = not significant at the p<.05 level; *p<.05; ** p<.01; ***p<.001.

a) These variables are the proximal predictors of intention in this model; b) These variables are the proximal predictors of behaviour in this model

Alpha = Cronbach's Alpha

r = Pearson product moment correlation coefficient

B = Regression coefficient for predictor variables included in the final regression model

Beta = Standardised regression coefficients

[b] For the results of the ANOVA analysis see 'Predicting what dentists say they would do' (behavioural simulation) and 'Predicting what dentists say intend to do' (behavioural intention).

Table 4. Results of the stepwise regression analyses which included all variables which significantly predicted outcomes

Outcome: Taking intra-oral radiographs

Predictive Variables	***Entered***	***B***	***Beta***	***p***	***Adj. R^2***	***df***	***F***	***p***
Behavioural intention, PBC direct, PBC indirect, Risk perception, Self efficacy, Action planning, Consequences of caries, Anticipated consequences, Habit	Action planning	1.48	0.26	***				
	PBC direct	0.44	0.20	**		3,		
	Risk perception	0.61	0.18	*	0.16	160	11.33	***
Outcome: Intention to take intra-oral radiographs								
Attitude direct, Attitude indirect, PBC indirect, Risk perception, Outcome expectancies, Self efficacy, Identity of caries, Control of caries, Emotional response to caries, Anticipated consequences, Habit, Experienced consequences, Knowledge	Habit	0.49	0.35	***				
	Risk perception	0.37	0.25	***				
	Self efficacy	0.10	0.23	***				
	Outcome expectancies	0.03	0.16	**				
	Control of caries	0.23	0.13	**		5,		
					0.53	190	44.58	***

PBC = perceived behavioural control; *p<.05; ** p<.01; ***p<.001