Introduction

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Virtually all health-relevant behaviours such as physical activity, eating five portions of fruit and vegetables per day, quitting smoking or regular dental hygiene pose great challenges to one's self-regulatory skills (Baumeister, Heatherton, & Tice, 1994; Kuhl & Schwarzer, 2006). What adds up to that, most of these behaviours are not very much fun to implement. Counter-intentional behavioural tendencies are often a more attractive alternative to health behaviour. For example, it may seem much more attractive to watch a movie instead of working out in the gym. Or, why not have a chocolate bar for coffee instead of an apple? Or, one might feel just too tired to floss before finally going to bed after a hard day's work.

In fact, forgetting, problems with initiating behaviour change, missing good opportunities to act or internal and external barriers to action constitute the most prevalent reasons for failing to adhere to self-set behavioural goals (Baumeister, Heatherton, & Tice, 1994).

This thesis will present empirical evidence for the effectiveness of self-regulatory processes derived from theories of health behaviour which may help to overcome these problems, and it will identify and characterise groups of persons in which these processes work better or differently than in others (e.g., subpopulations in the same behavioural stages). According to the claims of Noar & Zimmerman (2005) and Rothman (2004), this thesis tests elements of health behaviour theory in order to assess their explanatory value for health behaviour change and their practicability for intervention design.

1. 1. Theories of health behaviour

Theories of health behaviour formulate relations between psychological or other factors and actual health behaviour. They can be further categorised in (a) *continuous* or *motivational* theories, which propose a set of predictors for *goals* or *intentions* and (b) *stage* theories of health behaviour, which construe the process of changing behaviour as a sequence of qualitatively different *stages* or *mindsets* of people while approaching health behaviour (Scholz & Schwarzer, 2005; Schwarzer, Schüz, & Ziegelmann, 2006).

1. 1. 1. Motivational theories of health behaviour

For years, theories such as the Theory of Reasoned Action (TRA; Ajzen & Fishbein, 1977), its successor, the Theory of Planned Behaviour (TPB; Ajzen, 1985), Protection Motivation Theory (PMT; Maddux & Rogers, 1983), Social Cognitive Theory (SCT; Bandura, 1992) or the Information-Motivation-Behavioural Skills Model (IMB; Fisher, Fisher, & Harman, 2003) have dominated research and intervention practice in health-related disciplines.

These theories are all similar in structure: A set of factors such as attitude, social norm, perceived behavioural control (TPB); risk perception, severity, response efficacy, self efficacy (PMT); outcome expectations and self-efficacy (SCT) or information, personal and social motivation, behavioural skills (IMB) predicts intention to engage in health behaviour, which in turn predict actual behaviour.

These theories are characterised by several empirical and theoretical features:

First, all theories have a relatively parsimonious set of predictors for intentions, and it is assumed that the influence of third variables such as personality or socio-economic status is fully mediated by the cognitive predictors. However, the large conceptual and theoretical overlap between variables of the different theories makes it hard to compare and test theories differentially (Maddux, 1993; Noar & Zimmerman, 2005). For example, the concept of perceived behavioural control is similar to self-efficacy in that both concepts describe the subjective belief of having control over performing a task, and there are common characteristics between attitudes, social norms, response efficacy, information and outcome expectancies, with all concepts describing expected consequences from certain behaviour.

Second, the similarities in the structural assumptions of the theories make empirical tests easy to conduct. All theories assume that the higher the values in favour of health behaviour in the predictors, the greater the behavioural intention and the likelihood that a person will actually act (Weinstein, Rothman, & Sutton, 1998). Mostly, the predictors can be combined into a single linear regression equation to predict intentions in a first, and actual behavioural performance in a second step. This allows conducting research on theses theories in the form of regression analyses, as has been done in most of the empirical studies on motivational theories.

Third, interventions derived from these models are relatively easy to construe, as according to the assumptions of the theories, all target persons of the intervention would require the same intervention elevating the levels of the critical predictors. This is implied in the structural assumptions outlined above. If, for example, according to PMT, risk perception is positively related to the intention to carry out health behaviour, an increase in risk perception should lead to an increase in intention, which according to the theory corresponds with an increase in behaviour. Accordingly, an intervention would try to address risk perception in all target persons by e.g., risk communication in leaflets in order to raise intentions and make behaviour more likely (Schwarzer, 2001).

Fourth, there is a large body of (sometimes experimental) research seemingly confirming the main assumptions of the theories (for meta-analyses on the Theories of Reasoned Action and Planned Behaviour see Albarracín, Johnson, Fishbein, & Muellerleile, 2001; Hausenblas, Carron, & Mack, 1997; Sheeran & Taylor, 1999; for meta-analyses on Protection Motivation Theory see

Floyd, Prentice-Dunn, & Rogers, 2000; Milne, Sheeran, & Orbell, 2000). However, most of this research has been conducted in a regression-analytic way with the amount of variance explained in intentions and behaviour as criterion. Experimental evidence for the effectiveness of e.g. the Theory of Planned Behaviour in changing actual behaviour is rather modest (Hardeman et al., 2002). Additionally, many of the interventions reviewed in this meta-analysis are not solely based on TPB assumptions. In one of the few experimental studies with interventions strictly derived from the TPB (Chatzisarantis & Hagger, 2005), attitudes and intentions could be influenced by the interventions, however virtually no effects of the intervention on actual behaviour were observed. The authors therefore conclude that the elements of the theory are not sufficient to explain behaviour.

A meta-analysis on the relation between intentions and behaviour (Sheeran, 2002) supports this point. Here, it has been discussed that intentions alone are not sufficient to predict behaviour, with around 70%-80% of behavioural variance left unaccounted for. This implies that post-intentional processes such as if-then planning (Gollwitzer & Brandstätter, 1997; Lippke, Ziegelmann, & Schwarzer, 2004; Sniehotta, Schwarzer, Scholz, & Schüz, 2005; Ziegelmann, Lippke, & Schwarzer, 2006) or action control based on negative feedback loops (Carver & Scheier, 1998; Karoly, 1993; Miller, Galanter, & Pribram, 1960; Sniehotta, Scholz, & Schwarzer, 2005) need to be taken into account when looking at the complex relations between cognitions and behaviour. This implies a corresponding change of the person's mindset from a *motivational* to a *volitional* one (Gollwitzer, Heckhausen, & Steller, 1990; Heckhausen & Gollwitzer, 1987). While in the *motivational* mindset the focus of attention lies on information related to the pros and cons of a behaviour, resulting in a decision to engage in behaviour or not, the *volitional* mindset is characterised by a search of information related to the enactment of behaviour once decided.

Thus, if postintentional processes are included in research on motivational theories of health behaviour (e.g., if-then planning (Milne, Orbell, & Sheeran, 2002); self-monitoring (McCaul, Glasgow, & O'Neill, 1992)), a stage model with two distinct stages is implicitly assumed. Within this thesis, it will be examined whether if-then planning predicts the adherence to evidence-based oral self-care practices over and above the predictions made by SCT (Chapter 2).

1.1.2. Stage theories of health behaviour

In contrast to motivational theories of health behaviour, stage theories construe the process of contemplating, deciding, initiating and maintaining behaviour change as a sequence of discrete, qualitatively different stages or mindsets people pass through on their way to action (Prochaska, DiClemente, & Norcross, 1992; Weinstein, 1988; Weinstein, Rothman, & Sutton, 1998). The stages are characterised by different processes which are relevant in one, but not necessarily in

another stage. According to this class of theories, behaviour change is not a linear process, as cyclical movements, including progression in further and regression in previous stages, are possible. However, it is assumed that on the course to action, no stage is omitted[2] (Prochaska, DiClemente, Velicer, & Rossi, 1992).

The claim that there are different factors that promote progression or prevent regression in the different stages implies that interventions for health behaviour change can be targeted at people in specific stages, thus avoiding irrelevant or redundant information that might cause reactance. These stage-based interventions are therefore thought to be more effective than one-size-fits-all-interventions derived from motivational theories of health behaviour. This feature makes stage theories especially attractive as frameworks for the development of health promotion interventions.

The most prominent stage approaches are the Transtheoretical Model of Behaviour Change (TTM; Prochaska & DiClemente, 1992), the Precaution Adoption Process Model (PAPM; Weinstein, 1988) and the Health Action Process Approach (HAPA; Schwarzer, 1992; Schwarzer et al., in press), the latter of which will serve as theoretical backdrop for the studies presented in this thesis.

The Transtheoretical Model of Behaviour Change was developed in the context of addiction research and was first applied to study the process of smoking cessation and the maintenance of non-smoking. According to the TTM, people pass through five or six stages from *precontemplation* (not thinking about changing behaviour in the next six months) over *contemplation* (thinking about changing in the next six months, but not within the next 30 days), *preparation* (intending to change in the next 30 days), *action* (new behaviour has been initiated in the last six months, overt changes are observable) to *maintenance* (maintaining the new behaviour for more than six months) or *termination* (no risk of relapsing into earlier stages). Although the TTM stems from addiction research, the model has also been applied to other health behaviours such as screening behaviours, mental health problems (eating disorders), HIV prevention, medication compliance, dietary behaviours (Prochaska, Redding, & Evers, 2002) and physical exercise (for a systematic review, see Bridle et al., 2005).

Most characteristics of its stage constructs, including the widely criticised temporal definitions of the stages (e.g., Davidson, 1992; Smedslund, 1997; Sutton, 2001; West, 2005) have been derived from clinical observations with smokers. This could explain the application of temporal criteria to some extent, because the time intervals could serve as substitute measures of the underlying psychological change processes. Prochaska et al (1992) argue that the six months included in the

[2] With the exception of stage 4 in the PAPM (see below), where a explicit decision against changing behaviour is being made

definition of the precontemplation stage is how far people can usually plan in advance. In how far this claim is based on empirical evidence however remains unclear. Nevertheless, the TTM has been widely applied for stage-based intervention design, with some success in changing behavioural outcomes and less success in more strict experimental matched/mismatched research designs (e.g., De Vet, De Nooijer, De Vries, & Brug, 2005 for nutrition and Quinlan & McCaul, 2000 for smoking).

The Precaution Adoption Process Model depicts the processes leading to adoption and maintenance of risk-reducing behaviours. Instead of five stages in the TTM, it has seven stages without temporal definitions. In stage 1 (*unaware of the issue*), a person is not yet aware of threats to their health in their surroundings or in their behaviour. Stage 2 (*unengaged by issue*) refers to people being aware of a potential health threat but not being personally engaged by it. In stage 3 (*deciding*), the pros and cons of changing behaviour are evaluated, until a decision not to act (stage 4; *decided not to act*) or to act (stage 5; *decided to act*) is made. Individuals in stage 4 drop out of the precaution adoption process until they enter stage 3 again. Stage 6 (*action*) and stage 7 (*maintenance*) are similar to those in the TTM, but without temporal criteria. While *action* refers to conscious initiation of behaviour, *maintenance* describes additional stabilisation and behavioural regulation without much conscious effort. The sequence of stages to maintenance therefore would be 1-2-3-5-6-7. The PAPM has been examined in the context of various health behaviours such as radon testing (Weinstein, Lyon, Sandman, & Cuite, 1998), risky motorbike driving (Rutter, Quine, & Albery, 1998) or colon cancer screening (Costanza et al., 2005). Although the PAPM seems plausible by defining stages on psychological criteria, there is little specific advice on efficient factors in the stage and on how actual behaviour change can be facilitated. Most research on the PAPM has been non-experimental, and there has only been one intervention study (Weinstein, Lyon, Sandman, & Cuite, 1998), which focussed on the distinction between the *deciding* and *decided to act* stages.

Weinstein, Rothman & Sutton (1998) and Renner & Schwarzer (2003) argue that all stage models can be subsumed under three broader stages describing persons who have not yet decided to change their behaviour (Stage 1), people who have decided to change behaviour but have not yet started (Stage 2), and those who have already changed their behaviour (Stage 3).

This distinction has been adopted in the Health Action Process Approach, which distinguishes a *preintentional* or *motivational* stage, an *intentional* or *postintentional-preactional* and an *actional* stage. These three stages can also be, in accordance to Heckhausen & Gollwitzer's (1987) concept of a *motivational* and a *volitional* mindset be subsumed under two metastages, a *motivational* stage before a person has formed an intention to act, and a *volitional* stage after this decision has been made. In addition to the stage characteristics, the HAPA also specifies stage-specific factors that promote

stage progression and behaviour. It incorporates characteristics from both stage and continuum theories and has thus been described as a hybrid model (Lippke & Renneberg, 2006; Schwarzer et al., in press). Within this thesis, evidence for these broader distinctions with three, respectively two superordinate meta-stages will be presented. Chapter 3 examines differential effects of a self-monitoring intervention between persons in the motivational and volitional stages, Chapter 4 analyses stage-specific predictors of stage transitions in the preintentional, intentional and actional stages, and Chapter 5 presents the results from a planning intervention matched to individuals in the volitional stage and mismatched to individuals in the motivational stage.

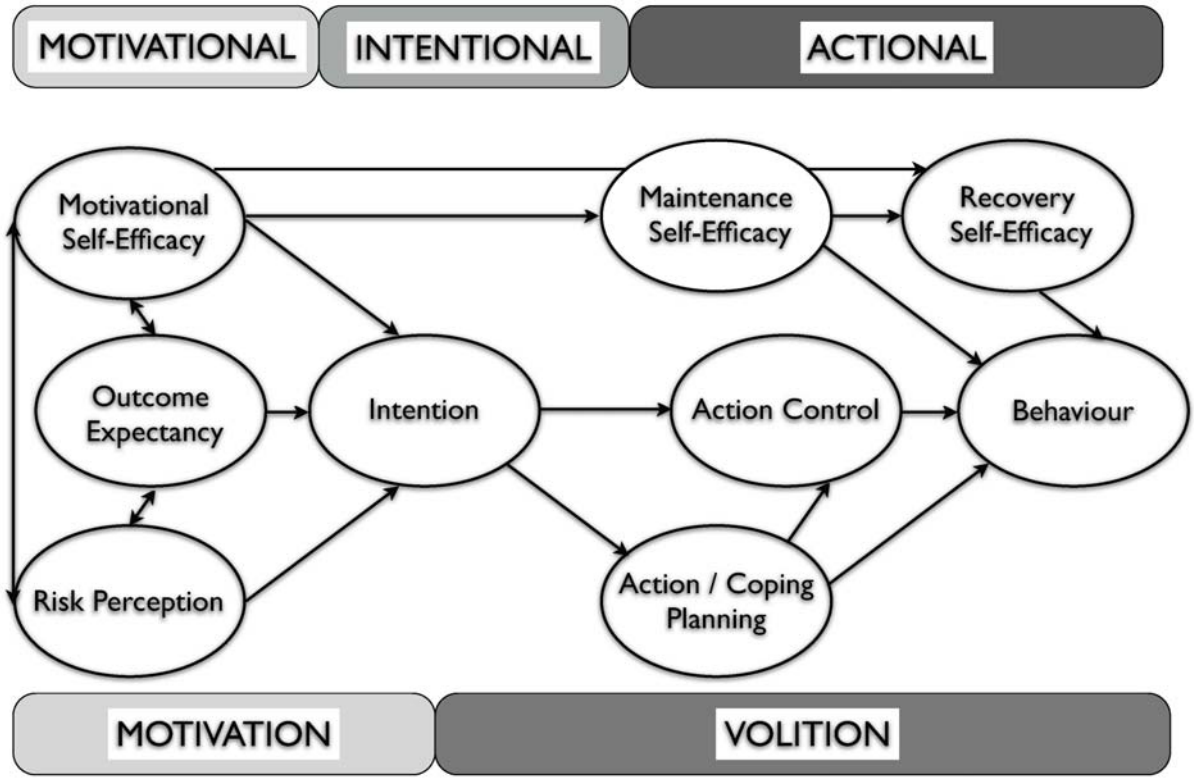

Figure 1.1: Health Action Process Approach (figure after Mallach, Schüz, & Sniehotta, 2006) with three and two stages

According to the HAPA, risk perceptions, outcome expectancies and motivational self-efficacy predict behavioural intentions. In a comparative study on the intention formation process, Garcia & Mann (2003) demonstrated that the HAPA predictors explain more variance in intentions than Health Belief Model or TPB predictors. With forming the intention to act or to change behaviour, the *motivational* or *preintentional* stage ends. The focus shifts from the information relevant for the decision of acting or not to the information and processes related to behaviour initiation. Here, in the *intentional* stage, the HAPA assumes planning to be the key mediating variable between inten-

tions and subsequent behaviour. In the *actional* stage, coping planning, action control and recovery/maintenance self-efficacy are important factors for behaviour maintenance and recovery from setbacks. Self-efficacy is conceptualised as highly task-specific and effective in the respective stages (Luszczynska & Schwarzer, 2003; Scholz, Sniehotta, & Schwarzer, 2005). So a person might be highly confident in their general ability to floss correctly (motivational self-efficacy), but at the same time lack the confidence in implementing a regular daily flossing regimen (maintenance self-efficacy).

The HAPA is intended to be a framework to guide research rather than a completed theory (Schwarzer, 1992), thus it is open for additional factors.

1.1.3. Validity of stage theories

In order to be a useful tool for the development of interventions, it is crucial to examine the key assumption of stage theories, i.e., qualitative differences between the stages in terms of psychological factors. If these differences could not be confirmed empirically, or if the stages turn out to be pseudostages (arbitrary steps cut off of an underlying continuum of e.g. intentions), stage-based interventions would promise no improvement compared with one-size-fits-all interventions as based on motivational theories. There are mainly three approaches to test the staging assumption, which differ substantially with regard to the strictness of the testing and the demands to study design and data quality (Weinstein, Rothman, & Sutton, 1998):

1. Detection of discontinuity, either cross-sectionally or longitudinally. In the cross-sectional examination, the stages are used as factors to detect mean differences in dependent psychological variables, e.g., intentions, self-efficacy, risk perception etc. If there are mean differences, the fit of the trend of the mean differences is examined, as suggested by Sutton (2000). If a linear trend fits the pattern of mean differences better than a non-linear (e.g., quadratic or cubic) trend, this would speak in favour of pseudostages rather than qualitatively different stages. However, the detection of discontinuity between stages in terms of non-linear trends or different prediction patterns between stages is considered the weakest evidence for stage differences, because they can still be caused by an underlying continuum with arbitrary cut-offs. This way of detecting discontinuity has been used by e.g. Sniehotta, Luszczynska, Scholz, & Lippke (2005). From a longitudinal perspective, discontinuity can be examined by demonstrating stage-specific prediction patterns for a dependent variable, e.g. physical activity (e.g., Lippke, Nigg, & Maddock, in press).
2. Longitudinal prediction of stage transitions. Here, the assumption that different causal factors are important for transitions in different stages can be tested. If, for example, variable X predicts stage progression from stage 1 to stage 2, but not from stage 2 to stage 3, whereas vari-

able Y predicts stage progression from stage 2 to stage 3, but not from stage 1 to stage 2, this would speak in favour of a three-stage model of change. If the stages were artificially derived from cutoffs of a linear continuum, no different predictors would be found at different stages. This strategy is considered to provide stronger evidence for a stage model. However, if the underlying continuum was nonlinear or contained interactions with other variables, such as intentions interacting with health status, this analysis strategy could however also fail in ruling out pseudostages. In a study on healthy food choice, Armitage, Sheeran, Conner & Arden (2004) tested the TPB predictors for their ability to predict TTM stage progression and found some support for the TTM stages, however, some variables (age and perceived behavioural control) were predictive of stage transitions from more than one stage.

3. Experimental studies of matched and mismatched interventions. This strategy requires the design of interventions based on the assumption of the stage theory on stage-specific causal factors. For example, if the stage theory states that variable X is important for the transition from stage 1 to stage 2, and that variable Y is important for the transition from stage 2 to stage 3, then an intervention a targeting variable X is matched to persons in stage 1 and mismatched to persons in stage 2. Similarly, an intervention b targeting variable Y would be matched to those in stage 2 and mismatched to those in stage 1. Within the experimental design, after assessing their stage, participants will be randomly assigned to interventions a or b, and if there is an interaction between their stage and the intervention in the way predicted by the stage theory, this would support the idea of qualitatively different stages. This way of testing stage differences would also provide the strongest evidence for stages, as stages based on an underlying continuum would produce main effects of treatment and stages, but no interaction. This strategy has been applied by e.g. Dijkstra, Conijn & De Vries (2006) in a study on tobacco smoking, where they provide evidence for some stage*treatment interactions as predicted by their stage theory.

Within three chapters of this thesis, the staging assumptions as made by the HAPA will be examined using these analysis strategies. Discontinuity in terms of stage-specific prediction patterns will be examined in Chapter 3. Here, the effects of a self-regulation intervention as indicated by changes in action control predicted behaviour change only in volitional participants. Chapter 4 examines stage-specific predictors of stage transitions by means of discriminant function analysis in three stages of change. Chapter 5 applies the approach of matched/mismatched interventions by applying a planning intervention matched to the volitional stage and mismatched to the motivational stage.

1.2. Postintentional factors in behaviour regulation: Planning and action control

In the HAPA, it is assumed that the effect of intentions on behaviour is mediated by action planning and coping planning (Sniehotta, Schwarzer, Scholz, & Schüz, 2005) as well as action control (Sniehotta, Scholz, & Schwarzer, 2005). While action planning and coping planning refer to a prospective strategy, the linking of concrete situational cues to intended behavioural responses, action control describes cognitive aspects of behavioural self-regulation during behaviour enactment (Schüz & Renneberg, 2006; Sniehotta, Winter, Dombrowski, & Johnston, in press).

1.2.1. Planning

Making concrete plans (*action plans* and *coping plans* or *implementation intentions*) in advance on how to implement intended behaviour has in a multitude of studies proven to facilitate behaviour enactment (for a meta-analysis, see Gollwitzer & Sheeran, 2006). These concrete plans follow an if-then-structure enclosing both an *if-condition* specifying a concrete situation (e.g., by means of delineating the when and where of a situation in which behaviour is intended) and a *then-component* which delineates the intended behaviour in this situation.

Planning can be further subdivided into *action planning* and *coping planning* (Sniehotta, Schwarzer, Scholz, & Schüz, 2005). While action planning describes the concrete linking of a behavioural response to a situational context in order to increase the likelihood of acting, coping planning refers to the prospective imagination of barriers to action and ways to overcome them. Although the stages that action planning and coping planning target at, differ (while action planning is supposed to be more helpful for the initiation of behaviour, coping planning seems to support the maintenance of behaviour), they both refer to the mental simulation of success scenarios with regard to intended behaviour. Thus, the assumed cognitive pathways are similar. Forming plans and concretely imagining situations beforehand should lead to increased activation as soon as the specified situation is entered. The plan contents therefore are better accessible, and the enactment of the plan becomes more likely.

Action plans and coping plans are subordinate to a higher-order goal such as the general intention to improve dental hygiene (Gollwitzer, 1999). If-then plans then serve as concrete means to realise these intentions in distinctive steps. It is assumed that intentions interact with plans in the way that plans are more effective in promoting behaviour enactment when goal intentions are high. This locates planning in the volitional stages of health behaviour change, which has been demonstrated in a number of studies (e.g. (Scholz, Schüz, Ziegelmann, Lippke, & Schwarzer, 2007; Sheeran, Webb, & Gollwitzer, 2005).

This hierarchy of goals, intentions, and concrete plans can be traced back as early as to Kurt Lewin (1926) and have been examined in the health behaviour context since the 1960s (Leventhal, Singer, & Jones, 1965).

Planning can be examined from two general viewpoints. It is possible to experimentally induce plans in participants in self-instructed or face-to-face settings and examine the outcomes as compared to a control group without plans. This has been widely applied for a range of health-relevant behaviours such as tetanus vaccination (Leventhal, Singer, & Jones, 1965), low-fat diet (Armitage, 2004) or physical activity (Sniehotta et al., 2005; Ziegelmann, Lippke, & Schwarzer, 2006). On the other hand, planning can be measured psychometrically and set in relation with health behaviour (Rise, Thompson, & Verplanken, 2003; Sniehotta, Schwarzer, Scholz, & Schüz, 2005). Within this thesis, action planning and coping planning were for the first time applied in the context of dental flossing behaviour. A psychometric measure of planning was used to predict the adherence to evidence-based practice in dentistry, the daily application of dental floss (Chapter 2), and an experimental manipulation of planning was applied to test whether participants in the volitional stages profited more from this intervention than participants in the motivational stage (Chapter 3).

1.2.2. Action Control

Action control refers to cognitive self-regulatory processes that become relevant during the actual enactment of self-set behavioural goals. These processes build upon the concept of negative feedback loops derived from cybernetic models of behaviour self-regulation such as the Test-Operation-Test-Exit-Loop for the completion of tasks with a set standard (Carver & Scheier, 1998; Karoly, 1993; Miller, Galanter, & Pribram, 1960). In this process, self-monitored behaviour is compared with a (either internal or external) set standard value for behaviour enactment. If this comparison emerges negative, i.e. if the self-monitored value of behaviour is below the standard, then means to reduce this discrepancy will be induced. These means can be approaching, i.e. increasing behaviour frequency in order to minimise differences with the standard, or avoidant, i.e. lowering the standard also in order to minimise differences.

An action control scale measuring these self-regulatory processes has been proposed by Sniehotta, Scholz, & Schwarzer (2005). Here, action control is measured with the facets *self-monitoring*, *awareness of standards* and *self-regulatory effort* describing behavioural self-regulation according to a negative feedback loop. In this study on physical exercise, action control emerged as the proximal predictor of actual exercise behaviour. Action control processes are also located in the volitional stage. In order to compare actual behaviour to set standards, these standards must have been elaborated

in an intention-building process. Additionally, the initiation of behaviour needs to be completed in order to compare own behaviour to the standards.
Within this thesis, it will be examined for the first time if experimentally manipulated action control levels are more predictive of dental flossing behaviour in participants in the volitional stage.

1.3. Context: Interdental hygiene to prevent caries and periodontitis

Although the last 30 years have seen a steady decline of dental diseases such as caries or periodontal diseases in industrialised countries due to the introduction of fluoridated tooth pastes, improved screening techniques for early sealing of dental fissures, and educational measures such as the teaching of tooth brushing skills in schools, there still is a substantial prevalence of dental diseases (Michaeelis & Reich, 1999). According to this representative survey, the German population in the age group between 35 and 44 still displays a DMF-T (Decayed, Missing and Filled Teeth) of 16,1 on average. The DMF-T indicates how many teeth are decayed (i.e. affected by carious lesions), missing (have been removed) or have been filled. Given that a fully grown adult denture has between 28 and 32 (including wisdom teeth), a mean value of 16,1 points to substantial dental impairments. For older adults, this value is even higher. Gingivitis (early stage of periodontal disease) has been diagnosed in 95% of the adult population, according to the German Society for Periodontology (DGP, 2005). The main causal factor for both interdental caries and periodontal disease is bacterial plaque on all dental surfaces. If not removed on a regular basis, this bacterial plaque causes demineralisation processes in the dentin through the dental surfaces, which lead to white spot lesions and later caries. In the periodontium (gums and jaw bone), calculus (hardened plaque) causes infection and inflammation. In an early stage, the inflammation is reversible; in later stages of periodontal diseases, the gum will recede irreversibly, leading to tooth loss.
Although there have been improvements in the development of medication and drugs the manual removal of plaque with toothbrushes and dental floss remains the most effective way of preventing periodontal diseases and caries (Bauroth et al., 2003; Warren & Chater, 1996). Thus, all major dental societies including the American Dental Association (ADA, 2005), the British Dental Association (BDA, n.d.) and the Deutsche Gesellschaft für Zahn-, Mund-, und Kieferheilkunde (DGZMK, n.d.) recommend the daily use of dental floss as a supplement to tooth brushing. An Emnid survey however showed that while the majority of Germans brushes their teeth at least twice daily, more than half of them flosses never or hardly at all (DGK, 2004). Additionally, the per-capita use of dental floss would add up to about 150 m per year -if the recommendation of daily flossing was followed- but the actual per-capita use in Germany in adults is as

low as 4,01 m (Staehle, 2004). This data indicates problems in the initiation and maintenance of dental flossing behaviour.

Only few studies have examined the psychological determinants of regular interdental hygiene (e.g., McCaul, O'Neill, & Glasgow, 1988; Rise, Åstrøm, & Sutton, 1998; Ronis, 1992; Stewart, Strack, & Graves, 1999), but they have been relying on continuum theories of health behaviour such as the HBM, TRA, TPB and SCT. Intervention studies for dental flossing behaviour based on health behaviour theories are rare, to my knowledge, only three studies have been published so far (Lavin & Groarke, 2005; McCaul, Glasgow, & O'Neill, 1992; Philippot, Lenoir, Hoore, & Bercy, 2005), and the results are inconsistent with regard to the efficacy of self-regulation interventions.

Thus, the present thesis aimed at testing evidence-based factors from health behaviour theories in the prediction and improvement of dental flossing behaviour.

1.4. Studies in the thesis

This thesis relies on three longitudinal experimental and non-experimental studies to examine the research plan as outlined above. In the following, a brief outline of the studies will be given. The respective chapters contain more detailed information about study design and proceedings.

1.4.1. Study 1: Prediction of adherence to daily oral self-care

The first, non-experimental study was conducted with 258 students at Freie Universität Berlin, Germany. It included three points of measurement over an eight-week period. Participants were approached during lectures at the psychology and educational science departments, and, after giving informed consent, were provided with pseudonymed questionnaires assessing the constructs of the HAPA adapted to dental flossing, self-monitoring calendars, floss samples and instructions according to the ADA recommendations (ADA, 2005). Two and eight weeks after baseline, the participants received questionnaires identical to the baseline questionnaire with prepaid return envelopes. Two weeks after baseline, they additionally were provided with fresh samples of dental floss and were asked to return the used samples together with the self-monitoring calendars.

The main purpose of this study was to examine the applicability of the HAPA constructs to the context of oral self-care and to examine if the predictive power of planning and action control depended on the stages of the HAPA. The findings from this study are presented in chapters 2 and 3, additional findings have been published by Schüz (2006). All questionnaires and materials can be found in Appendix A.

1.4.2. Study 2: RCT on stage-specific effects of planning

The second, experimental study, was conducted during a university open day ("Auf den Zahn gefühlt" at "Lange Nacht der Wissenschaften", http://www.langenachtderwissenschaften.de/archiv/lndw_2006/dahlem.php#2250). During this open day, participants (N=195) were approached by trained students, gave informed consent for participation, answered a brief questionnaire on dental flossing behaviour, and were, according to a randomly generated schedule, allocated to either the control group or a planning intervention. Participants additionally received flossing samples, information leaflets with flossing instructions, and a cartoon postcard (All questionnaires and materials can be found in Appendix B).

Two weeks and six weeks after baseline, participants received follow-up questionnaires with prepaid return envelopes similar to those applied in study 1.

The main purpose of this study was to examine if the planning intervention worked better with participants in the stage it was targeted at (the volitional stage) than with participants in the motivational stage. The findings from this study are presented in Chapter 5.

1.4.3. Study 3: Controlled Trial in dental practices

The third longitudinal study was conducted with dental patients (N= 488) in dental practices in Berlin. The study was conducted as an experimental match/mismatch research design with motivational and volitional leaflets matched to the respective stage and mismatched to the other stage. The content of the leaflets was designed to address the constructs of the HAPA for the respective stages. Within this thesis, however, experimental design was not analysed, but the longitudinal data set was used to predict stage transitions from the HAPA variables (Chapter 4). Questionnaires and additional material are provided in Appendix C.

While waiting for their appointments with the dentist, the patients were informed about the study by practice staff and invited to participate. Interested participants received a folder containing further information, an informed consent sheet, the baseline questionnaire (similar to those from study 1) and a self-monitoring calendar. Different urns for informed consent sheets and questionnaires were provided, so the personal data and the questionnaires of participants could be processed separately. Participants were allocated to experimental conditions according to a schedule with conditions changing daily. After the examination by the dentist, participants allocated to the motivational intervention group received samples of interdental hygiene measures (floss or interdental brushes) by recommendation of the dentist. Four weeks and three months after the baseline assessment, follow-up questionnaires with prepaid return envelopes were sent out to participants. Within this thesis, only findings regarding the first two measurement points are presented.

The main purposes of this study were to evaluate the effects of a matched/mismatched intervention and to identify the effectiveness of the HAPA constructs in explaining transitions between stages of behaviour change.

1.5. Aims of the thesis and thesis structure

In sum, this thesis addresses the following more general research questions:

- Is there empirical support for the distinction of three stages of health behaviour change (Chapter 4) and two meta-stages (Chapter 3 and Chapter 5)?
- Can transitions between these stages be predicted with factors derived from health behaviour theories (Chapter 4)?
- Can postintentional processes such as planning (Chapter 2) and action control (Chapter 3) predict health behaviour change over and above behavioural intentions?
- Are these postintentional processes most effective in persons in the stages they are targeted at (Chapter 3 and Chapter 5), thus supporting the assumption of qualitatively different stages?

Chapters 2-5 will present the findings for these research questions. Chapter 6 will provide an overall discussion of the findings of the thesis, integrate them into a broader context and will give implications for interventions and further research.

1.6. References

ADA. (2005). Cleaning Your Teeth and Gums (Oral Hygiene). Retrieved August 14th, 2006, from http://www.ada.org/public/topics/cleaning_faq.asp#4

Ajzen, I. (1985). From intentions to actions: A theory of planned behaviour. In J. Kuhl & J. Beckmann (Eds.), *Action control: From cognition to behaviour* (pp. 11-40). Berlin: Springer-Verlag.

Ajzen, I., & Fishbein, M. (1977). Attitude-behavior relations: A theoretical analysis and review of empirical research. *Psychological Bulletin, 84*(5), 888-918.

Albarracín, D., Johnson, B. T., Fishbein, M., & Muellerleile, P. A. (2001). Theories of reasoned action and planned behavior as models of condom use: A meta-analysis. *Psychological Bulletin, 127*(1), 142-161.

Armitage, C. J. (2004). Evidence That Implementation Intentions Reduce Dietary Fat Intake: A Randomized Trial. *Health Psychology, 23*(3), 319-323.

Armitage, C. J., Sheeran, P., Conner, M., & Arden, M. A. (2004). Stages of Change or Changes of Stage? Predicting Transitions in Transtheoretical Model Stages in Relation to Healthy Food Choice. *Journal of Consulting and Clinical Psychology, 72*(3), 491-499.

Bandura, A. (1992). Social cognitive theory. In R. Schwarzer (Ed.), *Self-Efficacy: Thought Control of Action*. Washington, DC: Hemisphere.

Baumeister, R. F., Heatherton, T. F., & Tice, D. M. (1994). *Losing control: How and why people fail at self-regulation*. San Diego, CA: Academic Press.

Bauroth, K., Charles, C. H., Mankodi, S. M., Simmons, K., Zhao, Q., & Kumar, L. D. (2003). The efficacy of an essential oil antiseptic mouthrinse vs. dental floss in controlling interproximal gingivitis: a comparative study. *Journal of the American Dental Association, 134*(3), 359-365.

BDA. (n.d.). Flossing. Retrieved February 3rd, 2006, from http://www.bdadentistry.org.uk /smile/adults/adults.cfm?contentid=1267&contentparentid=1036

Bridle, C., Riemsma, R. P., Pattenden, J., Sowden, A. J., Mather, L., Watt, I. S., et al. (2005). Systematic review of the effectiveness of health behavior interventions based on the transtheoretical model. *Psychology & Health, 20*(3), 283-301.

Carver, C. S., & Scheier, M. F. (1998). *On the self-regulation of behavior*. Cambridge: Cambridge University Press.

Chatzisarantis, N. L. D., & Hagger, M. S. (2005). Effects of a brief intervention based on the Theory of Planned Behavior on leisure-time physical activity participation. *Journal of Sport and Exercise Psychology, 27*(4), 470-487.

Costanza, M. E., Luckmann, R., Stoddard, A. M., Avrunin, J. S., White, M. J., Stark, J. R., et al. (2005). Applying a stage model of behavior change to colon cancer screening. *Preventive Medicine, 41*(3-4), 707-719.

Davidson, R. (1992). Prochaska and DiClemente's model of change: A case study? *British Journal of Addiction, 87*, 821-822.

De Vet, E., De Nooijer, J., De Vries, N., & Brug, J. (2005). *Testing the transtheoretical model for fruit intake: Comparing web-based individualized stage-matched and stage-mismatched feedback*. Manuscript under review.

DGK. (2004). "Wie Deutschland vorbeugt" - Neueste Emnid-Umfrage zum Prophylaxe- und Mundpflegeverhalten der Deutschen vorgestellt. Retrieved 27.05.2006, from http://www.rundum-zahngesund.de/web/zahn_inhalte/de /pressemeldung_2004_02_09.tm?OpenDocument&searchquery=Emnid

DGP. (2005). Gesundes Zahnfleisch. Retrieved 17.01.2007, from http://www.dgparo.de/patienten_45102/index.php?option=content&task=view&id=32 &Itemid=53

DGZMK. (n.d.). Häusliche Propylaxemaßnahmen: Information der DGZMK. Retrieved 08.02.2007, from http://www.dgzmk.de/index.php?site=h%E4usliche

Dijkstra, A., Conijn, B., & De Vries, H. (2006). A match-mismatch test of a stage model of behaviour change in tobacco smoking. *Addiction, 101*(7), 1035-1043.

Fisher, W. A., Fisher, J. D., & Harman, J. (2003). The information-motivation-behavioraI skills model: A general social psychological approach to understanding and promoting health behavior. In J. Suls & K. A. Wallston (Eds.), *Social psychological foundations of health and illness.* (pp. 82-106): Blackwell Publishing.

Floyd, D. L., Prentice-Dunn, S., & Rogers, R. W. (2000). A meta-analysis of research on protection motivation theory. *Journal of Applied Social Psychology, 30*(2), 407-429.

Garcia, K., & Mann, T. (2003). From "I wish" to "I will": Social-cognitive predictors of behavioral intentions. *Journal of Health Psychology, 8*(3), 347-360.

Gollwitzer, P. M. (1999). Implementation intentions: Strong effects of simple plans. *American Psychologist, 54*(7), 493-503.

Gollwitzer, P. M., & Brandstätter, V. (1997). Implementation intentions and effective goal pursuit. *Journal of Personality & Social Psychology, 73*(1), 186-199.

Gollwitzer, P. M., Heckhausen, H., & Steller, B. (1990). Deliberative and implemental mind-sets: Cognitive tuning toward congruous thoughts and information. *Journal of Personality and Social Psychology, 59*(6), 1119-1127.

Gollwitzer, P. M., & Sheeran, P. (2006). Implementation intentions and goal achievement: A meta-analysis of effects and processes. *Advances in Experimental Social Psychology, 38*, 69-119.

Hardeman, W., Johnston, M., Johnston, D. W., Bonetti, D., Wareham, N. J., & Kinmonth, A. L. (2002). Application of the theory of planned behaviour in behaviour change interventions: A systematic review. *Psychology and Health, 17*(2), 123-158.

Hausenblas, H. A., Carron, A. V., & Mack, D. E. (1997). Application of the theories of reasoned action and planned behavior to exercise behavior: A meta-analysis. *Journal of Sport & Exercise Psychology, 19*(1), 36-51.

Heckhausen, H., & Gollwitzer, P. M. (1987). Thought contents and cognitive functioning in motivational versus volitional states of mind. *Motivation and Emotion, 11*(2), 101-120.

Karoly, P. (1993). Mechanisms of self-regulation: A systems view. *Annual Review of Psychology, 44*, 23-52.

Kuhl, J., & Schwarzer, R. (2006). Selbstregulation und Gesundheit. *Zeitschrift für Gesundheitspsychologie, 14*(2), 33.

Lavin, D., & Groarke, A. (2005). Dental floss behaviour: A test of the predictive utility of the Theory of Planned Behaviour and the effects of making implementation intentions. *Psychology, Health & Medicine, 10*(3), 243-252.

Leventhal, H., Singer, R., & Jones, S. (1965). Effects of fear and specificity of recommendation upon attitudes and behavior. *Journal of Personality & Social Psychology, 2*(1), 20-29.

Lewin, K. (1926). *Vorsatz, Wille und Bedürfnis : mit Vorbemerkungen über die psychischen Kräfte und Energien und die Struktur der Seele*. Berlin: Springer.

Lippke, S., Nigg, C. R., & Maddock, J. R. (in press). The Theory of Planned Behavior within the stages of the Transtheoretical Model - Latent structural modeling of stage-specific prediction patterns in physical activity. *Structural Equation Modeling*.

Lippke, S., & Renneberg, B. (2006). Theorien und Modelle des Gesundheitsverhaltens. In B. Renneberg & P. Hammelstein (Eds.), *Gesundheitspsychologie* (pp. 35-60). Berlin, Heidelberg: Springer.

Lippke, S., Ziegelmann, J. P., & Schwarzer, R. (2004). Behavioral intentions and action plans promote physical exercise: A longitudinal study with orthopedic rehabilitation patients. *Journal of Sport and Exercise Psychology, 26*(3), 470-483.

Luszczynska, A., & Schwarzer, R. (2003). Planning and self-efficacy in the adoption and maintenance of breast self-examination: A longitudinal study on self-regulatory cognitions. *Psychology and Health, 18*(1), 93-108.

Maddux, J. E. (1993). Social Cognitive Models of Health and Exercise Behaviour: An Introduction and Review of Conceptual Issues. *Journal of Applied Sport Psychology, 5*, 116-140.

Maddux, J. E., & Rogers, R. W. (1983). Protection motivation and self-efficacy: A revised theory of fear appeals and attitude change. *Journal of Experimental Social Psychology, 19*(5), 469-479.

Mallach, N., Schüz, B., & Sniehotta, F. F. (2006). Self-monitoring interventions for health behaviour change. *Psychology and Health, 21*(Suppl. 1), 96.

McCaul, K. D., Glasgow, R. E., & O'Neill, H. K. (1992). The problem of creating habits: Establishing health-protective dental behaviors. *Health Psychology, 11*(2), 101-110.

McCaul, K. D., O'Neill, H. K., & Glasgow, R. E. (1988). Predicting the performance of dental hygiene behaviors: An examination of the Fishbein and Ajzen model and self-efficacy expectations. *Journal of Applied Social Psychology, 18*(2), 114-128.

Michaeelis, W., & Reich, R. H. (1999). *Dritte Deutsche Mundgesundheitsstudie*. Köln: Deutscher Ärzte-Verlag.

Miller, G. A., Galanter, E., & Pribram, K. H. (1960). *Plans and the structure of behavior*: Oxford, England: Holt.

Milne, S., Orbell, S., & Sheeran, P. (2002). Combining motivational and volitional interventions to promote exercise participation: Protection motivation theory and implementation intentions. *British Journal of Health Psychology, 7*(2), 163-184.

Milne, S., Sheeran, P., & Orbell, S. (2000). Prediction and intervention in health-related behavior: A meta-analytic review of protection motivation theory. *Journal of Applied Social Psychology, 30*(1), 106-143.

Noar, S. M., & Zimmerman, R. S. (2005). Health Behavior Theory and cumulative knowledge regarding health behaviors: Are we moving in the right direction? *Health Education Research, 20*(3), 275-290.

Philippot, P., Lenoir, N., Hoore, W., & Bercy, P. (2005). Improving patients' compliance with the treatment of periodontitis: a controlled study of behavioural intervention. *Journal of Clinical Periodontology, 32*(6), 653-658.

Prochaska, J. O., & DiClemente, C. C. (1992). The transtheoretical approach. In J. C. Norcross & M. R. Goldfried (Eds.), *Handbook of psychotherapy integration.* New York, NY: Basic Books, Inc.

Prochaska, J. O., DiClemente, C. C., & Norcross, J. C. (1992). In search of how people change: Applications to addictive behaviors. *American Psychologist, 47*(9), 1102-1114.

Prochaska, J. O., DiClemente, C. C., Velicer, W. F., & Rossi, J. S. (1992). Comments on Davidson's "Prochaska and DiClemente's model of change: a case study?" Criticisms and concerns of the transtheoretical model in the light of recent research. *British Journal of Addiction, 87*, 825-835.

Prochaska, J. O., Redding, C. A., & Evers, K. E. (2002). The transtheoretical model and stages of change. In K. Glanz, B. K. Rimer & F. M. Lewis (Eds.), *Health behavior and health education: Theory, research and practice* (3rd ed., pp. 99-120). San Francisco: Jossey-Bass.

Quinlan, K. B., & McCaul, K. D. (2000). Matched and mismatched interventions with young adult smokers: Testing a stage theory. *Health Psychology, 19*(2), 165-171.

Renner, B., & Schwarzer, R. (2003). Social-cognitive Factors in health behavior change. In J. Suls & K. A. Wallston (Eds.), *Social Psychological Foundations of Health and Illness* (pp. 169-196). Oxford: Blackwell.

Rise, J., Åstrøm, A., & Sutton, S. (1998). Predicting intentions and use of dental floss among adolescents: An application of the theory of planned behaviour. *Psychology & Health, 13*, 223-236.

Rise, J., Thompson, M., & Verplanken, B. (2003). Measuring implementation intentions in the context of the theory of planned behavior. *Scandinavian Journal of Psychology, 44*(2), 87-95.

Ronis, D. L. (1992). Conditional health threats: Health beliefs, decisions, and behaviors among adults. *Health Psychology, 11*(2), 127-134.

Rothman, A. J. (2004). "Is there nothing more practical than a good theory?": Why innovations and advances in health behavior change will arise if interventions are used to test and refine theory. *International Journal of Behavioral Nutrition and Physical Activity, 1*.

Rutter, D. R., Quine, L., & Albery, I. P. (1998). Perceptions of risk in motorcyclists: Unrealistic optimism, relative realism and predictions of behaviour. *British Journal of Psychology, 89*(4), 681-696.

Scholz, U., Schüz, B., Ziegelmann, J. P., Lippke, S., & Schwarzer, R. (2007). *Beyond Behavioral Intentions: Planning Mediates Between Intentions and Physical Activity.* Manuscript under review.

Scholz, U., & Schwarzer, R. (2005). Modelle der Gesundheitsverhaltensänderung. In R. Schwarzer (Ed.), *Enzyklopädie der Psychologie, Serie X, Band 1: Gesundheitspsychologie* (pp. 333-349). Göttingen: Hogrefe.

Scholz, U., Sniehotta, F. F., & Schwarzer, R. (2005). Predicting Physical Exercise in Cardiac Rehabilitation: The Role of Phase-Specific Self-Efficacy Beliefs. *Journal of Sport and Exercise Psychology, 27*(2), 135-151.

Schüz, B. (2006). Emotion und Volition bei regelmäßigem Gesundheitsverhalten: Angst und Planung bei Dentalhygiene mittels Zahnseide. *Zeitschrift für Gesundheitspsychologie, 14*(2), 64-72.

Schüz, B., & Renneberg, B. (2006). Theoriebasierte Strategien und Interventionen in der Gesundheitspsychologie. In B. Renneberg & P. Hammelstein (Eds.), *Gesundheitspsychologie* (pp. 123-142). Berlin, Heidelberg: Springer.

Schwarzer, R. (1992). Self-efficacy in the adoption and maintenance of health behaviors: Theoretical approaches and a new model. In R. Schwarzer (Ed.), *Self-Efficacy: Thought Control of Action* (pp. 217-242). Washington, DC: Hemisphere.

Schwarzer, R. (2001). Social-cognitive factors in changing health-related behaviors. *Current Directions in Psychological Science, 10*(2), 47-51.

Schwarzer, R., Luszczynska, A., Schüz, B., Ziegelmann, J. P., Lippke, S., & Scholz, U. (in press). Adoption and maintenance of four health behaviors: Theory-guided longitudinal studies on dental flossing, seatbelt use, dietary behavior and physical activity. *Annals of Behavioral Medicine*.

Schwarzer, R., Schüz, B., & Ziegelmann, J. (2006). Gesundheitspsychologie. In K. Pawlik (Ed.), *Psychologie* (pp. 673-685). Berlin, Heidelberg, New York: Springer.

Sheeran, P. (2002). Intention-behaviour relations: A conceptual and empirical review. In M. Hewstone & W. Stroebe (Eds.), *European Review of Social Psychology* (Vol. 12, pp. 1-36). New York: Wiley.

Sheeran, P., & Taylor, S. (1999). Predicting intentions to use condoms: A meta-analysis and comparison of the theories of reasoned action and planned behavior. *Journal of Applied Social Psychology, 29*(8), 1624-1675.

Sheeran, P., Webb, T. L., & Gollwitzer, P. M. (2005). The interplay between goal intentions and implementation intentions. *Personality and Social Psychology Bulletin, 31*(1), 87-98.

Smedslund, G. (1997). Some psychological theories are not empirical: A conceptual analysis of the 'Stages of Change' Model. *Theory & Psychology, 7*(4), 529-544.

Sniehotta, F. F., Luszczynska, A., Scholz, U., & Lippke, S. (2005). Discontinuity patterns in stages of the precaution adoption process model: Meat consumption during a livestock epidemic. *British Journal of Health Psychology, 10*(2), 221-235.

Sniehotta, F. F., Scholz, U., & Schwarzer, R. (2005). Bridging the intention-behaviour gap: Planning, self-efficacy, and action control in the adoption and maintenance of physical exercise. *Psychology and Health, 20*(2), 143-160.

Sniehotta, F. F., Scholz, U., Schwarzer, R., Behr, H., Fuhrmann, B., Kiwus, U., et al. (2005). Long-term effects of two psychological interventions on physical exercise and self-regulation after coronary rehabilitation. *International Journal of Behavioral Medicine, 12*(4), 244-255.

Sniehotta, F. F., Schwarzer, R., Scholz, U., & Schüz, B. (2005). Action Planning and Coping Planning for Long-Term Lifestyle Change: Theory and Assessment. *European Journal of Social Psychology, 35*(4), 565-576.

Sniehotta, F. F., Winter, J., Dombrowski, S. U., & Johnston, M. (in press). Volitionale Verhaltenskontrolle. In R. Fuchs, W. Göhner & H. Seelig (Eds.), *Aufbau eines körperlich-aktiven Lebensstils: Theorie, Empirie und Praxis*. Göttingen: Hogrefe.

Staehle, H. J. (2004). Oral health behavior in Germany and Switzerland. *Schweizerische Monatsschrift Zahnmedizin, 114*(12), 1236-1251.

Stewart, J. E., Strack, S., & Graves, P. (1999). Self-efficacy, outcome expectancy, dental health value, and dental plaque. *American Journal of Health Behavior, 23*(4), 303-310.

Sutton, S. (2000). Interpreting cross-sectional data on stages of change. *Psychology & Health, 15*(2), 163-171.

Sutton, S. (2001). Back to the drawing board? A review of applications of the transtheoretical model to substance use. *Addiction, 96*(1), 175-186.

Warren, P. R., & Chater, B. V. (1996). An overview of established interdental cleaning methods. *Journal of Clinical Dentistry, 7*(3 Spec No), 65-69.

Weinstein, N. D. (1988). The precaution adoption process. *Health Psychology, 7*(4), 355-386.

Weinstein, N. D., Lyon, J. E., Sandman, P. M., & Cuite, C. L. (1998). Experimental evidence for stages of health behavior change: The precaution adoption process model applied to home radon testing. *Health Psychology, 17*(5), 445-453.

Weinstein, N. D., Rothman, A. J., & Sutton, S. R. (1998). Stage theories of health behavior: Conceptual and methodological issues. *Health Psychology, 17*(3), 290-299.

West, R. (2005). What Does it Take for a Theory to be Abandoned? The Transtheoretical Model of Behaviour Change as a Test Case. *Addiction, 100*(8), 1048-1050.

Ziegelmann, J. P., Lippke, S., & Schwarzer, R. (2006). Adoption and maintenance of physical activity: Planning interventions in young, middle-aged, and older adults. *Psychology and Health, 21*(2), 145-163.