Fachbereich Erziehungswissenschaft und Psychologie der Freien Universität Berlin

Health Behaviour Change:

Differential Effects of Planning Processes

Dissertation zur Erlangung des akademischen Grades

Doktorin der Philosophie (Dr. phil.)

vorgelegt von Dipl.-Psych. Amelie U. Wiedemann

Erstgutachter: Prof. Dr. Ralf Schwarzer

Zweitgutachterin: PD Dr. Nina Knoll

Berlin, Dezember 2008

Disputation: 3. Februar 2009

Table of Contents

Abstract

Intentions describe the route of action in terms of direction and intensity. However, with regard to health behaviour, only every second person succeeds in translating intentions into action (Sheeran, 2002). Procrastination, forgetting, and missing good opportunities to act constitute common reasons for failure and turn health behaviour change into a challenge for an individual's self-regulatory competencies (Baumeister, Heatherton, & Tice, 1994). Self-regulatory processes that facilitate behaviour change in face of such barriers for action, are *action planning* and *coping planning* (e.g., Gollwitzer, 1999; Leventhal, Singer, & Jones, 1965; Sniehotta, Schwarzer, Scholz, & Schüz, 2005). Targeting these planning processes in interventions can support bridging the gap between intentions and behaviour (Gollwitzer & Sheeran, 2006).

The aim of this thesis is to contribute to the understanding of health behaviour change by investigating differential effects of planning processes. Therefore, the interplay between intentions, planning processes, and health behaviour was investigated at different levels of intentions. Moreover, the differential effectiveness of planning interventions in different stage groups was examined, and the factors and working mechanisms that account for intervention effects on health-related outcomes in field settings. Moreover, the role of planning processes as predictor of transitions between different stages of behaviour change was tested.

The theoretical rationale of this thesis was based on the *Health Action Process Approach* (HAPA; Schwarzer, 1992; 2008), which integrates assumptions from continuum and stage models of health behaviour. The theory-derived hypotheses were tested in five experimental and correlational studies in various samples (patients, employees of a company, and internet users) and across different behavioural domains (physical activity, dietary behaviour, and oral self-care behaviour).

The main findings attest the beneficial effects of planning processes to reduce the gap between intentions and behaviour. The hypothesised interrelations between intentions, planning cognitions, and behaviour were confirmed to vary in accordance to levels of intentions as modelled by *moderated mediation*. This implies that theory refinement might

gain from modelling interrelations beyond simple mediation and moderation models. Furthermore, planning processes, along with other social-cognitive variables derived from the HAPA, showed differential prediction patterns of *stage transitions*, and thus, lend support to the assumption that the model is useful to describe behaviour change within a stage-theoretical approach. In *two experimental studies*, combined *action planning and coping planning interventions* improved health behaviour and body mass index through changes in self-regulatory planning processes. In particular, effects of the planning intervention differed between people in different stages of behaviour change (intenders and actors). These differences were identified to rely on the *numbers of generated plans* in the intervention. Moreover, the *working mechanism* of the intervention was explained by main and interactive effects of action planning and coping planning. Thus, planning interventions might focus on stimulating action planning and coping planning processes beyond the intervention to induce health-related outcomes, and the number of plans should be considered in future applications.

The theoretical considerations and empirical results may guide the development of theory- and evidence-based interventions: The findings underline the usefulness of targeting planning strategies in interventions in field settings. Interventions may be matched to the participants' needs and characteristics. The demonstration of the applied methodological approaches (e.g., moderated mediation, multiple mediation, three-path mediation, and threshold models) may inform the evaluation procedures of future theory-based interventions.

Gesundheitsverhaltensänderung:
Differentielle Effekte von Planungsprozessen

Zusammenfassung

Intentionen leiten das menschliche Handeln. Sie bestimmen die Richtung und die Intensität von Bestrebungen, ein selbstgesetztes Handlungsziel zu erreichen. Bei der Veränderung von Gesundheitsverhalten reichen Intentionen jedoch oft nicht aus: Nur jede zweite Person schafft es, ihre Intentionen in die Tat umzusetzen (Sheeran, 2002). Die gefassten Absichten scheitern oft am Aufschieben von Handlungen auf spätere Zeitpunkte, am Vergessen, sowie am Verpassen geeigneter Möglichkeiten zu ihrer Umsetzung. Somit werden die Aufnahme und die Aufrechterhaltung von Gesundheitsverhaltensweisen oft eine Herausforderung an die *selbstregulativen Kompetenzen* einer Person (Baumeister, Heatherton, & Tice, 1994). Prospektive Strategien, die die Prozesse der Verhaltenausführung angesichts von selbstregulativen Schwierigkeiten begünstigen, sind *Handlungsplanung* und *Bewältigungsplanung* (Gollwitzer, 1999; Leventhal, Singer, & Jones, 1965; Sniehotta, Schwarzer, Scholz, & Schüz, 2005).

Das Ziel dieser Dissertation ist es, die differentielle Wirkung von Planungsprozessen in der Gesundheitsverhaltensänderung modellhaft abzubilden und empirisch zu testen. Dazu wurde das Zusammenspiel von Planungsprozessen und anderen sozial-kognitive Variablen untersucht. Desweiteren wurden Planungsinterventionen auf Faktoren hin untersucht, die zur Erklärung ihrer unterschiedlichen Effektivität in angewandten Settings beitragen können. Den theoretischen Rahmen für die Untersuchungen lieferte das *Sozial-kognitive Prozessmodell gesundheitlichen Handelns* (Health Action Process Approach; HAPA; Schwarzer, 1992; 2008), das Annahmen aus verschiedenen Klassen von Theorien der Gesundheisverhaltensänderung vereint. Im einleitenden *Kapitel 1* wird der theoretische Hintergrund der Arbeit dargestellt und die Ableitung der Hypothesen aus Theorie und bisherigen Forschungsergebnissen dargelegt.

Forschungsdesiderata hinsichtlich der differentiellen Effekte von Planungsprozessen werden aufgezeigt und in drei Forschungsfragen zusammengefasst:

1. *Können verschiedene Modelle, die die Beziehungen zwischen Intentionen, Planungsprozessen und Gesundheitsverhalten beschreiben, in einem integrativen Modell geprüft werden?*
2. *Sind Planungsinterventionen effektiv, um Verhaltensänderungen zu bewirken, und wie können ihre unterschiedlichen Effekte in angewandten Settings erklärt werden?*
3. *Sind die im HAPA-Modell spezifizierten sozial-kognitiven Faktoren Prädikoren für spezifische Veränderungen in Stadien der Gesundheitsverhaltensänderung?*

Diese Forschungsfragen wurden in fünf experimentellen und korrelativen Studien an verschiedenen Stichproben (Patienten, Betriebsangehörigen und Internetnutzern), und in Bezug auf verschiedene Verhaltensweisen (körperliche Aktivität, gesundes Ernährungsverhalten und Zahnhygiene) getestet. Diese Studien sind in den empirischen Kapiteln 2 bis 5 beschrieben:

Im *zweiten Kapitel* werden Ergebnisse zweier Längsschnittstudien zu körperlicher Aktivität und Zahnhygiene dargestellt, die das angenommene Modell einer *moderierten Mediation* bestätigen: Intentionen beeinflussen die Beziehung zwischen Planungsprozessen und Verhalten und verstärken dadurch den indirekten Effekt von Intentionen auf das Verhalten. Der Einfluss von Intentionen auf Gesundheitsverhalten erfolgt somit direkt und indirekt (mediiert und moderiert) über Planungsprozesse. Für das Auftreten des Mediationseffekts muss hinsichtlich körperlicher Aktivität ein höherer Schwellenwert der moderierenden Intentionen überschritten werden als hinsichtlich der Interdentalhygiene. Dies deutet auf die unterschiedliche Komplexität der Verhaltensweisen hin. Aus den Ergebnissen kann abgeleitet werden, dass Planungsinterventionen zur Veränderung von komplexen Gesundheitsverhaltensweisen Maßnahmen zur Intentionssteigerung vorangehen sollten.

Im *dritten Kapitel* wurden die *Wirksamkeit* und der *Wirkmechanismus* einer Planungsintervention in einer Studie mit randomisiertem Kontrollgruppendesign untersucht. Die Teilnehmer an der Studie waren Betriebsangehörige, die ein gesundes

Ernährungsverhalten beabsichtigten. Diese wurden im Rahmen der Studie einer computergestützten *Handlungs- und Bewältigungsplanungsintervention* oder einer Kontrollbedingung zugeteilt. Die Intervention führte zu einem Anstieg in Planungsprozessen in der Interventionsgruppe. Die Interventionseffekte auf den Obst- und Gemüsekonsum können durch Veränderungen in der regelmäßigen Anwendung von Strategien der *Handlungs*- und *Bewältigungsplanung* erklärt werden (multiples Mediationsmodell), nicht aber durch motivationale Faktoren (Selbstwirksamkeit, Intentionen). Haupt- und Interaktionseffekte von diesen Planungsprozessen als Prädiktoren von Verhaltensänderungen deuten zudem ein additives und synergistisches Zusammenspiel der Planungsprozesse an. Des Weiteren konnte ein positiver Einfluss der Intervention auf den *Body Mass Index* aufgezeigt werden, der durch Veränderungen in der Planung und im Verhalten erklärt werden konnte (Drei-Pfad-Modell). Daraus kann geschlussfolgert werden, dass Planungsinterventionen insbesondere eine regelmäßige Anwendung von Planungsstrategien im Alltag stimulieren sollten.

Im *vierten Kapitel* wurde die Wirksamkeit einer *kombinierten Planungsintervention* auf körperliche Aktivität untersucht (Studiendesign wie in *Kapitel 3*). Darüber hinaus wurde der Zusammenhang zwischen der *Stadienzugehörigkeit* und der *Anzahl von Plänen*, die in der Intervention generiert wurden, untersucht. Die Befunde deuten darauf hin, dass das Formulieren von Plänen bei inaktiven Personen zur *Handlungsaufnahme* und bei aktiven Personen zur *Handlungsaufrechterhaltung* führt. Diese differentiellen Verhaltensänderungen werden durch eine unterschiedliche Anzahl generierter Pläne erklärt: Inaktive Personen formulieren im Vergleich zu aktiven Personen mehr Handlungspläne, aber unterscheiden sich nicht von ihnen in der Anzahl von Bewältigungsplänen. Darüber hinaus zeigte sich ein *kurvilinearer Effekt von Handlungsplänen*: Grundsätzlich ging mit einer steigenden Anzahl von Plänen eine Verhaltenssteigerung einher. Die maximale Anzahl von drei Handlungsplänen war jedoch weniger wirksam als das Formulieren von zwei Handlungsplänen. Diese differentiellen Effekte könnten beispielsweise auf eine kognitive Überlastung während des Planens

zurückgeführt werden. Es kann geschlussfolgert werden, dass bei der Implementierung von Planungsinterventionen die Anzahl von Plänen berücksichtigt werden sollte.

Im *fünften Kapitel* wurden sozial-kognitive Variablen des HAPA-Modells auf stadienspezifische Prädiktionsmuster von Übergängen zwischen den drei HAPA-Stadien hin untersucht (Stadienprogression und Stadienregression). Diese Stadienübergänge wurden bei den Teilnehmern einer internetbasierten Studie zum Obst- und Gemüsekonsum erfasst. Handlungsergebniserwartungen, Planung, und soziale Unterstützung zeigten ein stadien-spezifisches Prädiktionsmuster. Selbstwirksamkeitserwartungen waren universelle Prädiktoren von Stadienübergängen. Stadienprogression könnte in zukünftigen stadien-passenden Interventionen durch das Fördern dieser stadien-spezifischen Faktoren unterstützt werden.

Im *sechsten Kapitel* werden die Ergebnisse aus den vier empirischen Kapiteln zusammenfassend diskutiert und weiterführende Forschungsansätze aufgezeigt. Die Befunde der Dissertation implizieren, dass eine Theorieverfeinerung von der Modellierung komplexerer Beziehungen profitieren würde, die über einfache Mediations- und Moderationsmodelle der Wirkfaktoren hinausgehen, und dass diese sich empirisch prüfen lassen. Veränderungen im Prozess der Verhaltensänderung lassen sich je nach Stadium durch verschiedene sozial-kognitive Faktoren vorhersagen. Die Befunde bestätigen außerdem die Wirksamkeit von Planungsinterventionen und deuten darauf hin, dass differentielle Interventionseffekte durch Veränderungen in Planungsprozessen und die Anzahl der generierten Pläne in Planungsinterventionen erklärt werden können. Abschließend werden Implikationen der Befunde zu den Planungsinterventionen hinsichtlich ihrer Anwendung als theorie- und evidenzbasierter Maßnahmen in angewandten Settings aufgezeigt. Beispielsweise liessen sich zukünftige (‘stadien-passende’) Interventionen auf die Charakteristiken und Bedürfnisse der Teilnehmer hin maßschneidern. Zudem zeigt diese Arbeit, wie die Evaluation zukünftiger theoriegeleiteter Interventionen mittels der angewandten methodischen Auswertungsansätze (z.B. moderierter Mediation, multipler Mediation, 3-Pfad-Mediation und Schwellenwert-Modelle) erfolgen könnte.

1

Introduction

Introduction

About every other individual with the intention to engage in physical activity or another regular health behaviour fails to do so (Sheeran, 2002). This empirical finding represents a well-known problem of everyday life, and indicates that intentions are an important but insufficient prerequisite for successful behaviour change - a phenomenon that has been labelled the *intention-behaviour gap* (Sheeran, 2002). But what are the key facilitators that translate intentions into action? Difficulties in the initiation and long-term maintenance of complex behaviours arise from internal and external barriers that may pose persistent risks for the behavioural performance (Baumeister, Heatherton, & Tice, 1994). Research on self-regulatory strategies identified *planning processes* as promising candidate to overcome such barriers of intention implementation (Gollwitzer, 1999; Leventhal, Singer, & Jones, 1965). Furthermore, planning interventions have been identified as effective self-regulatory tool to promote regular health behaviour (e.g., Sniehotta et al., 2005). However, while research has progressed by focussing on post-intentional planning processes, less is known about the integration of proposed interrelations between intentions and planning processes and the predictive value of volitional processes within stage theory. Moreover, research on working mechanisms of planning interventions has been mainly conducted in laboratory settings, and questions about the factors that explain effects of planning interventions in field settings have remained unanswered.

This thesis aims at integrating *planning processes* into a comprehensive framework of health behaviour change that is derived from the *Health Action Process Approach* (Schwarzer, 1992; 2008). Moreover, factors that may account for the effects of theory-based *planning interventions* are investigated to gain a better understanding of their underlying working mechanism in field settings.

This chapter starts by describing the behavioural context of the thesis to portray the need to investigate the determinants of health behaviour change. The subsequent description of the theoretical framework includes an overview of the recent relevant literature, and comprises the rationale for the investigation of the theoretical assumptions. Finally, an outline of the empirical chapters is given in relation to the research aims.

The behavioural context: Regular health behaviours

Health behaviours may broadly be defined as any activities performed to prevent or detect disease, or to improve, maintain, or restore health and well-being (Conner, 2001). The behaviours that set the context of this thesis are health-enhancing behaviours, namely physical activity, fruit and vegetable intake, and interdental hygiene. These behaviours share characteristics that enable the analyses of the theoretical considerations: First, they have to be practiced *regularly* to be effective, which poses special challenges for self-regulation as compared to behaviours with one-off performance (Sutton, 1994). Additionally, the adherence to health authorities' recommendations for the level of regular performance of these behaviours in the general population is low (cf. Table 1). This leaves room for investigating behavioural improvements due to interventions. And in particular, the risks inherent in non-adherence to the recommendations are substantial, as non-adherence is strongly associated with premature morbidity, a reduced quality of life, and mortality (the latter mainly relates to inactivity and malnutrition; WHO, 2004). Beyond these effects on the individual, non-adherence to the recommendations produces high costs for the health care system (e.g., Schult, McGovern, Dowd, & Pronk, 2006).

Table 1. Health behaviours: Recommendations, levels of adherence, and selected associated diseases

Behaviour	Recommendation	Adherence in Germany	Diseases associated with non-adherence
Physical activity	To engage in 30 minutes of moderate to strenuous activity on 3-7 days of the week[1]	13%[2]	- Cardiovascular disease - type 2 diabetes - certain types of cancer[3]
Fruit and vegetable intake	To consume 5 servings of fruit and vegetable a day (~ 400g)[4]	50%[5]	- Cardiovascular disease - type 2 diabetes - certain types of cancer[4]
Interdental hygiene	To clean interdental spaces once a day before brushing teeth[6]	17%[7]	- Caries - periodontal diseases[8]

Note. [1]American College of Sports Medicine, 1998; Blair, La Monte, & Nichaman, 2004; [2]Mensink, 2002; [3]WHO, 2004; [4]WHO, 2003; [5]Robert Koch-Institut, 2006; [6]American Dental Association, 2005; [7]Handrick; 2001; [8]Bauroth et al., 2003.

To support people in overcoming the self-regulatory challenges related to health behaviour change, the development of effective interventions for sustainable behaviour change is both necessary and challenging. A prerequisite for suitable interventions is the establishment of a sound theoretical framework: Without a thorough understanding of the determinants of behaviour change, of ways to promote them in interventions in different target groups, and of these interventions' working mechanisms, the possibilities of improving upon interventions remain limited.

Modelling health behaviour change

Health behaviour theories help to predict, explain, and improve upon health behaviours. Most theories can be subsumed under either continuum theories or stage theories. Continuum models such as *Theory of Reasoned Action* (TRA; Ajzen & Fishbein, 1977), its successor the *Theory of Planned Behaviour* (TPB; Ajzen, 1985), and the *Protection Motivation Theory* (PMT; Maddux & Rogers, 1983) aim at predicting intentions and behaviour by a parsimonious set of social-cognitive factors (cf. Lippke & Ziegelmann, 2008). Stage models such as *Transtheoretical Model* (TTM; Prochaska, DiClemente, & Norcross, 1992) or the *Precaution Adoption Process Model* (PAPM; Weinstein, 1988) posit that people pass through several stages (mindsets) with certain cognitive and behavioural characteristics on their course of health behaviour change (Weinstein, Rothman, & Sutton, 1998). The theoretical framework of this thesis is the Health Action Process Approach (HAPA; Schwarzer, 1992; 2008), which can be termed a hybrid model as it integrates characteristics of both continuum and stage models.

Continuum models

Intentions are the key factor in most continuum models, as they represent an individual's motivation towards a target behaviour in terms of direction and intensity, and are generally proposed as immediate antecedent of behaviour (Conner & Norman, 2005). Moreover, most of these theories suggest self-efficacy (or perceived behavioural control; TPB) as predictors of behaviour alongside intentions. Intentions, in turn, are determined by

a theory-specific set of social-cognitive factors (Conner & Norman, 2005; Lippke & Ziegelmann, 2008). Due to their main characteristic, these models are often alluded to as *continuum models*: They propose that favourable values on the specified social-cognitive factors induce movement along a continuum of action likelihood (Weinstein, Rothmann, & Sutton, 1998). Thus, interventions based on continuum models would stimulate behaviour change by promoting all social-cognitive predictors of intentions in all persons of the target group (Weinstein et al., 1998). Effects of such 'one size fits all'-interventions on these factors should result in changes in intentions, which, given perceived control over the behaviour, should engender behaviour change.

The intention-behaviour gap

Interventions based on continuum models produce rather modest effects on average: For example, only two-thirds of TPB interventions result in behaviour change, and their effect sizes are generally small (see Hardeman et al., 2002, for a review). This may result from several features that are common to most continuum models. At first, effects on distal predictors of intentions on behaviour would be diluted on their way through the theoretically defined causal chain of mediators (Sniehotta, in press). Accordingly, a TPB intervention enhanced attitudes towards physical activity, increased intentions, but did not result in behaviour change (Chatzisarantis & Hagger, 2005). Even "jumping into the causal chain" (Sutton, 2008) by directly targeting intentions does not promise to produce the desired effects: Although intentions are substantially associated with behaviour (intentions explain about 28% of the behavioural variance; see Sheeran, 2002, for a meta-analysis), even "medium-to-large" changes in intentions (d = 0.66) result only in "small-to-medium" changes in behaviour (d = 0.36; see Webb & Sheeran, 2006, for a systematic review of experimental studies). Thus, effects of interventions based on most continuum models might be poor because they are directed at distal factors of behaviour and because intentions, i.e., the most proximal determinants, do not reliably engender behaviour change. This *intention-behaviour gap* (Sheeran, 2002) leaves room for suggestions on how intentions can be successfully translated into behaviour.

Recent theories focus on the volitional processes that underlie goal striving (e.g., Carver & Scheier, 1998; Heckhausen & Golliwitzer, 1987; Schwarzer, 1992; 2008), i.e., they describe the processes that follow intention formation, and thereby augments the TPB and other continuum models that focus on pre-intentional processes. One of these models is the *Health Action Process Approach* (Schwarzer, 1992; 2008), which aims to bridge the intention-behaviour gap by explicitly integrating post-intentional factors. In line with other social-cognitive theories, the HAPA specifies self-efficacy and outcome expectancies, and additionally risk perception as determinants of intention formation (Schwarzer, 1992; 2008). Concerning post-intentional influences, self-regulatory strategies and self-efficacy are proposed as determinants of intention implementation. Self-efficacy is supposedly important during the entire process of behaviour change, but different kinds of self-efficacy beliefs are distinguished in the HAPA. This distinction reflects that different tasks have to be mastered while adopting health behaviour and thus, different self-efficacy beliefs are required for their successful mastery (Schwarzer, 2008).

Planning processes in health behaviour change

A self-regulatory process that facilitates the adoption of intended health behaviour is planning. *Planning processes* serve the purpose of superordinate goal intentions: They prepare individuals for forthcoming action before a good opportunity to realise the behavioural intention is encountered. In the HAPA framework, two kinds of such prospective self-regulatory strategies may be distinguished, namely *action planning* and *coping planning* (Sniehotta et al., 2005). *Action planning* (Sniehotta et al., 2005) refers to the specification of the situational details of action implementation, and a willful linking of these precise situational cues to concrete behavioural responses. Thereby, planning creates cognitive representations of the target situation that make the specified cues easily detectable. Moreover, if the specified cue is encountered, the initiation of the intended behavioural response becomes "automated" as some control over the behavioural performance is transferred to the environment (Gollwitzer, 1999; 2006). However, despite action planning, the execution of the planned action may still be impeded by formerly

established links between situational cues and unintended actions, such as habitual responses. Thus, by *coping planning* (Sniehotta et al., 2005) anticipated personal risks that may jeopardise the behavioural performance can be prospectively linked to coping strategies to inhibit undesired responses or prioritize desired ones (Sniehotta et al., 2005). Hence, action planning and coping planning serve different purposes: Action planning is a behaviour-facilitating strategy that is mostly associated with action initiation in good opportunities to act (e.g., 'If I am in the cafeteria on Monday at 1 pm, then I'll eat salad.'). In contrast, coping planning is barrier-focused (e.g., 'If salad is sold out, then I'll eat a dish with two servings of vegetables for lunch instead.'), grounds largely upon personal experience with the behaviour, and is more relevant for resolving maintenance problems (Sniehotta et al., 2005; Ziegelmann, Lippke, & Schwarzer, 2006).
Thus, these planning processes may help to overcome difficulties in the self-regulation of behaviour.

Planning as mediator between intention and behaviour. In the HAPA, planning processes are proposed to mediate between intentions and behaviour: Intentions are assumed to engender planning processes, which in turn stimulate behaviour change. Previous research attests that self-reported action planning as measured by psychometric scales (e.g., action planning: 'I have already precisely planned when, where, and how to exercise') reliably predicts of behaviour, and substantially adds to the variance explained in health behaviour beyond intentions (e.g., Sniehotta et al., 2005). However, whilst in most studies intentions instigated action planning, which in turn affected behaviour (e.g., Norman & Conner, 2005, Study 2), other studies failed to find such mediation effects as implied in the HAPA (e.g., Norman & Conner, 2005, Study 1). This suggests more complex relationships between intentions, planning, and behaviour, which are not yet unravelled. Moreover, theorising on intentions as post-intentional factor implies also a moderator role of intentions. Moderating effects of intentions on the planning-behaviour relation have also been identified (see Sheeran, Milne, Webb, & Gollwitzer, 2005, for a review). However, a comprehensive model of the interplay between intentions, planning, and behaviour would integrate these two assumptions into to one model, which suggests

that the mediation process might vary in accordance to moderating values of intentions. Such an integrated moderated mediation model, however, has not been tested so far.

Interrelations between planning facets. Modelling planning within the HAPA should also relate action planning and coping planning as simultaneous processes: Despite their differences in content and function, action planning and coping planning share similar structures (e.g., the wilful establishment of situation-response associations), and their perceptual, attentional, and mnemonic mediating processes are assumed to be alike (Sniehotta et al., 2005). Thus, if their action-inducing effects are not tested concurrently, a fragmentary representation of the relations between both planning facets might be construed. In extension to previous research, their simultaneous influence might thus rather be mapped by multiple mediation models as compared to multiple single mediation models (cf. Scholz, Schüz, Ziegelmann, Lippke, & Schwarzer, 2008), to control for concurrent mediators in a combined model.

Moreover, action planning and coping panning are supposedly more effective if they work in orchestration: As action planning alone may not suffice to instigate action initiation in situations that provoke habitual behaviour (Sniehotta et al., 2005), coping planning might add to prediction models of behaviour change over and above action planning. Furthermore, coping planning specifies strategies to overcome risks for intention implementation in specific situations, and thus requires action planning (Sniehotta et al., 2005). In particular, however, coping plans are supposed to shield the effects of action plans, and may thus amplify its effects on behaviour (Sniehotta et al., 2005). Evidence for such synergistic effects of action planning and coping planning on behaviour change, however, is rare (Araújo-Soares, McIntyre, & Sniehotta, in press).

Stage theories of behaviour change

By acknowledging that different processes are responsible for intention formation than for intention implementation, the supposition of health behaviour change as a continuous process cannot be upheld. Thus, by explicitly integrating post-intentional factors such as planning processes, the HAPA turns into a stage model. Stage models

construe behaviour change as a transition through an ordered series of discrete stages. Thus, persons at different stages are characterized by different mindsets, delineated by differences in terms of their cognitions, perceived barriers and action tendencies, and they can be allocated to these stages by theory-specific algorithms (Weinstein et al., 1998). In accordance with Heckhausen and Gollwitzer's (1987) notion of a motivational and a volitional mindset, the HAPA distinguishes between a *motivational* stage and a *volitional* stage (Figure 1; Schwarzer, 2008): The motivation stage encompasses processes of intention formation, and can be distinguished from the volitional stage that refers to processes of intention implementation. The volitional stage is further subdivided into an (preactional) *intention stage* and an *action* stage in the HAPA. Figure 1 displays the resulting three-stage distinction between (a) the *preintention* (motivation) *stage*, including persons who have not (yet) set a goal to act ('preintenders'), (b) the *intention stage*, comprising persons with the goal to change their behaviour, but who are not yet acting ('intenders') and (c) the *action stage*, including those who already perform the behaviour in question ('actors'). Figure 1 depicts the social-cognitive predictors specified in the HAPA in relation to the respective stages of behaviour change (Schwarzer, 2008).

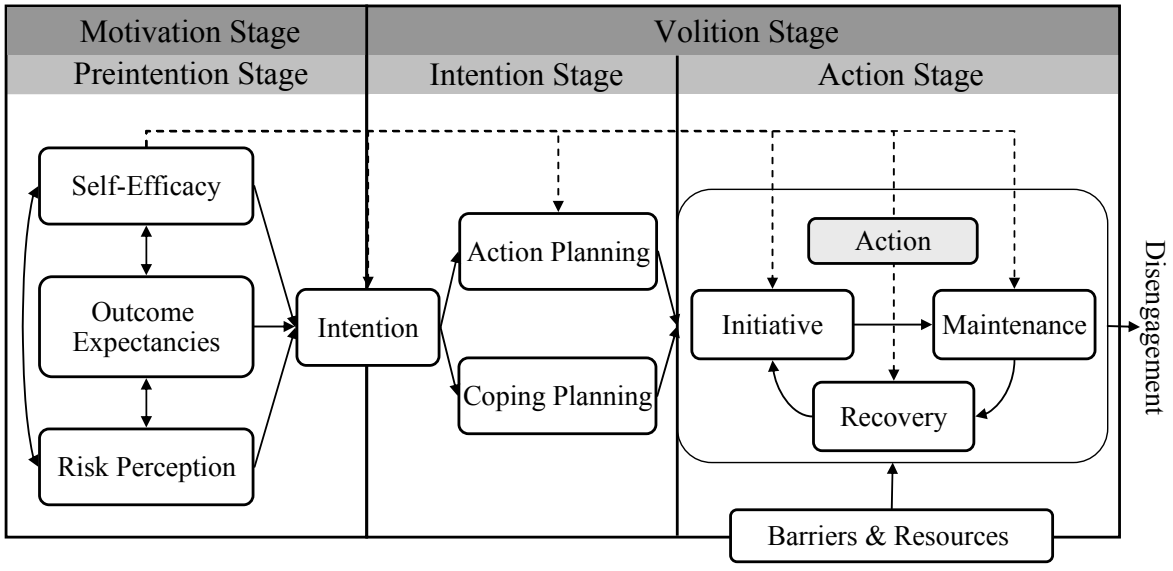

Figure 1. Health Action Process Approach (HAPA; Schwarzer, 1992; 2008)

Specifically, the course of behaviour change can be reflected by an individual's forward and backward transitions (progression and regression) between the stages: For instance, if individuals initiate an intended behaviour, they progress from the intention stage to the action stage. The idea of stages implies that specific factors are responsible for remaining in each stage, progressing to the next one or regressing to the previous one, and that interventions can be matched to a person's stage by targeting stage-specific needs (Weinstein et al., 1998). These stage-matched interventions are supposedly more effective than 'one size fits all'-interventions, and less costly, time-consuming, and reactance-inducing as irrelevant and redundant information can be avoided. However, effects of interventions matched to the TTM stages yielded only marginal better results than unmatched ones (Fisher's $r+ = 0.09$, see Noar, Benac, & Harris, 2007, for a meta-analysis). However, the effectiveness of interventions - whether stage-matched or not - largely depends on the factors being targeted (Noar et al., 2007).

Stage-specific facilitators of change. According to the HAPA, risk perception, outcome expectancies, and self-efficacy should foster individual goal setting in preintenders, i.e., a progression from the preintention stage to the intention stage (Figure 1). In the intention stage, this goal (intention) is the starting point of goal striving processes, and planning and self-efficacy should foster progression to as well as remaining in the action stage (i.e., action initiation and maintenance). Furthermore, additional 'resource factors' such as social support may be supportive in these stages (Schwarzer, 1992; 2008), but research on social support within stage theoretical approaches s rare (Fuchs, 1996). Stage-matched interventions derived from the HAPA would be directed at these proposed stage-specific social-cognitive variables as depicted in Figure 1. However, a theorizing and modelling phase should precede the application of such complex interventions (Campbell et al., 2000). Thus, findings on this set of variables, including planning and social support, as stage-specific predictors of stage transitions might be priorly accumulated. So far, only subsets of these variables have been tested (e.g., Schüz, Sniehotta, Wiedemann, Mallach, & Schwarzer, 2008). The identification of stage-specific

facilitators of change, however, might contribute to understanding the process of health behaviour change.

Planning interventions: Effects on regular health behaviours

This thesis distinguishes between psychometrically measured *planning processes* (action planning and coping planning) and *planning interventions* as specific behaviour change strategies. Planning components in interventions usually refer to instructions that request participants to link one or more precisely defined situations with respective matching responses in accordingly pre-structured planning sheets. Such planning interventions can target two kinds of planning processes, analogously to psychometric measures of the planning construct: For *action plans* (i.e., implementation intentions; Gollwitzer; 1999), participants are asked to specify the implementation of an intended action, e.g., by 'when', 'where', and 'how' statements. For *coping plans,* individuals are asked to anticipate risk situations (e.g., 'What barrier might prevent you from being physically active?'), and to link them to suitable coping responses (e.g., 'What strategy might help you to overcome this barrier?'; Sniehotta, Scholz, & Schwarzer, 2006; Ziegelmann et al., 2006). The effects of action plans in laboratory studies were described by '*strategic automaticity*' (Gollwitzer & Sheeran, 2006): As soon as the specified situation occurs, the intended behaviour is elicited immediately, efficiently, and almost outside conscious awareness through a single act of wilful planning (Webb & Sheeran, 2007). Action planning interventions yielded improvements in a wide range of health behaviours with satisfactory effect sizes on average ($d+ = 0.59$; see Gollwitzer & Sheeran, 2006, for a meta-analysis). Coping planning interventions supposedly produce positive effects if applied alone, or combined with action plans (e.g., Armitage, 2008; Sniehotta, Scholz, & Schwarzer, 2006; Van Osch, Lechner, Reubsaet, Wigger, & de Vries, 2008; Ziegelmann et al., 2006).

Working mechanism of interventions. Most findings regarding the effects of action planning interventions and assumed their working mechanism by strategic automaticity

result from laboratory studies and scrutinised simple behaviours, such as manual responses (e.g., pressing keys) to arbitrary visual cues presented on screens (cf. Sniehotta, in press). However, due to a larger situational and behavioural complexity of health behaviour change in everyday life, the effects of planning interventions in applied settings may differ from those in the laboratory: Single cue-response linkages may not be sufficient to cause enduring changes in the field by strategic automaticity. Accordingly, a number of methodological strict trials found no benefits of action planning interventions outside the laboratory (Jackson et al., 2005; Michie, Dormandy, & Marteau, 2004; Rutter, Steadman, & Quine, 2006; Skår et al., 2008). Reasons for such differential effects are inconclusive, as the working mechanisms that underlie the effects of generated plans have not been fully elucidated in field settings. Scarce evidence suggests, however, that effects of planning interventions are mediated by continuous self-regulatory effort (e.g., Luszczynska, 2006), while motivational factors should not explain such intervention effects (Webb & Sheeran, 2008). The theoretical understanding of the working mechanisms might be advanced by testing mediation effects through changes in self-reported action planning and coping planning. Theorizing about such mechanisms might particularly profit from considering the supposed additive and synergistic effects of action planning and coping planning, and should thus model their relationship as outlined above.

Quantity of plans. An additional factor that warrants investigation in field settings is how the quantity of plans generated in an intervention relates to intervention effects. Several studies in field settings found participants to generate less plans than requested (e.g., Skår et al., 2008). Such different numbers of action plans or coping plans may result from baseline differences between the participants, and may influence the effect sizes of interventions (Webb, 2006). Though it has been discussed whether behaviour change shows a linear or curvilinear association with the quantity of plans (Webb, 2006), the quantity of generated plans has not been addressed in previous research on health behaviours.

Stage-specific effects. Action planning and coping planning should be stage-matched to the intention stage and the action stage due to their presumed beneficial effects

on the self-regulation of behaviour, and not on intention formation. Such stage-specific effects of action plans were identified to be largest in intenders (Lippke, Ziegelmann, & Schwarzer, 2004). However, whether residing in the intention stage is a beneficial condition for effects of planning interventions, and whether such interventions may promote behaviour maintenance as well needs further investigation - in particular, as most intervention has focused on action initiation (versus maintenance; Conner, 2008).

Aims of the Present Thesis

The present thesis aims to contribute to the description and facilitation of health behaviour change. In particular, planning processes will be investigated in a comprehensive framework of health behaviour theory, and explanatory factors for the effects of planning interventions will be tested in a field setting. The superordinate goal is to support progress in the theoretical modelling of behaviour change and in the development of effective, theory-based interventions to change regular health behaviours. Therefore, three main research questions are addressed in this thesis:

1. ***Can the interrelations between intentions, action planning, and regular health behaviours be modelled as theoretically predicted?***

Chapter 2: The mediating effects of action planning on the intention-behaviour relation are tested as a function of intentions as moderators of the planning-behaviour relation. This was tested in moderated mediation models in two studies. Particularly, the threshold of moderating intentions is determined above which the mediation effect is established.

2. ***Are planning interventions effective to facilitate change in health-related outcomes, and how can differential effects be explained in field settings?***

Are planning interventions effective to facilitate change in health-related outcomes?

Chapter 3: Effects of a combined action planning and coping planning intervention on fruit and vegetable intake as well as on body mass index are tested in a RCT against an active control condition.

Chapter 4: Effects of a combined action planning and coping planning intervention on physical activity are tested in a RCT against an active control condition in a combined volitional sample, and separately for intenders and actors.

How can the effects of planning interventions be explained in field settings?

(a) The underlying working mechanism of a planning intervention

Chapter 3: The working mechanism of a combined action planning and coping planning intervention on behaviour change through intervention-induced changes in volitional processes (action planning, coping planning) is investigated in a field setting. In particular, the simultaneous individual effects of putative mediators are estimated within a multiple mediation model, and a threshold model beyond which changes in planning processes predict behaviour change is determined. Additionally, intervention effects on body mass through changes in planning and behaviour are tested in a three-path mediation model.

(b) Relation between intervention effects and the number of generated plans

Chapter 4: Whether the quantity of plans explains differential intervention effects in intenders and actors is tested in a mediation model with changes in physical activity as outcome measure. Therefore, it is tested whether residing in the intention stage or the action stage explains differences in the number of generated plans. Linear and curvilinear relations between the quantity of plans and behaviour change are investigated.

3. Are the social-cognitive factors derived from the HAPA stage-specific predictors of change processes, i.e., stage transitions?

Chapter 5: Stage-specific prediction patterns by volitional variables (planning, social support), motivational (outcome expectations, and risk perception) and self-efficacy as proposed universal factor are tested for transitions between the three HAPA stages. For predictions of stage progression and stage regression, binary, respectively multinomial logistic regressions were applied.

In Figure 2, the content of the empirical chapters is summarized within their theoretical framework, the *Health Action Process Approach* (Schwarzer, 1992; 2008). The empirical chapters were written for publication in journals. Thus, they contain sufficient information about the theoretical and behavioural embedding of the respective research questions to be understood as stand-alone chapters and in any order. *Chapter 6* provides a summary and discussion of the findings of the empirical chapters and draws conclusions about implications for theory refinement, and intervention development and evaluation.

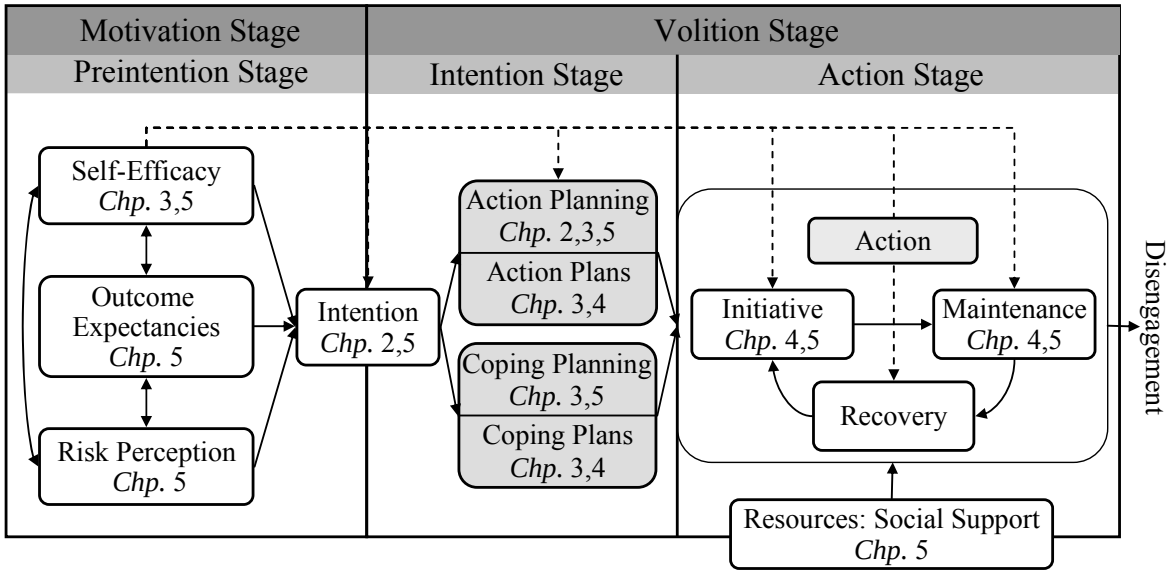

Figure 2. Summary of the chapters' content within the Health Action Process Approach

Note. *Chp*. = *Chapter*(*s*). Behavioural measures are included in all chapters, and only included in the figure if specifically initiation or maintenance were regarded.

Studies in this thesis

To examine the research questions, five studies with different designs, behavioural domains, and samples were conducted. The structure of the longitudinal correlational and experimental studies is specified in Table 2. All studies were conducted in field settings, i.e., baseline assessments took place either in medical environments (rehabilitation centres, respectively dental practices, both in *Chapter 2*), in a logistics company (*Chapters 3, 4*), or via an open access website with an online population (*Chapter 5*). The follow-up measures

were taken up to four months after baseline (see Table 2), with questionnaires being sent by regular mail (*Chapters 2* to *4*) or email (*Chapter 5*). Physical activity was the behavioural context in a study on action planning with cardiac rehabilitation patients (*Chapter 2*) and in a RCT with employees of a logistics company (*Chapter 4*). Fruit and vegetable intake was investigated in a longitudinal online panel study (*Chapter 5*), and - together with the body mass index - target criterion in a RCT (*Chapter 3*), which was conducted in the same setting as the study described in *Chapter 4*. Interdental hygiene was the behavioural context in a longitudinal study with dental patients (*Chapter 2*). More detailed information about study design, inclusion criteria, and proceedings is provided in the empirical chapters.

Table 2. Longitudinal design of the studies

	Months after baseline				
Study	Baseline	1	2	3	4
Physical activity (C*hp. 2*)	**M**				**M**
Dental flossing (*Chp. 2*)	**M**			**M**	
Fruit and vegetable intake (*Chp. 3*)	**M & I**	**M**			
Physical activity (*Chp. 4*)	**M & I**	**M**			
Fruit and vegetable intake (*Chp. 5*)	**M**	**M**			

Note. Bold letters are indicative for measurements ('M') and interventions ('I'). *Chp. = Chapter*

References

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, Germany: Springer.

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

American College of Sports Medicine (1998). Position stand: The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. *Medicine and Science in Sports and Exercise*, *30*, 975-991.

American Dental Association (2005). Cleaning your teeth and gums. Retrieved December 10th, 2008, www.ada.org/public/topics/cleaning_faq.asp#4

Araújo-Soares, V., McIntyre, T., Sniehotta, F. F. (in press). Predicting changes in physical activity amongst adolescents: The role of self-efficacy, intention, action planning and coping planning. *Health Education Research*.

Armitage, C. J. (2008). A volitional help sheet to encourage smoking cessation: A randomized exploratory trial. *Health Psychology, 27*, 557-566.

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*, 359-365.

Blair, S. N., LaMonte, M. J., & Nichaman, M. Z. (2004). The evolution of physical activity recommendations: How much is enough? *American Journal of Clinical Nutrition, 79*, 913-920.

Campbell, M., Fitzpatrick, R., Haines, A., Kinmonth, A. L., Sandercock, P., Spiegelhalter, D., & Tyrer, P. (2000). Framework for design and evaluation of complex interventions to improve health. *British Medical Journal, 321*, 694-696.

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*, 470-487.

Conner, M. T. (2001). Health behaviors. In N. J. Smelser & P. B. Baltes (Eds.), *The International Encyclopedia of the Social & Behavioural Sciences* (Vol. 10, pp. 6506-6512). Oxford: Elsevier Science.

Conner, M., & Norman, P. (2005). Predicting health behaviour: A social cognition approach. In M. Conner & P. Norman (Eds.), *Predicting health behaviour: Research and practice with social cognition models*. (2nd ed., pp. 1-28). Buckingham: Open University Press.

Conner, M. T., (2008). Initiation and maintenance of health behaviours. *Applied Psychology, 57*(1), 42-50.

Fuchs, R. (1996). Causal models of physical exercise participation: Testing the predictive power of the construct 'Pressure to change'. *Journal of Applied Social Psychology, 21*, 1931-1960.

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

Gollwitzer, P. M. (2006). Open questions in implementation intention research. *Social Psychological Review*, *8*, 14-18.

Gollwitzer, P. M., & Sheeran, P. (2006). Implementation intentions and goal achievement: A meta-analysis of effects and processes. *Advances in Experimental Social Psychology*, *38*, 70-110.

Handrick, M. (2001). Das Zahnputzverhalten der Deutschen. *Zahnärzteblatt Baden-Württemberg 29*, 45.

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 & Health*, *17*, 123-158.

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

Jackson, C., Lawton, R., Knapp, P., Raynor, D. K., Conner, M., Lowe, C., et al. (2005). Beyond intention: Do specific plans increase health behaviors in patients in primary care? a study of fruit and vegetable consumption. *Social Science and Medicine, 60*, 2383-2391.

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

Lippke, S., & Ziegelmann, J. P. (2008). Theory-based health behavior change: Developing, testing and applying theories for evidence-based interventions. *Applied Psychology: International Review, 57*, 698-716.

Lippke, S., Ziegelmann, J. P., & Schwarzer, R. (2004). Initiation and maintenance of physical exercise: Stage-specific effects of a planning intervention. *Research in Sports Medicine, 12*, 221-240.

Luszczynska, A. (2006). An implementation intention interventions, the use of a planning strategy, and physical activity after myocard infarction. *Social Science and Medicine, 62*, 900-908.

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*, 469-479.

Mensink, G. B. M. (2002). Bundes-Gesundheitssurvey: Körperliche Aktivität. *Beiträge zur Gesundheitsberichterstattung des Bundes*. Berlin: Robert Koch-Institut.

Michie, S., Dormandy, E., & Marteau, T. M. (2004). Increasing screening uptake amongst those intending to be screened: The use of action plans. *Patient Education and Counseling, 55*, 218-222.

Noar, S. M., Benac, C., & Harris, M. (2007). Does tailoring matter? Meta-analytic review of tailored print health behavior change interventions. *Psychological Bulletin, 133*, 673-693.

Norman, P., & Conner, M. (2005). The theory of planned behavior and exercise: Evidence for the mediating and moderating roles of planning on intention-behavior relationships. *Journal of Sport & Exercise Psychology, 27*, 488-504.

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

Robert Koch-Institut (Ed.) (2006). Gesundheit in Deutschland. *Beiträge zur Gesundheitsberichterstattung des Bundes*. Berlin: Robert Koch-Institut.

Rutter, D. R., Steadman, L., & Quine, L. (2006). An implementation intentions intervention to increase uptake of mammography. *Annals of Behavioral Medicine, 32*, 127-134.

Scholz, U., Schüz, B., Ziegelmann, J.P., Lippke, S., & Schwarzer, R. (2008). Beyond behavioral intentions: Planning mediates between intentions and physical activity. *British Journal of Health Psychology, 13*, 479-494.

Schult, T. M. K., McGovern, P. M., Dowd, B., & Pronk, N. P. (2006). The future of health promotion/ disease prevention programs: The incentives and barriers faced by stakeholders. *Journal of Occupational and Environmental Medicine, 48*, 541-548.

Schüz, B., Sniehotta, F. F., Wiedemann, A. U., Mallach, N., & Schwarzer, R. (2008). Predicting transitions from preintentional, intentional and actional stages of change: Adherence to oral self-care recommendations. *Health Education Research.* Advance online publication. DOI: 10.1093/her/cym092.

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. 217-243). Washington, DC: Hemisphere.

Schwarzer, R. (2008). Modeling health behavior change: How to predict and modify the adoption and maintenance of health behaviors. *Applied Psychology, 57*(1), 1-29.

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

Sheeran, P., Milne, S., Webb, T. L., & Gollwitzer, P. M. (2005). Implementation intentions and health behaviours. In M. Conner & P. Norman (Eds.), *Predicting health behaviour: Research and practice with social cognition models* (2nd ed., pp. 276-323). Buckingham: Open University Press.

Skår, S., Prestwich, A., Araújo-Soares, V., Molloy, G. J., Lawton, R., Conner, M., & Sniehotta, F. F. (2008). Do brief online planning interventions embedded in lifestyle surveys change health behaviour? Two randomised controlled trials. *Manuscript under review.*

Sniehotta, F. F. (in press). Towards a theory of intentional behaviour change: Plans, planning and self-regulation. *British Journal of Health Psychology.*

Sniehotta, F. F, Scholz, U., & Schwarzer R. (2006). Action plans and coping plans for physical exercise: A longitudinal intervention study in cardiac-rehabilitation. *British Journal of Health Psychology, 11,* 23-37.

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,* 565-576.

Sutton, S. (1994). The past predicts the future: Interpreting behaviour-behaviour relationships in social-psychological models of health behaviours. In D. R. Rutter & L. Quine (Eds.), *Social Psychology and Health: European Perspectives*. Aldershot: Avebury Publishers.

Sutton, S. (2008). How does the Health Action Process Approach (HAPA) bridge the intention-behavior gap? An examination of the model's causal structure. *Applied Psychology, 57*, 66-74.

Van Osch, L., Lechner, L., Reubsaet, A., Wigger, S., & de Vries, H. (2008). Relapse prevention in a national smoking cessation contest: Effects of coping planning. *British Journal of Health Psychology, 13*, 525-535.

Webb, T. L. (2006) Getting things done: Self-regulatory processes in goal pursuit. *Social Psychological Review, 8*, 2-13.

Webb, T. L., & Sheeran, P. (2006). Does changing behavioural intentions engender behavior change? A meta-analysis of the experimental evidence. *Psychological Bulletin,* 132, 249-268.

Webb, T. L., & Sheeran, P. (2007). How do implementation intentions promote goal attainment? A test of component processes. *Journal of Experimental Social Psychology, 43*, 295-302.

Webb, T. L., & Sheeran, P. (2008). Mechanisms of implementation intention effects: The role of goal intentions, self-efficacy, and accessibility of plan components. *British Journal of Social Psychology, 47*, 373-395.

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

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.

WHO (2003). *Diet, nutrition and the prevention of chronic diseases. Report of a joint WHO/FAO expert consultation.* Retrieved December 10th, 2008, www.who.int/hpr/NPH/docs/who_fao_expert_report.pdf.

WHO (2004). *Global strategy on diet, physical activity and health*. Geneva, Switzerland: World Health Organization.

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

2

Disentangling the Relation between Intentions, Planning, and Behaviour: A Moderated Mediation Analysis

Amelie U. Wiedemann[1], Benjamin Schüz[2], Falko F. Sniehotta[3], Urte Scholz[4], & Ralf Schwarzer[1]

[1]Freie Universität Berlin, [2]German Centre of Gerontology, [3]University of Aberdeen, [4]University of Zurich

---

Wiedemann, A. U., Schüz, B., Sniehotta, F. F., Scholz, U., & Schwarzer, R. (in press). Disentangling the relation between intentions, planning, and behaviour: A moderated mediation analysis. *Psychology & Health*, *24*, 67-79.

Abstract

Action planning is assumed to mediate between intentions and health behaviours. Moreover, intentions are assumed to moderate the planning-behaviour relation, because people with high intentions are more likely to enact their plans. The present studies extend these suppositions by integrating both assumptions to a novel and parsimonious model of moderated mediation: the mediation effect is hypothesised to be stronger in individuals who report higher intention levels.

In two longitudinal studies on physical activity (N = 124) and interdental hygiene (N = 209), intentions and action planning were assessed at baseline, and behaviour was measured four (Study 1), and respectively, three (Study 2) months later. The moderated mediation hypothesis was tested with continuously measured intentions using regression analyses with non-parametric bootstrapping. Results from both studies suggest that levels of intentions moderate the mediation process: The strength of the mediated effect increased along with levels of intentions. Planning mediates the intention-behaviour relation, if individuals hold sufficient levels of intentions. Implications for theory advancement and intervention development are discussed.

Keywords: intentions, action planning, health behaviour change, moderated mediation, physical activity, dental hygiene

Introduction

Health behaviour theories such as the Theory of Planned Behaviour (Ajzen, 1991) or the Protection Motivation Theory (Maddux & Rogers, 1983) propose intentions to be proximal determinants of behaviour. However, people often fail to act on their intentions (Sheeran, 2002). To understand why some people succeed in translating their intentions into behaviour whereas others do not, individual differences in post-intentional processes of goal pursuit such as action planning should be considered (Abraham, Sheeran, & Johnston, 1998).

Intentions, action planning, and behaviour

Action planning is a prospective self-regulatory strategy that helps to translate intentions into action. Thus, it serves the purpose of superordinate goal intentions such as 'I intend to be more physically active'. While intentions describe a desired goal state, action planning refers to mental simulations of linking concrete behavioural responses to situational cues in order to achieve this goal state. These simulations create cognitive representations of the target situation that make situational cues easily detectable and, thus, the behavioural response more likely as soon as the critical situation occurs (Gollwitzer, 1999).

A conceptual distinction can be made between experimentally induced if-then planning (implementation intentions; Gollwitzer, 1999) as opposed to self-reported action planning. The latter refers to responses to psychometric scales asking people whether they have formed action plans or not (e.g. Sniehotta, Scholz, & Schwarzer, 2005), and predicts behaviour over and above goal intentions up to 12 months (Ziegelmann, Luszczynska, Lippke, & Schwarzer, 2007). The present studies investigate the interplay between these self-induced planning processes, intentions and behaviour.

Interrelation between intentions, planning, and behaviour: mediation and moderation

It has been hypothesised that holding intentions instigates individuals to engage in action planning, which in turn affects the active behaviour-changing process (Schwarzer et

al., 2007). Indeed, several studies found action planning to partially mediate the intention-behaviour relation and to add explained variance to the prediction of health behaviours (e.g. Norman & Conner, 2005, Study 2; Scholz, Schüz, Ziegelmann, Lippke, & Schwarzer, in press; Schwarzer et al., 2007, Study 1-3; full mediation, Sniehotta et al., 2005). However, the evidence is inconclusive as some studies failed to find mediation effects of planning (Norman & Conner, 2005, Study 1; Schwarzer et al., 2007, Study 4; White, Terry, & Hogg, 1994).

This suggests that the complex relations between intentions, planning and behaviour cannot be subsumed within simple mediation models, but might also depend on moderating variables. Thus, mediation mechanisms might differ in subgroups of participants (e.g. sex, age groups). For example, the degree to which planning mediates between intentions and behaviour has been found to be higher in older than in younger individuals (Reuter, Ziegelmann, Wiedemann, Lippke, & Schüz, 2007). Statistically speaking, this represents a case of moderated mediation (Edwards & Lambert, 2007; Preacher, Rucker, & Hayes, 2007): The amount to which the mediator (Me) translates the effect of the independent variable (IV) on the dependent variable (DV) may depend on the levels of a moderator variable (Mo).

One potential moderator for the degree to which planning mediates the intention-behaviour relationship is intention itself. Intentions moderate the planning-behaviour relation, because (a) high intentions increase the encoding depth of the situational cue and the cue-response link, and, thus, the efficacy of if-then plans; and (b) intention strength influences the degree of specification of if-then plans, which in turn predicts the likelihood of behaviour enactment (see Sheeran, Milne, Webb, & Gollwitzer, 2005, for a review). The fact that in individuals with high intentions planning is more closely related to behaviour (moderation) might also impact on the mediation process: Whether intentions that affect behaviour via planning (mediation) might depend on intention levels.

Therefore, the aim of the present studies is to analyse whether planning (Me) mediates the effect of intentions (IV) on behaviour (DV) as a function of the underlying level of intentions (Mo). Of course, models integrating other moderators (e.g. intention

stability; Conner & Godin, 2007) or additional mediators (e.g., phase-specific self-efficacy; Scholz, et al., 2005) are plausible as well. However, the present studies aimed at testing whether the independent variable additionally serves as a continuous moderator variable, thus resulting in a parsimonious model of the intention-planning-behaviour relation. This model satisfies one major principle of theory building, the principle of parsimony (Preacher et al., 2007). Components of this model (simple mediation and moderation) have been tested before, but are now combined to a model of moderated mediation. To our knowledge, the present study is the first one to test moderated mediation for this research question.

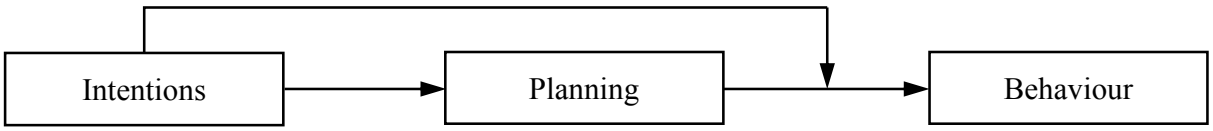

Figure 1. Conceptual moderated mediation model.

Aim and Hypothesis

The present studies aim at

(i) Testing a parsimonious model of moderated mediation (Figure 1), which integrates two assumptions in one model: (a) Intentions influence behaviour through action planning processes (mediation), and (b) the strength of the planning-behaviour association depends on the level of intentions (moderation). In particular, we hypothesised that mediation by action planning is particularly strong in people with high intentions to engage in health behaviour (moderated mediation). As a preliminary analysis, the indirect effect of intentions on behaviour via action planning (simple mediation) is tested.

(ii) Exemplarily presenting a systematic method of testing this special model of moderated mediation as suggested and instigated by Preacher et al. (Model 1; 2007), with rationale and methods being applicable to other models of moderated mediation as well.

Two studies on physical activity and interdental hygiene

Moderated mediation is examined in two samples dealing with two health behaviours. Study 1 assessed physical activity in the context of cardiac rehabilitation. Despite high motivation to change their lifestyle after discharge from inpatient treatment (e.g. Sniehotta, Schwarzer, Scholz, & Schüz, 2005), the majority of people with coronary heart disease fail to follow the recommendations for physical activity in the long run (Willich et al., 2001). For the implementation of a physically active lifestyle, action planning proved beneficial: Action planning mediated the intention-behaviour relation, and effects of action planning were moderated by intentions (Norman & Conner, 2005; Scholz et al., in press).

Study 2 focused on interdental hygiene. Interdental hygiene is effective for the prevention of oral diseases such as caries and periodontitis (Bellamy et al., 2004), yet few people adhere to daily interdental hygiene as recommended by the American Dental Association (ADA, 2005; Bader, 1998). In a longitudinal study on social-cognitive variables, action planning emerged as the only predictor of adherence to dental flossing recommendations when controlling for intentions (Schüz, Sniehotta, Wiedemann, & Seemann, 2006). Intentions did not moderate the effect of planning on flossing. Thus, in contrast to research on physical activity, there is little evidence that intentions moderate the influence of planning on interdental hygiene.

Method

Analytical procedure

Preliminary analysis: Simple mediation

The product-of-coefficients strategy with bootstrapping was used to test strength and significance of the indirect effect. Bootstrapping is a non-parametric method for assessing indirect effects (Preacher & Hayes, 2004; Preacher et al., 2007). Exact normal distribution may only be found in large samples, but bootstrapping overcomes several problems with non-normally distributed variables such as power problems. Thus, the indirect effect was estimated by first regressing planning (Me) on intentions (IV), and

subsequently regressing behaviour (DV) on planning (Me) and intentions (IV). The indirect effect was then quantified as the product of the mean bootstrapped sample estimates of the regression coefficients ('Me on IV'*'DV on ME controlling for IV'). The standard deviation of the estimate of the indirect effect obtained over 5000 bootstrapped resamples is the estimated standard error of the mean indirect effect (Preacher & Hayes, 2004). Based on this information, bootstrap confidence intervals were generated for the indirect effect.

Hypothesis on moderated mediation

In order to test whether the indirect effect depends on intentions levels (Mo), coefficients were estimated independently in two regression analyses using bootstrapping. First, action planning (Me) was regressed on intentions (IV). Subsequently, behaviour (DV) was regressed on intentions (IV), planning (Me), and the interaction between intentions and planning (Mo*Me; using mean centered variables). An overall effect of the IV on the Me is a necessary precondition for moderated mediation: A significant interaction effect (Mo*Me) on behaviour is only indicative of moderated mediation if intentions (IV) also affect action planning. Given a significant interaction effect, regression analyses were then conducted on several values of the moderator to obtain the degree to which mediation varies depending on the level of the moderator. Variables were *z*-standardised, and indirect effects are reported at *M* and ± 1 *SD* of the moderator. Bias-corrected bootstrapping was applied as it produces more accurate confidence intervals (MacKinnon, Lockwood, & Williams, 2004).

Additionally, an extension of the Johnson-Neyman technique to moderated mediation was applied (Preacher et al., 2007). This technique tests the significance of the indirect effect on a large range of values of the moderator until the value of the moderator is identified for which the conditional indirect effect is just statistically significant at a set α-level (here, $\alpha = 0.05$). Values of the moderator for which the mediation effect is significant constitute the region of significance of the indirect effect.

Study 1: Physical activity

Participants and procedure

Persons with medical indication to adhere to regular physical activity were recruited for Time 1 (T1) assessments during their second week of stay in one of three cardiac rehabilitation centers. After giving informed consent, 171 participants completed T1 questionnaires assessing intentions, action planning and sociodemographic variables. The four-month follow-up questionnaires (T2) assessed physical activity and were sent to the participants with a prepaid return envelope. Participation was voluntary and unpaid in both Study 1 and Study 2. Both studies were conducted in accordance with the WMA declaration of Helsinki (WMA, 2004).

The longitudinal sample comprised 124 participants (72.5% of baseline), 81.7% of them were men (Table 1). Mean age was 60.3 years (SD = 10.4; range 33 to 84 years). Drop-out analyses indicated that participants who continued study participation reported significantly higher baseline intentions than those who did not ($F(1, 169) = 9.77$, $p < 0.05$), but did not differ with regard to planning, physical activity and sociodemographic variables (age, sex, as well as marital, educational and occupational status, all ps > 0.05). Missing data (< 10% on all variables in both studies) were imputed using the Expectation Maximization (EM) algorithm (Enders, 2001) in SPSS 13.

Table 1. Sample characteristics

	Study 1: Physical activity	*Study 2*: Interdental hygiene
Participation: *N* (% of baseline)	124 (72.5%)	209 (62.9%)
Age in years: *M* (*SD;* Range)	60.3 (10.4; 33-84)	45.1 (16.8; 18-81)
Gender: female	23 (18.3%)	139 (66.5%)
Marital status: married	98 (77.8%)	134 (64.1%)
Education: higher education	24 (19.1%)	108 (51.7%)
Employment: working for pay	66 (52.4%)	108 (51.7%)

Measures

Item examples of both studies given below are translations from German. Unless otherwise stated, response formats were four-point Likert scales, ranging from completely disagree (1) to completely agree (4). Scale scores were obtained by averaging item responses.

Behavioural intentions were measured by six items (Sniehotta et al., 2005), such as 'I intend to be physically active several times per week'. Means, standard deviations, reliability coefficients and intercorrelations of all variables are displayed in Table 2.

Action planning was assessed with four items: 'I have made a detailed plan on [when; where; how; how often] to exercise' (Sniehotta et al., 2005).

Table 2. Descriptive statistics, reliability and intercorrelations for Time 1 intentions, planning, and Time 2 behaviour

	Study 1: Physical activity			*Study 2*: Interdental hygiene		
	Intention	Planning	Behaviour	Intention	Planning	Behaviour
α	0.84	0.93	-	0.64	0.90	-
M	3.41	3.06	123.7	3.41	3.42	18.36
SD	0.55	1.01	131.19	0.68	0.72	11.13
Intention	-	0.66**	0.36**	-	0.51**	0.37**
Planning	-	-	0.36**	-	-	0.47**

Note. ** $p < .01$

Physical activity was assessed by an adaptation of the International Physical Activity Questionnaire (Booth, 2000) to the special characteristics of the cardiac sample. Participants indicated how often per week and how long per session they performed (a) vigorous exercise (e.g. swimming), (b) fitness activities (e.g. gymnastics), (c) game sports (e.g. volleyball), (d) moderate exercises to train muscle strength and (e) other prescribed exercises on average during the last four weeks. Total physical activity was the sum of the

multiplied exercise sessions per week by minutes per session. All measures were significantly associated with each other (Table 2).

Results

Mediation. Results from bootstrapping yielded a significant mean indirect effect of intentions on physical activity through action planning of β = 0.15 (*SE* = 0.06) with a 95%-confidence interval from 0.05 to 0.19. Planning only partially mediated the intention-behaviour relation, as intentions still had a significant direct effect on behaviour (β = 0.23, $p < 0.05$), albeit lower than without planning being controlled for (β = 0.38, $p < 0.01$).

Moderated mediation. The moderated mediation hypothesis was tested by two regression analyses. First, planning (Me) was predicted by intentions (IV; β = 0.68, $p < 0.01$). Subsequently, physical activity was predicted by intentions (β = 0.32, $p < 0.01$), action planning (β = 0.22, $p < 0.05$), and the intention*planning interaction (Mo*Me; β = 0.18, $p < 0.05$), with 19% of the behavioural variance being explained. The significant interaction effect supported the assumption of moderated mediation (Figure 2).[1]

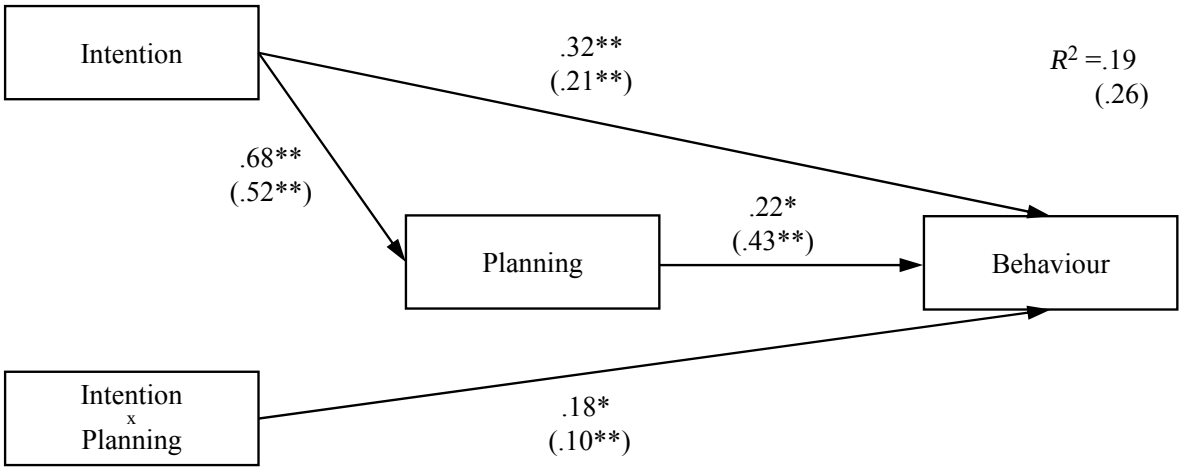

Figure 2. Results of regression analyses for moderated mediation of Study 1 and Study 2 (in parentheses).

[1]Analyses using a normal-theory approach yielded similar results. Only results from bootstrapping are reported here.

Given the overall significant interaction term, significance tests were conducted on the hypothesis that the conditional indirect effect equals zero at specific values (*M*, ± 1 *SD*) of the moderator. Action planning mediated the effect of intentions on physical activity at the mean and at high levels (+ 1 *SD*) of intentions, but not when intentions were low (- 1 *SD*; see Table 3). In particular, the strength of the conditional indirect effect increased along with levels of intentions (β = 0.15 at *M*, and β = 0.28 at + 1 *SD*; both *p*s < 0.01).

The region of significance had its lower bound at intentions β = 0.22 (*z*-value; $p < 0.05$) and its upper bound at 1.17 (*z*-value; $p < 0.01$). The lower bound describes the lowest *z*-value of the moderator, for which the indirect effect is significant. Here, the upper bound equals the largest value of the moderator within the data range, as the mediation effect could not be tested at higher values of the moderator.

Table 3. Bootstrapped indirect effects of intentions on behaviour via planning at specific values of the moderator (intentions)

	Study 1: Physical activity				*Study 2*: Interdental hygiene			
Intention	β	*SE*	LL BCA	UL BCA	β	*SE*	LL BCA	UL BCA
- 1 *SD*	.02	.07	-.12	.16	.16**	.04	.06	.23
Mean	.15**	.06	.04	.27	.20**	.05	.11	.31
+ 1 *SD*	.28**	.09	.10	.46	.25**	.08	.12	.43

Note. ** $p < .01$; $N = 5{,}000$ Bootstrapping Resamples; LL BCA and UL BCA= Lower Level and Upper Level of the Bias Corrected and Accelerated Confidence Interval for $\alpha = .05$.

In Figure 3 the indirect effect is plotted at all values of the moderator with a 95%-confidence band. The horizontal line denotes indirect effects of zero. The vertical line represents the lower boundary of the region of significance. The indirect effect of intentions on physical activity via planning is significant (region of significance) where the confidence band does not contain zero. In line with the assumptions, the indirect effect increases along with intention levels.

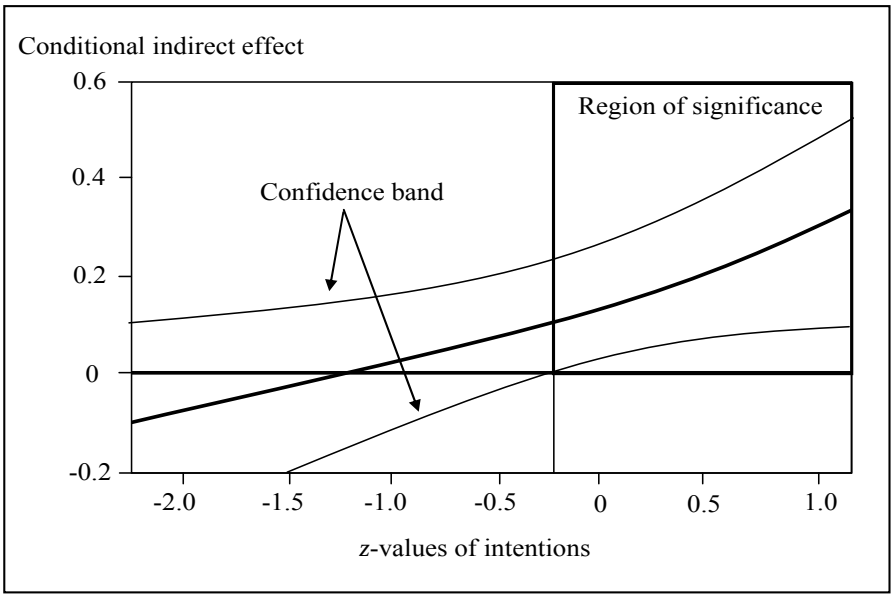

Figure 3. Study 1: Moderated indirect effect of intentions on physical activity through planning with a 95%-confidence band.

Study 2: Interdental hygiene

Participants and procedure

Participants were recruited in dental practices in Germany. Exclusion criteria were being younger than 18 years (full age) and having full dental prosthetics. A total of 332 persons gave informed consent and received Time 1 (T1) questionnaires including scales on intentions, action planning and sociodemographic variables. Additionally, participants were provided with dental floss or interdental brushes as well as interdental hygiene instructions. Time 2 (T2) questionnaires assessed interdental hygiene behaviour and were mailed three months after T1 along with prepaid return envelopes.

Longitudinal data are available from 209 participants (62.9% of baseline); 66.5% of them were women. Mean age was 45.1 years (SD = 16.8; range 18 to 81 years). Drop-out analyses revealed higher intentions ($F(1, 330) = 4.42$, $p < 0.05$) and higher levels of action planning ($F(1, 330) = 11.15$, $p < 0.01$) in the longitudinal sample. No differences in interdental hygiene and sociodemographic variables (age, sex and marital, educational and occupational status, all ps > 0.05) were found.

Measures

Behavioural intentions were assessed using three items based on Rise, Åstrøm, and Sutton (1998). The stem 'I intend to…' was followed by items such as '…clean my interdental spaces daily.'

Action planning was measured by five items: 'I have made a detailed plan on [when; how; how often; how long; combined with which regular behaviour] to clean my interdental spaces' (Schüz et al., 2006).

Interdental hygiene was measured using an open-ended single item: 'How often did you clean your interdental spaces during the last month?' Self-report measures of this kind proved valid against objective measures of flossing behaviour (correlations between flossing self-reports and residual floss ranged between 0.59 and 0.80; McCaul, Glasgow, & Gustafson, 1985; Schüz et al., 2006; Sniehotta, Araújo-Soares, & Dombrowski, 2007). Descriptive data are displayed in Table 2.

Results

Mediation. Results from bootstrapping yielded a mean indirect effect of $\beta = 0.18$ ($SE = 0.04$) with a 95%-confidence interval from 0.11 to 0.27. However, planning was only a partial mediator, as intentions still had a significant direct effect on behaviour ($\beta = 0.18$, $p < 0.01$), albeit lower than without planning being controlled for ($\beta = 0.36$, $p < 0.01$).

Moderated mediation. As in Study 1, intentions (IV) predicted action planning (Me; $\beta = 0.52$, $p < 0.01$) and intentions ($\beta = 0.21$, $p < 0.01$); action planning ($\beta = 0.43$, $p < 0.01$) and the intention * planning interaction (Mo * Me; $\beta = 0.10$, $p < 0.01$) predicted interdental hygiene (Figure 2). The significant interaction supported the moderated mediation hypothesis. Bootstrapping analyses indicated a significant indirect effect of intentions on behaviour on all three chosen values of intentions (see Table 3), which increased along with levels of the moderator ($\beta = 0.16$ at - 1 *SD*, $\beta = 0.20$ at *M*, and $\beta = 0.25$ at + 1 *SD*; all *p*s < 0.01).

The region of significance had its lower bound at $z = 1.86$ ($p < 0.05$) and its upper bound at $z = 1.22$ ($p < 0.01$) of the moderator. The upper bound equals the largest value of the moderator within the data range in Study 2 as well, as the indirect effect could not be tested at a higher value of the moderator. Figure 4 displays results for Study 2 analogous to Figure 3 for Study 1. As hypothesised, the indirect effect increases along with intention levels.

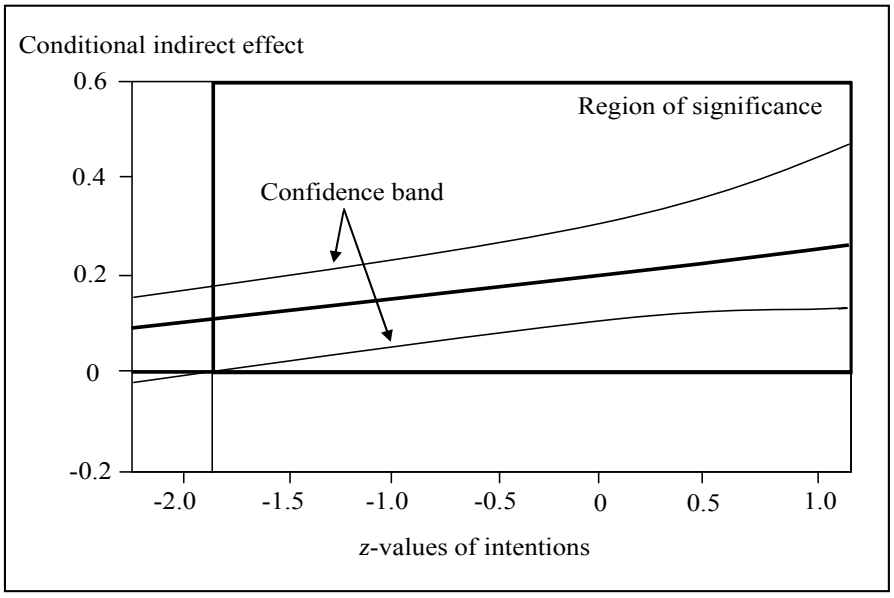

Figure 4. Study 2: Moderated indirect effect of intentions on interdental hygiene through planning with a 95%-confidence band.

General discussion

This article analysed in two studies whether the mediation effect of the intention-behaviour relation by planning varies due to different levels of intentions, thus providing first evidence for this parsimonious model of moderated mediation.

Interrelations between intentions, planning, and health behaviour

The present findings emphasise the importance of both intentions and planning for behaviour change, as both had main effects on behaviour (Figure 2). However, they work best in orchestration: intentions are translated into action by planning (mediation), and the effects of planning on behaviour are moderated by intentions, indicating that people with

high intentions are more likely to enact their plans (moderation). This is in line with assumptions of stage theories and recent experimental research (cf. Lippke, Ziegelmann, & Schwarzer, 2004; Sheeran, Webb, & Gollwitzer, 2005).

As an extension of previous research, we examined whether this moderation effect influences the translation of intentions into action by planning. In both studies, the strength of the partial mediation effect increased along with levels of intentions (Table 3, Figures 3 and 4): Planning helps to translate intentions into behaviour particularly well in individuals with moderate to high intentions, as they are more likely to act on their plans (Sheeran, Milne, Webb, & Gollwitzer, 2005). Hence, this refinement might explain the inconsistent results of previous studies regarding the role of action planning as a mediator between intentions and behaviour (e.g. Norman & Conner, 2005; Schwarzer et al., 2007).

The indirect effect represents a facilitating mechanism, i.e. people with high intentions make more use of planning and, thus, are more likely to act (Sutton, 2008). However, by taking moderated mediation into account, we acknowledge that this automatic process works differently in subgroups of individuals. Thus, moderated mediation allows a better description of the causal mechanisms by which intentions influence behaviour: intentions affect behaviour via three pathways, (a) directly, as indicated by a main effect on behaviour, and indirectly via (b) the mediation path and (c) via the moderator effect which catalyzes the mediation effect.

Implications

The present findings have several implications. Theory building might gain from consideration of such moderated mediation assumptions, because they help to explain how indirect effects vary at different levels of moderating conditions. Theoretical considerations may also be translated into theory-based interventions: Interventions based on the simple mediation model would promote intentions which would lead to higher planning and, thus, to higher performance. However, if the effects of such interventions would be estimated by simple mediation models, the actual effect of intentions on the behavioural outcome would be underestimated: direct effects as well as the moderating

effects of intentions would be disregarded. In addition, to 'jump into the assumed causal chain' (Sutton, 2008) by promoting planning directly should be less effective than a combined intervention on intentions and planning, given the moderating effect of intentions.

Thus, interventions might work best if they target intentions as precondition or in combination with planning, because intentions (as IV) not only promote planning processes but also enhance the likelihood that plans will be enacted (as Mo). Thus, even small changes in intention to act might affect whether planning interventions are beneficial for behaviour change, as our results indicate that indirect effects through planning develop only above a certain threshold of intentions and gradually increase with small increments of intentions (Mo). However, the total magnitude of intentions necessary for planning to mediate between intentions and behaviour is assumed to differ between simple and complex behaviours, as intentions had to exceed a higher threshold in physical activity than in interdental hygiene. This was indicated by the lower boundary of the region of significance for interdental hygiene. The present findings are based on non-experimental longitudinal data. Thus, suggestions for interventions are tentative. Future experimental studies should compare the effect variance explained by direct, indirect and moderator effects of intentions and explicitly test the differential effectiveness of simple planning and planning plus goal setting interventions.

Limitations

Limitations of the present studies include that there was systematic dropout, as indicated by baseline differences in levels of intentions (Study 1 and 2) and action planning (Study 2) between dropouts and participants remaining in the study. Therefore, the present findings should be interpreted cautiously. A second limitation, the high attrition rate in both studies, might be due to voluntary participation without compensation. Third, although evidence exists that self-reports of physical activity and interdental hygiene are valid (e.g. Miller, Freedson, & Kline, 1994; Schüz et al., 2006; Sniehotta et al., 2005), objective measures of the dependent variables are desirable. Fourth, the cross-sectional

measurement of intentions and planning does not allow strong inferences for cause-and-effect relations. Yet, by having predictor and mediator assessed at the same measurement point in time, confounds with temporal proximity between mediator and criterion are circumvented. Fifth, including baseline behaviour might have added variance explained to future behaviour, but might also have masked the theoretically more interesting effects of social-cognitive variables without providing further insights into the processes leading to behaviour (e.g. Ajzen, 2002).

Conclusions and outlook

The present studies tested a specific model in which intentions serve as independent variable of a simple mediation process and additionally as moderating variable. The findings provide evidence that mediation effects are not constant across different levels of intentions and indicate that more research is needed beyond the mere investigation of planning as a mediator by taking possible interaction effects into account.

Additionally, the intention-behaviour relation was only partially mediated by planning in both studies. Future research might therefore test the existence of additional mediators such as action control (Sniehotta, Scholz et al., 2005) or maintenance and recovery self-efficacy (Scholz et al., 2005) in multiple mediation models. Moderators can influence the mediation process in several ways. More research is needed that examines whether the mediation between intentions and behaviour by action planning is influenced by further moderators of the intention-planning relation (IV-Me), the planning-behaviour relation as in the present studies (Me-DV), or both relations. Extensive research by Conner and Godin (2007) indicated that intention stability moderates the intention-behaviour relation across several types of health behaviours, samples and time intervals. Future research might examine whether intention stability also moderates the intention-planning or the planning-behaviour relation. Since different levels of intentions were necessary for planning to mediate the intention-behaviour relation, further research might also focus on thresholds of moderators that determine the occurrence of causal relations. For instance, research by Priester and Petty (1996) provides correlational and experimental evidence for

the usefulness of a gradual threshold model to describe the influence of attitudinal reactions on subjective ambivalence. This might guide future research on the relation between intentions, planning and behaviour.

References

Abraham, C., Sheeran, P., & Johnston, M. (1998). From health beliefs to self-regulation: Theoretical advances in the psychology of action control. *Psychology & Health, 13*, 569-591.

ADA (2005). *Cleaning your teeth and gums (Oral hygiene)*. Retrieved May 11, 2007, from http://www.ada.org/public/topics/cleaning_faq.asp#4.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*, 179-211.

Ajzen, I. (2002). Residual effects of past on later behavior: Habituation and reasoned action perspectives. *Personality and Social Psychology Review, 6*, 107-122.

Bader, H.I. (1998). Floss or die: Implications for dental professionals. *Dentistry Today, 17*, 76-78, 80-82.

Bellamy, P., Barlow, A., Puri, G., Wright, K.I., Mussett, A., & Zhou, X. (2004). A new in vivo interdental sampling method comparing a daily flossing regime versus a manual brush control. *Journal of Clinical Dentistry, 15*, 59-65.

Booth, M.L. (2000). Assessment of physical activity: An international perspective. *Research Quarterly for Exercise and Sport, 71*, 114-120.

Conner, M., & Godin, G. (2007). Temporal stability of behavioural intention as a moderator of intention-health behaviour relationships. *Psychology & Health, 22*, 875-897.

Edwards, J.R., & Lambert, L.S. (2007). Methods for integrating moderation and mediation: A general analytical framework using moderated path analysis. *Psychological Methods, 12*, 1-22.

Enders, C.K. (2001). A primer on maximum likelihood algorithms available for use with missing data. *Structural Equation Modeling, 8*, 128-141.

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

Lippke, S., Ziegelmann, J.P., & Schwarzer, R. (2004). Initiation and maintenance of physical exercise: Stage-specific effects of a planning intervention. *Research in Sports Medicine, 12*, 221-240.

MacKinnon, D.P., Lockwood, C.M., & Williams, J. (2004). Confidence limits for the indirect effect: Distribution of the product and resampling methods. *Multivariate Behavioral Research, 39*, 99-128.

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*, 469-479.

McCaul, K.D., Glasgow, R.E., & Gustafson, C. (1985). Predicting levels of preventive dental behaviors. *Journal of the American Dental Association, 111*, 601-605.

Miller, D.J., Freedson, P.S., & Kline, G.M. (1994). Comparison of activity levels using the Caltrac accelerometer and five questionnaires. *Medicine and Science in Sports and Exercise, 26*, 376-382.

Norman, P., & Conner, M. (2005). The theory of planned behavior and exercise: Evidence for the mediating and moderating roles of planning on intention-behavior relationships. *Journal of Sport & Exercise Psychology, 27*, 488-504.

Preacher, K.J., & Hayes, A.F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, Instruments, & Computers, 36*, 717-731.

Preacher, K.J., Rucker, D.D., & Hayes, A.F. (2007). Addressing moderated mediation hypotheses: Theory, methods, and prescriptions. *Multivariate Behavioral Research, 42*, 185-227.

Priester, J.R., & Petty, R.E. (1996). The gradual threshold model of ambivalence: Relating the positive and negative bases of attitudes to subjective ambivalence. *Journal of Personality and Social Psychology, 71*, 431-449.

Reuter, T., Ziegelmann, J.P., Wiedemann. A.U., Lippke, S., & Schüz, B. (2007). *Beyond good resolutions: Planning mediates the intention-behavior relation as a function of age.* Manuscript submitted for publication.

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

Scholz, U., Schüz, B., Ziegelmann, J.P., Lippke, S., & Schwarzer, R. (in press). Beyond behavioural intentions: Planning mediates between intentions and physical activity. British *Journal of Health Psychology*.

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*, 135-151.

Schüz, B., Sniehotta, F.F., Wiedemann, A., & Seemann, R. (2006). Adherence to a daily flossing regimen in university students: Effects of planning when, where, how, and what to do in the face of barriers. *Journal of Clinical Periodontology, 33*, 612-619.

Schwarzer, R., Schüz, B., Ziegelmann, J.P., Lippke, S., Luszczynska, A., & Scholz, U. (2007). Adoption and maintenance of four health behaviors: Theory-guided longitudinal studies on dental flossing, seat belt use, dietary behavior, and physical activity. *Annals of Behavioral Medicine, 33*, 156-166.

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). Chichester, UK: John Wiley & Sons.

Sheeran, P., Milne, S., Webb, T.L., & Gollwitzer, P.M. (2005). Implementation intentions and health behaviours. In M. Conner & P. Norman (Eds.), *Predicting health behaviour: Research and practice with social cognition models* (2nd ed., pp. 276-323). Buckingham: Open University Press.

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

Sniehotta, F.F., Araújo-Soares, V., & Dombrowski, S.U. (2007). Randomised controlled trial of a one-minute intervention changing oral self-care behaviour. *Journal of Dental Research, 86*, 641-645.

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 & Health, 20*, 143-160.

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*, 565-576.

Sutton, S. (2008). How does the Health Action Process Approach (HAPA) Bridge the intention- behavior gap? An examination of the model's causal structure. *Applied Psychology. An International Review, 57*, 66-74.

White, K.M., Terry, D.J., & Hogg, M.A. (1994). Safer sex behavior: The roles of attitudes, norms and control factors. *Journal of Applied Social Psychology, 24*, 2164-2192.

Willich, S.N., Muller-Nordhorn, J., Kulig, M., Binting, S., Gohlke, H., et al. (2001). Cardiac risk factors, medication, and recurrent clinical events after acute coronary disease: A prospective cohort study. *European Heart Journal, 22*, 276-279.

WMA (2004). *World Medical Association Declaration of Helsinki: Ethical principles for medical Research involving human subjects.* Retrieved May 11, 2007, from http://www.wma.net/e/ policy/pdf/17c.pdf.

Ziegelmann, J.P., Luszczynska, A., Lippke, S., & Schwarzer, R. (2007). Are goal intentions or implementation intentions better predictors of health behavior? A longitudinal study in orthopedic rehabilitation. *Rehabilitation Psychology, 52*, 97-102.

3

How Planning Facilitates Behaviour Change: Additive and Interactive Effects

Amelie U. Wiedemann, Sonia Lippke, Tabea Reuter,
Jochen P. Ziegelmann, & Ralf Schwarzer

Freie Universität Berlin, Germany

Wiedemann, A. U., Lippke, S., Reuter, T., Ziegelmann, J. P., & Schwarzer, R. (2008). *How planning facilitates behaviour change: Additive and interactive effects*. Manuscript submitted for publication.

Abstract

Objective. Planning interventions have proven effective to change behaviour. However, less is known about their underlying mechanisms. Therefore, to better understand the processes by which planning interventions unfold their effects, a combined action planning and coping planning intervention was tested in a field setting, with a focus on mediating and moderating effects of theory-derived social-cognitive variables.

Method. In a randomized controlled trial (N = 374), employees of a logistics company were asked to participate in a combined action planning and coping planning intervention. Four weeks later, self-reported changes in fruit and vegetable intake, body mass index, as well as action planning, coping planning, intentions, and self-efficacy were measured. Single and simultaneous mediating effects on behaviour, respectively body mass were tested, along with interaction effects between planning processes.

Results. Self-reported action planning and coping planning simultaneously mediated intervention effects on fruit and vegetable intake (multiple mediation), and coping planning and behaviour mediated effects on body mass (three-path mediation). Self-reported action planning and coping planning had main and interactive effects on behaviour change (moderation).

Conclusions. Action planning and coping planning may exert both additive and synergistic effects on health behaviour change. Volitional interventions should include both action planning and coping planning components, and stimulate the use of planning strategies.

Keywords: planning, randomized controlled trial, fruit and vegetable intake, moderation, multiple mediation, three-path mediation

How Planning Facilitates Behaviour Change:

Additive and Interactive Effects

The primary focus of most evaluations of health behaviour interventions is on assessing change in behavioural outcomes, such as physical activity or dietary behaviour. However, mere information about behaviour change does not allow inferences about reasons for an intervention's success or failure (Michie & Abraham, 2004). Mediation analyses are recommended to evaluate interventions, as they provide a combined test of the effects of the applied intervention technique on theory-derived determinants of behaviour change, and their influence on the behavioural outcome (Chen, 1990; Preacher & Hayes, 2008). Using such mediation analyses, this study examines the mechanism by which a planning intervention leads to health-related outcomes.

Action planning and coping planning interventions

Extensive research on key determinants of health behaviour has clearly focused on motivational factors, and considerable knowledge exists about predictors of intentions (see Conner & Norman, 2005 for a review). However, individuals with a high motivation to improve their health-enhancing behaviour do not always succeed in accomplishing such desired changes (Sheeran, 2002). Prompting people to plan the implementation of their intentions is a promising means to support behaviour change. Two conceptually different kinds of plans can be formed in interventions: *Action plans* (i.e., forming *implementation intentions*; Gollwitzer, & Sheeran, 2006; Leventhal, Singer & Jones, 1965; Sniehotta, Schwarzer, Scholz, & Schüz, 2005), consist of precise descriptions of critical situations in which to perform a target behaviour, e.g., in terms of 'when', 'where', and 'how' specifications. In laboratory studies, linking such situational cues to goal-directed responses elicited intended behaviour immediately, efficiently, and almost outside conscious awareness (Webb & Sheeran, 2007). Though action planning may support individuals to implement their intentions, habitual responses can still impede the execution of the intended action (e.g., Sniehotta et al., 2005). Thus, in *coping plans* (Sniehotta et al.,

2005) anticipated internal and external risk situations that may jeopardise the behavioural performance are linked to coping strategies for the inhibition of undesired responses or the prioritization of desired ones (Sniehotta et al., 2005).

Action plans and coping plans can feature similar structures (e.g., the specification in an if-then format), but they serve different purposes. Action plans are a behaviour-facilitating strategy that is mostly associated with action initiation in good opportunities to act (e.g., 'If I am at 1 pm in the cafeteria on Monday, then I'll eat a salad.'). In contrast, coping plans are barrier-focused (e.g., 'If salad is sold out, then I'll eat a dish with two servings of vegetables for lunch instead.'), ground largely upon personal experience with the behaviour, and are more relevant for resolving maintenance problems (Sniehotta et al., 2005; Ziegelmann, Lippke, & Schwarzer, 2006).

Gollwitzer and Sheeran's (2006) meta-analysis attests to the beneficial effects of linking situational cues to behavioural responses on task performance in the laboratory ($d+ = .70$; $k = 38$;), and cue accessibility and cue-response association strength are supposed to mediate the intervention success in such studies (Webb & Sheeran, 2007). In field studies, however, single cue-response linkages may not be sufficient to cause enduring changes in complex behaviours such as dietary behaviour: Though action planning interventions yield changes in health behaviour with satisfactory effect sizes on average ($d+ = .59$, $k = 23$; Gollwitzer & Sheeran, 2006), and recent studies also point to positive effects of coping planning, or combined action planning and coping planning interventions (e.g., Armitage, 2008; Sniehotta, Scholz, & Schwarzer, 2006; Van Osch, Lechner, Reubsaet, Wigger, & de Vries, 2008; Ziegelmann et al., 2006), formal mediation analyses are rare (e.g., Michie & Abraham, 2004; Ziegelmann et al. 2006). Additionally, several methodologically strict tests found no such promising effects of action planning interventions on health behaviour change in field settings (Jackson et al., 2005; Michie, Dormandy, & Marteau, 2004; Rutter, Steadman, & Quine, 2006; Skår et al., 2008). This questions whether a single act of linking situational cues to action can produce sustainable effects on lifestyle behaviours *in field settings* via '*strategic automaticity*' (Gollwitzer & Sheeran, 2006) as supposed to results from laboratory studies. In field settings, such volitional interventions might rather unfold

their impact via effects on social-cognitive determinants of behaviour change, but the working mechanism by which they operate is not well understood (Armitage, 2008; Sniehotta, in press).

Mediation analyses elucidate the working mechanisms

The present study tests whether a combined action planning and coping planning intervention exerts its effects through the *use of planning strategies* over time, as measured by responses to psychometric scales. Analogous to intervention-induced planning, the use of planning strategies in everyday life can be subdivided into *action planning* and *coping planning* (i.e., linking suitable situations to specific behavioural acts, respectively linking suitable cognitive or behavioural coping responses to risk situations), and the conceptual difference of these processes has proven valid (e.g., Scholz, Schüz, Ziegelmann, Lippke, & Schwarzer, 2008; Sniehotta et al., 2005; Ziegelmann et al., 2006).

The use of both planning processes may be stimulated by forming plans in interventions (Luszczynska, 2006): The general strategy of first anticipating good opportunities to act (action plans) and potential risk situations (coping plans), of specifying them precisely, and then linking them to goal-directed responses may be transferred from the intervention content to everyday life. Thus, after exposure to a planning intervention people may engage in a more frequent use of action planning and coping planning. These two planning processes are specified as volitional causal factors for the realization of intentions in the *Health Action Process Approach* (HAPA; Schwarzer, 2008). Thus, the model represents the rationale for the assumed mediation process that describes the assumed working mechanism of planning interventions. Planning strategies as transferred from the intervention content are proposed to engender changes in behaviour. Because planning is proposed as post-intentional strategy, the intervention should not affect motivational self-efficacy or intentions, which are conceptualized as pre-intentional factors (Schwarzer, 2008). Accordingly, only small effects of planning interventions on both constructs were identified in a recent meta-analysis ($d+_{\text{self-efficacy}} = .10$, $d+_{\text{intention}} = .12$; Webb & Sheeran, 2008). The few studies that examined whether planning interventions

engender changes in self-reported action planning or coping planning over time, and whether these result in behaviour change, obtained equivocal results. For example, forming action plans and coping plans in a study on body weight led to a higher use of subsequent action planning and mediated the intervention effects (Luszczynska, Sobczyk, & Abraham, 2007). In another study, however, such intervention effects on coping planning but not on action planning were found (Araújo-Soares, McIntyre, MacLennan, & Sniehotta, in press; Scholz, Sniehotta, Burkert, & Schwarzer, 2007). Changes in coping planning, in turn, mediated intervention effects on behaviour in a study on physical activity in rehabilitation patients (Scholz et al., 2007), but not in adolescents (Araújo-Soares, McIntyre, MacLennan et al., in press). Further mediation tests on intervention-induced changes in planning processes are needed, and tests under which conditions they affect behaviour.

Relations between mediators

Both, action planning and coping planning processes are supposed to contribute to intervention success: Their proposed mediating perceptual, attentional, and mnemonic processes are assumed to be alike, but they differ in content and function (Sniehotta et al., 2005). Thus, analyses of intervention mechanisms should take the interrelations between action planning and coping planning into account by

a) testing their mediating effects simultaneously: *Multiple mediation models* parallel theoretical assumptions and, from a statistical perspective, circumvent problems such as an overestimation of indirect effects as done in multiple *single mediation models* (Preacher & Hayes, 2008).

b) taking *moderating effects* of action planning and coping planning into account. Both processes are supposedly more effective if they work in orchestration (Sniehotta et al., 2005): High levels of action planning alone may not suffice to change complex and regular behaviours unless they are shielded continuously against counter-productive tendencies by coping planning. Thus, coping planning was discussed to amplify the effects of action planning (Araújo-Soares, McIntyre, & Sniehotta, in press).

The only study published so far testing moderating effects of action planning and coping planning provided consistent evidence for their interaction as predictor of changes in physical activity over several measurement combinations and a study period of 5 months (Araújo-Soares, McIntyre, & Sniehotta, in press). To our knowledge, no study so far acknowledged the interrelations between experimentally induced changes in action planning and coping planning by using multiple mediation models. This study aims at extending previous work by investigating the working mechanisms of an action planning and coping planning intervention, focussing on simultaneous and interactive effects of changes in the use of planning processes on fruit and vegetable intake.

The context of the study

The study's aim was to test intervention effects in a real-life setting that allowed people to experience the challenges associated with lifestyle changes under natural conditions. Data collection took part in a logistics service company, whose employees constituted a sample at risk for morbidity. Due to the setting, the study followed an opportunistic randomised controlled design (Araújo-Soares, McIntyre, MacLennan et al., in press), and thus sample size and randomization procedures depended on the company's premises. A one-month time frame was chosen to allow people time to develop cognitive strategies based on the exposure to the intervention. Further, we opted for fruit and vegetable intake as a complex, regular behaviour (primary outcome) and body mass (body mass index; BMI, secondary outcome). Overweight and obesity (i.e., BMI $\geq$ 25 and $\geq$ 30; WHO, 2006) may pose a problem for human resources management as it endangers the workforce's employability when health is a job requirement, as for the present sample that consisted mainly of shift-workers in security-relevant, and physically demanding positions (e.g., engine drivers). A key preventive measure against obesity is a diet with low energy-dense foods, including five servings of fruit and vegetable a day (WHO, 2002).

Aim and Hypotheses

The purpose of this paper was to investigate the mechanisms by which an action planning and coping planning intervention impacts on fruit and vegetable and BMI, focussing on mediating effects of the self-reported use of action planning and coping planning, and the interrelations between these planning strategies. To control for the effects of motivational variables, self-efficacy and intentions were tested as mediators of intervention effects as well. Intervention effects on fruit and vegetable intake in a sub-sample of this study are reported elsewhere (Reuter, Ziegelmann, Wiedemann, & Lippke, 2008). This study is the first to test the following hypotheses.

Preliminary tests

1. The intervention does not affect self-efficacy and intentions.
2. The intervention leads to increases in fruit and vegetable intake (primary outcome) and minor changes in BMI (secondary outcome) compared to an active control condition.

Hypotheses on mediation and moderation

1. The intervention affects the use of action planning and coping planning strategies.
2. Changes in action planning and coping planning mediate between the exposure to the experimental conditions and changes in fruit and vegetable intake, which in turn may also lead to changes in BMI (three-path mediation).

3 a. Action planning and coping planning are simultaneous mediators of intervention effects (multiple mediation model).

b. The effect of changes in action planning on changes in fruit and vegetable intake is moderated by changes in coping planning (moderation model).

Method

Participants and Procedure

Employees of a logistics service company (Deutsche Bahn AG) were invited to participate in a computer-based health promotion program at the occasion of a regular medical check-up. Exclusion criteria were diabetes, an acute myocardial infarction within

the last year, a medical condition that conflicts with health recommendations for dietary behaviour, and not intending to adhere to the WHO recommendations for fruit and vegetable intake. Participation was voluntary and unpaid.

After giving informed consent, $N = 374$ participants completed a questionnaire on behavioural, social-cognitive, and sociodemographic variables. Subsequently, a computer algorithm randomly assigned participants (blinded to their allocation) to the planning intervention or the active control condition. Follow-up questionnaires were sent one month after the treatment, and were returned by $n = 184$ participants (49.2%; $n = 159$ in the experimental group, $n = 25$ in the control group; uneven quota due to restrictions placed on the intervention by the company). The longitudinal sample was composed of 71.4% men, and had a mean age of 44.2 years ($SD = 7.7$; range 23 - 64).

Dropout analyses compared the longitudinal sample to those who discontinued after T1 using analyses of variance (ANOVAs) for continuous measures, and χ^2-tests for categorical measures. No baseline differences were identified regarding fruit and vegetable intake, action planning, coping planning, intentions, self-efficacy, BMI, age, gender, and marital status (all p-values > .13). Thus, study dropout was non-selective regarding these variables.

Experimental conditions

The computer-based program consisted of the questionnaire, information about health authority guidelines (WHO, 2006), and the respective experimental component. Study assistants were available in case of questions.

Planning intervention. The intervention consisted of two components, namely action planning and coping planning prompts, that were designed in accordance to the behavioural criterion, i.e., to consuming five servings of fruit and vegetable a day as recommended by the WHO (2002). First, participants were asked to generate up to five action plans, i.e., to specify up to five types of fruit and vegetable and to plan when, how much, and how to consume them in the near future. Subsequently, participants specified

coping plans, i.e., up to five potential risk situations and corresponding coping responses. Examples were provided for clarification.

Active control condition. The active control component contained general health information (e.g., on the etiology of obesity) and a quiz on healthy diet. Additionally, feedback on participants' body mass index (BMI) was provided, such as 'You are slightly overweight. If you have additional ailments, such as problems with your joints or cardiovascular system, you should try to lose weight. Please contact your general practitioner!'

Randomization checks compared participants of the intervention group to those in the active control group by means of ANOVAs for continuous and χ^2-tests for categorical measures. No baseline differences were found for fruit and vegetable intake, action planning, coping planning, intentions, self-efficacy, BMI, age, gender, education status, and marital status (all *p*-values > .18), indicating that the randomization procedure succeeded (see Table 1).

Table 1. Pre- and posttest means and standard deviations

	Intervention condition (n = 159)		Active control condition (n = 25)	
	T1	T2	T1	T2
Action planning	2.4 (1.0)	2.6 (0.9)	2.1 (1.1)	2.0 (0.7)
Coping planning	2.5 (1.0)	2.7 (0.9)	2.3 (1.1)	2.1 (0.8)
Intentions	3.2 (0.8)	3.4 (0.7)	3.0 (0.8)	3.2 (0.6)
Self-efficacy	3.0 (0.9)	2.9 (0.9)	2.9 (0.9)	2.6 (0.9)
Fruit and vegetable intake[a]	3.8 (1.4)	4.5 (2.1)	3.7 (1.3)	3.5 (1.6)
BMI	27.4 (4.5)	27.0 (4.2)	28.1 (5.2)	28.3 (5.0)

Note. [a]Fruit and vegetable intake in servings/day. Standard deviations in parentheses.

Measures

Primary outcome measure: Fruit and vegetable intake was measured by the sum score of two open-ended questions, 'How many servings of fruit [vegetables] do you eat on an average day?' The items followed the definition of a serving, i.e., 'one handful of fruit (e.g., grapes) or vegetables (e.g., lettuce)'.

Secondary outcome measure: The *body mass index* was calculated by the formula 'BMI = weight (kg) / height $(m)^2$'.

The putative *cognitive mediators* were assessed using four-point Likert scales, ranging from completely disagree (1) to completely agree (4). Measures had been validated in previous studies (e.g., Lippke, Ziegelmann, Schwarzer, & Velicer, in press; Schwarzer et al., 2007; Sniehotta et al., 2005). Items below are specific to the intake of five portions of fruit and vegetable per day, and translated from German. *Action planning* was assessed by responses to the item 'I have already precisely planned when, where, and how to eat five servings of fruit or vegetables throughout the day.' *Coping planning* was measured by the item 'I have already planned how to eat five servings of fruit and vegetable in face of barriers and difficulties.' *Intentions* were assessed by the item 'I intend to eat fruit and vegetables with every meal or snack.', and *self-efficacy* by the item 'I am confident that I can regularly eat five servings of fruit and vegetables even if it is not always easy for me.' To obtain change variables, residualized change scores were calculated by regressing T2 variables on the respective baseline variables.

Data missing at random (< 10% on all variables) were imputed using the Expectation Maximization algorithm (Enders, 2001) in SPSS, as it has proven more robust than regression imputation (Gold & Bentler, 2000). BMI data were not imputed.

Analytical Procedure

Variance analyses with baseline variables as covariates (ANCOVAs) were used to analyse intervention effects on the outcomes and the putative mediators. Mediation analyses were tested by regression procedures using change variables for mediators and outcomes. In particular, intervention effects on body mass through cognitive and

behavioural changes were tested by three-path mediation analyses with SAS 9, as described in detail by Taylor, MacKinnon, and Tein (2008; macro provided by MacKinnon, 2008) to test the effects of the intervention on BMI through changes in planning and behaviour. Total, direct, and indirect effects of the multiple mediator model were obtained using a macro by Preacher and Hayes (2008). For the moderator analysis, predictors that built the interaction terms were centered. The Johnson-Neyman technique as outlined by Aiken and West (1991) was applied to identify the range of values of the continuous moderator (coping planning) in which the effect of the continuous independent variable (action planning) on the outcome (fruit and vegetable intake) is statistically significant (macro by Hayes & Matthes, 2008). This procedure was favoured over the commonly used simple slope analyses as no clear guidelines exist for picking non-arbitrary values of the moderator at which to probe the interaction (Aiken & West, 1991). When bootstrapping was applied, confidence intervals generated from with 5,000 resamples were used (CI_{BCA} = bias-corrected and accelerated confidence intervals with $\alpha = .10$; MacKinnon, Lockwood, & Williams, 2004). If not otherwise stated, analyses were run with SPSS 15.

Results

Descriptive results

Fruit and vegetable intake averaged 3.8 servings per day at baseline (*SD* = 1.4). Of the participants, 71.7% did not meet the WHO (2002) goal criterion of consuming five servings of fruit and vegetable per day. BMI data were available for 147 persons, and indicated that the BMI averaged 27.5 (*SD* = 4.6, range = 19.4 - 46.0), and was higher than the cut-off point for overweight of the WHO International BMI classification (BMI ≥ 25.0; WHO, 2006). According to their BMI, 63.6% of the sub-sample were overweight.

Preliminary tests

1. Intervention effects on self-efficacy and intentions

Comparisons between the experimental conditions regarding self-efficacy and intentions were conducted using ANCOVAs. No differences between the conditions were found regarding in terms of self-efficacy, $F(1, 183) = 1.03$, *ns*, or intentions, $F(1, 183) = 2.36$, *ns*.

2. Intervention effects on fruit and vegetable intake and BMI

ANCOVAs were conducted to test whether at follow-up participants of the planning intervention consume more fruit and vegetable and have a lower BMI as compared to controls. For both conditions, pre- and post-test means of cognitive and health-related variables are displayed in Table 1. At follow-up, the intervention group reported a higher fruit and vegetable intake, $F(1, 183) = 5.33$, $p < .05$, $d = .34$, and a lower BMI as compared to controls, $F(1, 146) = 4.24$, $p < .05$, $d = .20$.

Hypotheses on mediation and moderation

1. Intervention effects on putative mediators

Comparisons between the experimental conditions regarding the putative mediators action planning and coping planning were conducted with ANCOVAs. Differences between the conditions were found regarding both action planning, $F(1, 183) = 7.92$, $p < .01$, $d = .47$, and coping planning, $F(1, 183) = 6.31$, $p < .01$, $d = .34$.

2. Mediation of intervention effects: Three-path mediation

As one precondition for mediation, namely significant intervention effects on the mediator, was not met for self-efficacy and intentions, mediation analyses were conducted with planning variables only. Support for the second prerequisite, significant associations between variables in the mediation model, was supported by significant correlations (ps < .05; range of Pearson's r from -.18 to .75). Indication of multicollinearity among predictors was not given.

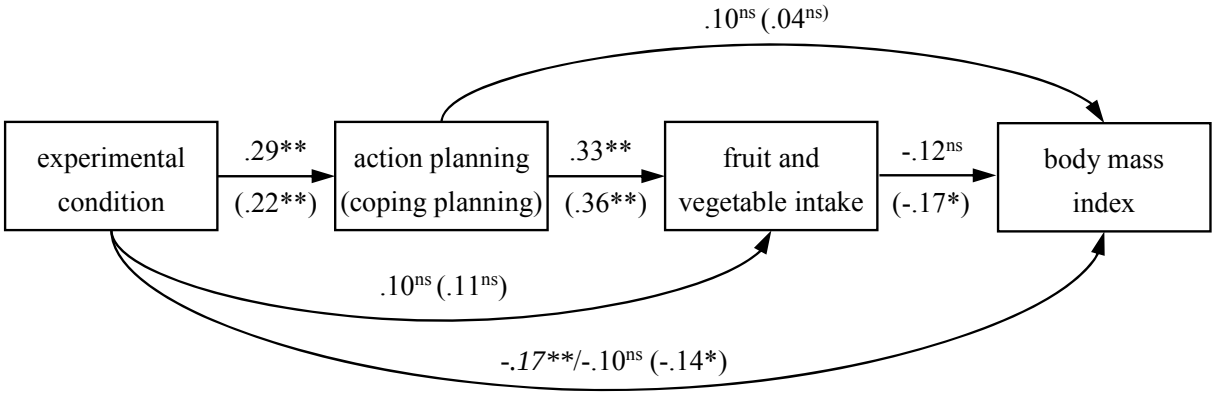

Figure 1. Three-path mediation model: Intervention effects on change in body mass index through changes in planning and behaviour (fruit and vegetable intake).

Note. *$p < .10$, **$p < .05$. Standardized regression coefficients for action planning and coping planning (in parentheses); Mediator and outcome variables refer to residualized change scores. In italics, the total effect of the intervention.

As precondition for the three-path model, action planning and coping planning were tested as independent mediators of the intervention effect on the primary intervention outcome (i.e., fruit and vegetable intake). Results from bootstrapping yielded a significant indirect effect of the intervention on changes in fruit and vegetable intake through action planning changes ($\beta = .07$, $p < .05$), respectively coping planning changes ($\beta = .06$, $p < .05$). The direct intervention effect, $\beta = .18$, $p < .05$, turned non-significant when controlling for changes in action planning, $\beta = 0.10$, $p = .14$, respectively coping planning, $\beta = 0.11$, $p = .11$, indicating full mediation of the intervention effect in both models. Together, the intervention and action planning, respectively coping planning explained 14% of the variance in behaviour change. In a next step, changes in planning and behaviour as sequential mediators of the intervention effects on the secondary outcome (BMI) were analyzed using three-path mediation models. In line with the results reported above, the direct intervention effect on changes in BMI was significant, $\beta = -.17$, $p < .05$. The indirect effect of the intervention on BMI through planning processes and fruit and vegetable intake was non-significant for action planning, (see Figure 1), but significant for coping planning, $\beta = -.013$, $CI_{BCA} = -.001$ to $-.04$). The direct intervention effect was reduced due to the introduction of the mediators into the model (see Figure 1), but

remained significant in the coping planning model, thus indicating direct and indirect effects on BMI.

3a. Relations between mediators: Multiple mediation

In a multiple mediator analysis, changes in action planning and coping planning were simultaneously tested as intervening factors between the intervention and behaviour change (Figure 2). The indirect effect through both mediators equalled β = .08 (CI_{BCA} = .04 to .14). Controlling for the other mediator, the intervention affected behaviour change indirectly through changes in action planning (β = .04, CI_{BCA} = .002 to .10) and coping planning (β = .04, CI_{BCA} = .007 to .09). The direct intervention effect on behaviour change was reduced to non-significance after controlling for the mediators, (β = .10, p = .16). The multiple mediator model accounted for 17% of the variance in behaviour change (p < .05).

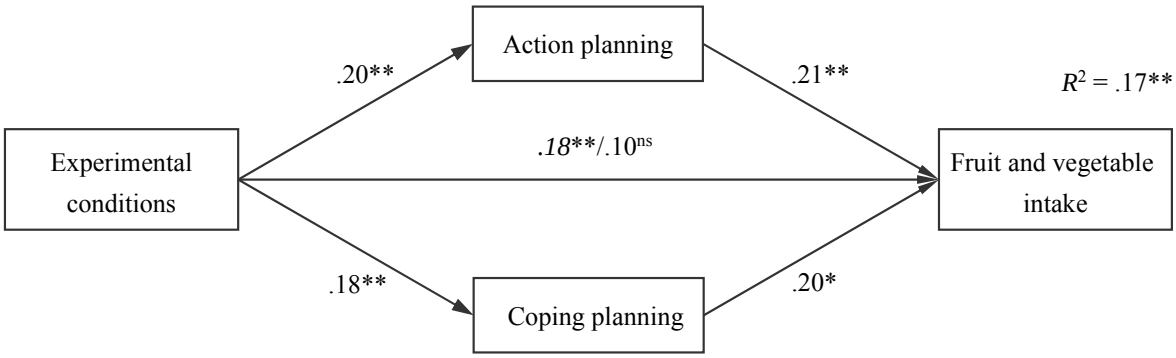

Figure 2. Multiple mediator model of intervention effects.

Note. *p < .10, **p < .05. Standardized estimates are reported. Mediator and outcome variables refer to residualized change scores. In italics, the total effect of the intervention.

3b. Relations between mediators: Moderation analysis

To test interaction effects of changes in the planning processes as predictors of changes in behaviour, a regression analysis was used with hierarchical entries of the experimental condition (step 1), changes in action planning and coping planning (step 2), and their interaction term (step 3). The interaction term predicted change in fruit and vegetable intake over and above the main effects of changes in planning variables, and led to a significant increase of the variance explained in behaviour change (s. Table 2).

Table 2. Results of hierarchical regression of behaviour change (fruit and vegetable intake) on experimental conditions, change in action planning, coping planning, and their interaction

	Change in behaviour		
Predictors	B	ΔR^2	R^2
Step 1			.03**
Experimental condition	.18**		
Step 2		.14**	.17**
Change in action planning	.21*		
Change in coping planning	.20*		
Step 3		.03**	.20**
Interaction: Change in action planning* Change in coping planning	.17**		

Note. *$p < .05$, **$p < .01$.

The significant interaction was probed using the Johnson-Neyman technique, i.e., the effects of change in action planning on behaviour change were estimated at all change values of coping planning as continuous moderator. Increases in action planning were amplified by increases in coping planning. In particular, for change in action planning to affect behaviour change, the change in coping planning had to be positive: The lower bound of the region of significance was at $z \geq 0.17$ ($p < .05$), i.e., when coping planning increased. The upper bound of the region of significance ($z = 2.0$, $p < .01$) constitutes the largest change value of coping planning within the data range (see Figure 3).

Discussion

This study tested the effects of forming action plans and coping plans on social-cognitive intermediate and health-related outcome variables and the underlying causative theory of the mediation process in a field setting. For the first time, evidence is provided that experimentally induced changes in action planning and coping planning operate simultaneously as mediating causal processes and presumably as synergistic counterparts.

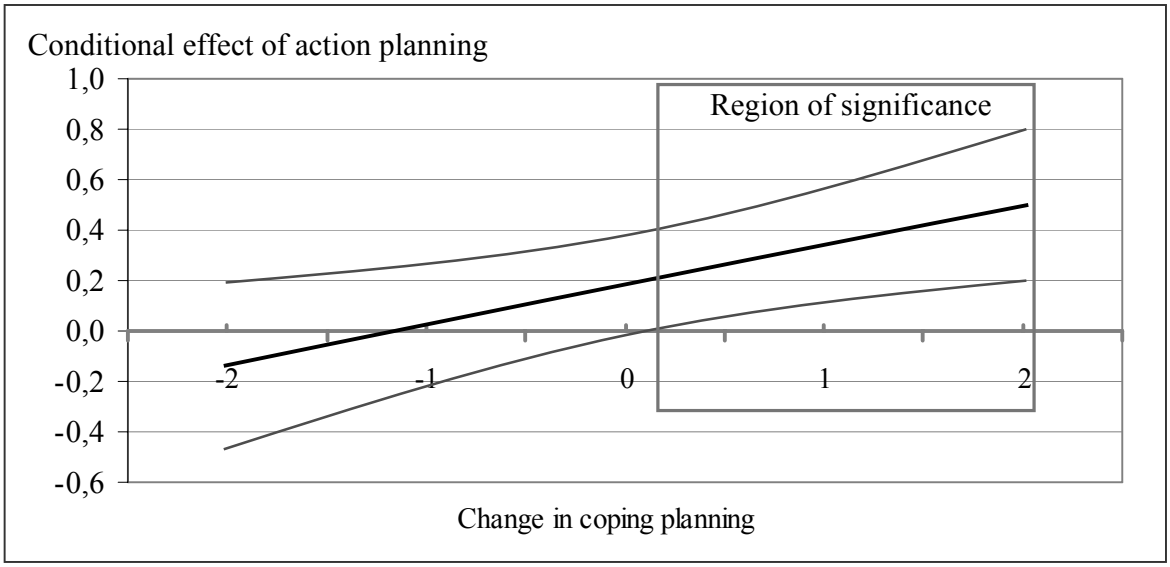

Figure 3. Effect of change in action planning on change in behaviour (fruit and vegetable intake) as function of change in coping planning.

Forming action plans and coping plans improved employees' fruit and vegetable intake as compared to the active control condition. This corroborates previous findings regarding this specific behaviour (Chapman, Armitage, & Norman, in press; Kellar & Abraham, 2005; action plans only), but the effect size (d = .34) was smaller than the average effect size in the meta-analysis by Gollwitzer and Sheeran (2006; d+ = .59). Adding to these findings, this study investigated the working mechanism of the combined intervention.

Mediation was tested first based on the rationale that the effects of plans are mediated by volitional planning processes. This implies that an initial act of learning how to form precise plans in the intervention may sustainably affect the use of planning strategies in every day life. This was supported by the increase in action planning and coping planning in the intervention group only. Although the study aimed at explaining the effects of a broadly applied behaviour change technique, and not on probing one that was specifically developed to enhance action planning or coping planning beyond the intervention, it caused changes in the use of planning strategies of a small-moderate effect size (Cohen, 1988). However, there may be more optimal tools to enhance the use of

planning strategies. In line with Webb and Sheeran's (2008) meta-analysis and theories that distinguish motivational and volitional processes (e.g., the HAPA), the intervention did not impact on intentions and self-efficacy. Thus, intervention effects on behaviour change were not attributable to the motivational influences of these control variables.

Mediation models for action planning and coping planning indicated that either of these change variables influenced behaviour change if both processes were tested separately ($\beta = .07$, $p < .05$, and $\beta = .06$, $p < .05$, for changes in action planning, respectively coping planning). Moreover, both mediational pathways were still predictive for behaviour change if they were tested simultaneously in the multiple mediation model (i.e., when controlling for their respective influence). Together, they explained more variance in behaviour change as if tested alone, suggesting additive effects. However, the unique effects were smaller in comparison to the single mediator models ($\beta = .04$, $CI_{BCA} = .002$ to .10, and $\beta = .04$, $CI_{BCA} = .007$ to .09 for action planning, respectively coping planning). This lends support for the necessity to use multiple mediation models if one aims at disentangling individual mediating processes that might overlap to some extent, while multiple single mediation models should rather be employed if mediators are not associated.

In all models, the direct effect of the intervention on behaviour change was non-significant after the introduction of the mediators. This indicates that outside the laboratory, different mediators may explain how intervention effects based on forming plans are obtained. In the lab, the content of plan formation often refers to simple manual responses (e.g., pressing keys) to arbitrary visual cues presented on screens (cf. Sniehotta, in press), and intervention effects may be explained by 'strategic automaticity'. Under natural conditions in the field, however, changes in complex and regular real-life behaviours appear to depend on different mediators, such as continuous self-regulation. This may be particularly true for longer-term behaviour change, when a single act of linking cues with responses might not be sufficient to cause enduring changes, for example, in the face of changing environments (e.g., seasonally reduced availability of the favoured and planned fruit). The strength of the indirect effect of the intervention might be

stronger if moderators are taken into account. For example, correlational evidence suggests a moderating role of self-efficacy and intentions on the relation between planning and behaviour which affects the strength of the indirect effect of intentions on behaviour via planning (Lippke, Wiedemann, Ziegelmann, Reuter, & Schwarzer, in press; Wiedemann, Schüz, Sniehotta, Scholz, & Schwarzer, in press).

Accordingly, the obtained changes in self-reported planning may have a stronger impact on behaviour change than may be expected from the present mediation analyses: Beyond main effects on behaviour change, a significant interaction between action planning and coping planning indicated that individuals benefit only from increases in action planning if these were accompanied by changes in coping planning. Only when coping planning increased due to the intervention (i.e., above the threshold value $z \geq 0.17$), the increase in action planning resulted in behaviour changes. This extends findings that an interaction of action planning and coping planning is predictive of subsequent physical activity (Araújo-Soares, McIntyre, Sniehotta, in press), and suggests that making plans for intention implementation may not always be sufficient for changing complex behaviours such as fruit and vegetable intake unless these plans are shielded by planned coping strategies (Jackson et al., 2005). Accordingly, in a study on physical activity only a combined intervention (including both action plans and coping plans) proved to promote behaviour effectively, while no effects of forming mere action plans were indicated (Sniehotta et al., 2006). This is indicative for additive or interactive effects of action plans and coping plans. Although both interpretations suggest benefits from including coping planning components in interventions, they point to constraints faced by multi-component interventions: Intervention components may be related and work jointly in changing behaviour. To fully disentangle the processes by which both components unfold their effects, full factorial designs are needed to assess the incremental effects of the individual components. The present two-component approach impedes the determination of the independent effects of changes in action planning and coping planning. Furthermore, the plan components as well as the mediators may be non-orthogonal, that is, a single component may affect various mediators, and a single mediator may be influenced by both

components, as well as a mediator may be influenced simply by its relation to another second mediator. This points to the complexity of the investigated relations, and might be focus of future research.

Forming plans also led to effects on BMI, which were mediated by coping planning and fruit and vegetable intake. The direct effect of the intervention on BMI indicates that other social-cognitive or behavioural changes (such as a reduced intake of high-density food items) have additionally affected BMI changes. The indirect effect points to an attenuation effect (Sniehotta, in press): Small-moderate changes in action planning and coping planning (d = .47 and .34) exerted an influence on employees' BMI, but effect sizes diminished as the effects work their way through the causal model (d = .34 for fruit and vegetable intake, d = .20 for BMI). However, even small decreases in BMI may be critical at a population level, as prompting plans can be cost-and time-effectively applied to a high number of people through mass media like the internet.

This small-scale intervention provides an explanation of processes regarding the effects of forming plans which may inform future interventions, which should be based on both action planning and coping planning components. As increases in the use of planning strategies resulted in changes in health-related outcomes, future studies might consider a) which intervention techniques are mostly effective to induce changes in planning (e.g., Ziegelmann, et al., 2006), respectively how interventions based on plans might be optimized to stimulate the generalization of planning processes from the intervention to everyday life, and b) under which conditions planning processes are most effectively to promote health-related changes. Moreover, future research might investigate planning stability, i.e., whether high levels of planning over time moderate the planning-behaviour relation similarly to the effects of intention stability on the relation between intentions and behaviour (Conner, Sheeran, Norman, & Armitage, 2000). Since changing health outcomes is the ultimate aim of theory-based interventions, more studies in applied contexts are needed. This is particularly critical in people at risk for overweight to prevent obesity and other serious morbidities. Here, opportunistic trials allow testing the effectiveness, feasibility, and acceptability of interventions and may provide guidance for future large-

scale implementations (Araújo-Soares, McIntyre, MacLennan et al., in press). Including measures of subjective well-being might broaden the present approach (Schüz et al., in press).

To conclude, this study identified mechanisms underlying an effective planning intervention. In specific, it was the first study that found that intervention-induced changes in action planning and coping planning operating as simultaneous and presumably synergistic counterparts, as well as testing the indirect effect of plans on BMI change through the supposed cognitive-behavioural causal sequence. Thus, the findings provide evidence for the value of combining action planning and coping planning in interventions to promote fruit and vegetable intake, and provided insight into their working mechanisms. Such future interventions may stimulate the use of planning strategies beyond the intervention.

References

Aiken, L. S., & West, S. G. (1991). *Multiple Regression: Testing and interpreting interactions*. Newbury Park, CA: Sage.

Araújo-Soares, V., McIntyre, T., MacLennan, G., & Sniehotta, F. F. (in press). Development and exploratory cluster-randomised opportunistic trial of a theory-based intervention to enhance physical activity among adolescents. *Psychology & Health*.

Araújo-Soares, V., McIntyre, T., Sniehotta, F. F. (in press). Predicting changes in physical activity amongst adolescents: The role of self-efficacy, intention, action planning and coping planning. *Health Education Research*.

Armitage, C. J. (2008). A volitional help sheet to encourage smoking cessation: a randomized exploratory trial. *Health Psychology, 27*, 557-566.

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.

Chapman, J., Armitage, C. J., & Norman, P. (in press). Comparing implementation intention interventions in relation to young adults' intake of fruit and vegetables. *Psychology & Health.*

Chen, H.-T (1990). *Theory driven evaluations.* Newbury Park, CA: Sage.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Earlbaum Associates.

Conner, M., & Norman, P. (2005) (Eds.). *Predicting health behaviour: Research and practice with social cognition models* (2nd ed.). Maidenhead: Open University Press.

Conner, M., Sheeran, P., Norman, P., & Armitage, C. J. (2000). Temporal stability as a moderator of relationships in the theory of planned behaviour. *British Journal of Social Psychology, 39*, 469-493.

Enders, C. K. (2001). A primer on maximum likelihood algorithms available for use with missing data. *Structural Equation Modeling, 8*, 128-141.

Gold, M. S., & Bentler, P. M. (2000). Treatments of missing data: A Monte Carlo comparison of RBHDI, iterative stochastic regression imputation, and expectation-maximization. *Structural Equation Modeling, 7,* 319-355.

Gollwitzer, P. M., & Sheeran, P. (2006). Implementation intentions and goal achievement: A meta-analysis of effects and processes. *Advances in Experimental Social Psychology*, *38*, 70-110.

Hayes, A. F., & Matthes, J. (2008). *MODPROBE: An SPSS and SAS procedure for probing single-degree-of-freedom interactions in linear regression models*. Manuscript submitted for publication.

Jackson, C., Lawton, R., Knapp, P. R., Raynor, D. K., Conner, M. T., Lowe, C. J., & Closs, S. J. (2005). Beyond intention: Do specific plans increase health behaviours in patients in primary care? A study on fruit and vegetable consumption. *Social Science & Medicine, 60*, 2383-2391.

Kellar, I ., & Abraham, C. (2005). Randomised controlled trial of a brief research-based intervention promoting fruit and vegetable consumption. *British Journal of Health Psychology, 10*, 543-558.

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

Lippke, S., Wiedemann, A. U., Ziegelmann, J. P., Reuter, T., & Schwarzer, R. (in press). Self-efficacy moderates the mediation of intentions into behavior via plans. *American Journal of Health Behavior*.

Lippke, S., Ziegelmann, J. P., Schwarzer, R., & Velicer, W. F. (in press). Validity of stage assessment in the adoption and maintenance of physical activity and fruit and vegetable consumption. *Health Psychology.*

Luszczynska, A. (2006). An implementation intention interventions, the use of a planning strategy, and physical activity after myocard infarction. *Social Science and Medicine, 62*, 900-908.

Luszczynska, A., Sobczyk, A., & Abraham, C. (2007). Planning to reduce weight: Implementation intentions intervention helps to reduce body weight among overweight or obese women by prompting action planning. *Health Psychology, 26*, 507-512.

MacKinnon, D. P. *SAS program for estimating three-path mediated effects*. Retrieved 1 November, 2008, www.public.asu.edu/~davidpm/ripl/mediate.htm.

Michie, S., & Abraham, C. (2004). Interventions to change health behaviours: Evidence-based or evidence inspired? *Psychology & Health, 19,* 29-49.

Michie, S., Dormandy, E., & Marteau, T. M. (2004). Increasing screening uptake amongst those intending to be screened: The use of action plans. *Patient Education and Counseling, 55*, 218-222.

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods, 40*, 879-891.

Reuter, T., Ziegelmann, J. P., Wiedemann, A. U., & Lippke, S. (2008). Dietary planning as a mediator of the intention-behavior relation: An experimental-causal-chain design. *Applied Psychology: An International Review. Special Issue: Health and Well-Being, 57*, 194-207.

Rutter, D. R., Steadman, L., & Quine, L. (2006). An implementation intentions intervention to increase uptake of mammography. *Annals of Behavioral Medicine, 32*, 127-134.

Scholz, U., Schüz, B., Ziegelmann, J. P., Lippke, S., & Schwarzer, R. (2008). Beyond behavioral intentions: Planning mediates between intentions and physical activity. *British Journal of Health Psychology, 13*, 479-494.

Scholz, U., Sniehotta, F. F., Burkert, S., & Schwarzer, R. (2007). Increasing physical exercise levels: Age-specific benefits of planning. *Journal of Aging and Health, 19*, 851-866.

Schwarzer, R. (2008). Modeling health behavior change: How to predict and modify the adoption and maintenance of health behaviors. *Applied Psychology, 57*(1), 1-29.

Schwarzer, R., Schüz, B., Ziegelmann, J. P., Lippke, S., Luszczynska, A., & Scholz, U. (2007). Adoption and maintenance of four health behaviors: Theory-guided longitudinal studies on dental flossing, seat belt use, dietary behavior, and physical activity. *Annals of Behavioral Medicine, 33*, 156-166.

Schüz, B., Wurm, S., Warner, L. M., & Tesch-Römer, C. (in press). Health and subjective well-being in later adulthood: Different health states-different needs? *Applied Psychology: Health and Well-Being.*

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

Skår, S., Prestwich, A., Araújo-Soares, V., Molloy, G. J., Lawton, R., Conner, M., & Sniehotta, F. F. (2008). *Do brief online planning interventions embedded in lifestyle surveys change health behaviour? Two randomised controlled trials.* Manuscript under review.

Sniehotta, F. F. (in press). Towards a theory of intentional behaviour change: Plans, planning and self-regulation. *British Journal of Health Psychology.*

Sniehotta, F. F., Scholz, U., & Schwarzer, R. (2006). Action plans and coping plans for physical exercise: A longitudinal intervention study in cardiac rehabilitation. *British Journal of Health Psychology, 11*, 23-37.

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,* 565-576.

Taylor, A. B., MacKinnon, D. P., & Tein, J. Y. (2008). Tests of the three-path mediated effect. *Organizational Research Methods, 11,* 241-269.

Van Osch, L., Lechner, L., Reubsaet, A., Wigger, S., & de Vries, H. (2008). Relapse prevention in a national smoking cessation contest: Effects of coping planning. *British Journal of Health Psychology, 13*, 525-535.

Webb, T. L., & Sheeran, P. (2007). How do implementation intentions promote goal attainment? A test of component processes. *Journal of Experimental Social Psychology, 43*, 295-302.

Webb, T. L., & Sheeran, P. (2008). Mechanisms of implementation intention effects: The role of goal intentions, self-efficacy, and accessibility of plan components. *British Journal of Social Psychology, 47*, 373-395.

WHO (2002). *The World Health Report 2002. Reducing Risks, Promoting Healthy Life.* Geneva: WHO.

WHO (2006). *Global database on body mass index.* Retrieved 1 November, 2008 from http://www.who.int/bmi/index.jsp?introPage=intro_1.html.

Wiedemann, A. U., Schüz, B., Sniehotta, F. F., Scholz, U., & Schwarzer, R. (in press). Disentangling the relation between intentions, planning, and behaviour: A moderated mediation analysis. *Psychology & Health.*

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

4

Intervention Effects on Physical Activity in Different Stage Groups: The Number of Action Plans and Coping Plans

Amelie U. Wiedemann, Sonia Lippke, & Ralf Schwarzer

Freie Universität Berlin, Germany

Wiedemann, A. U., Lippke, S., & Schwarzer, R. (2008). *Intervention effects on physical activity in different stage groups: The number of action plans and coping plans*. Manuscript submitted for publication.

Abstract

Objective. Planning has been found to support behavior change. How well planning interventions translate into behavior change is supposed to vary according to the number of generated plans, and baseline levels of behavior. This study tested the effects of the number of specified action plans and coping plans on changes in physical activity in intenders (motivated, less active persons) and actors.

Design. In a randomized controlled trial (N = 264), employees of a logistics service company were asked to specify up to three action plans and coping plans. Four weeks later, changes in physical activity were recorded.

Method. Direct effects of baseline stage and the number of action plans, respectively coping plans, as well as indirect effects were tested by analyses of variance and regression procedures.

Results. Intenders generated more action plans than actors, but groups did not differ in terms of coping plans. Intervention effects on physical activity were strongest in intenders and in those who specified a higher quantity of plans (2 action plans, or 3 coping plans). The number of action plans mediated between baseline stage (intenders vs. actors) and changes in physical activity.

Conclusions. The study underlines the effectiveness of action plans and coping plans in less active individuals. Optimal intervention effects might be realized if participants' specified number of plans is considered.

Keywords: baseline stage by treatment, planning, physical activity, mediation, randomized controlled trial, stage of change

Intervention effects on physical activity in different stage groups:

The number of action plans and coping plans

Individuals with the motivation to improve their health-enhancing behavior not always succeed in accomplishing such desired changes. Prompting people to plan when, where, and how to act, and how to overcome goal-conflicting barriers, is a promising means to support behavior change, and empirical evidence attests the overall beneficial effects of such action planning and coping planning interventions (e.g., Sniehotta, Scholz, & Schwarzer, 2006; Ziegelmann, Lippke, & Schwarzer, 2006). However, several studies failed to find such positive effects (e.g., Jackson et al., 2005; Michie, Dormandy, & Marteau, 2004). Therefore, this study investigates two possible reasons for such heterogeneity, namely pre-intervention differences in behavior (i.e., baseline stages of behavior change; Lippke, Ziegelmann, Schwarzer, 2004; Schwarzer, 2008) and the number of self-generated plans. In particular, the mechanism of a combined action planning and coping planning intervention will be examined in a field study on physical activity: The number of plans is assumed to mediate between pre-intervention stage of change and behavior change.

Action Planning and Coping Planning

Two kinds of planning interventions can be differentiated: *Action planning* (e.g., implementation intentions; Gollwitzer, 1999) consists of 'when', 'where', and 'how' specifications of critical situations in which to enact a target behavior. Linking such situational cues to goal-directed responses helps to elicit the intended behavior immediately, efficiently, and almost outside conscious awareness due to an increased accessibility and processing of critical cues and strong cue-response associations (Webb & Sheeran, 2006; 2007). Thus, action planning is a behavior-facilitating strategy that is mostly related to coping with problems of action initiation. Similarly, *coping planning* (Sniehotta, Schwarzer, Scholz, & Schüz, 2005; Ziegelmann et al., 2006) aims at linking

internal and external barriers (e.g., distractions, forgetting, or conflicting habits) to strategies for the inhibition of undesired responses or the prioritization of desired responses (Sniehotta et al., 2005) to promote the maintenance of behaviors that need to be performed regularly to be effective. Thus, coping planning grounds upon experience with personal barriers, and is supposedly more relevant for resolving maintenance problems in people who already perform the target behavior (Sniehotta et al., 2005; Ziegelmann et al., 2006).

Interventions based on action planning have proven to induce changes in different health behaviors, such as physical activity (e.g., Milne, Orbell, & Sheeran, 2002; Sniehotta et al., 2006), with medium effect sizes on average (meta-analysis; Gollwitzer & Sheeran, 2006). Coping plans on top of action plans lead to increments in effect sizes (Sniehotta et al., 2006; Van Osch, Lechner, Reubsaet, Wigger, & de Vries, 2008; Ziegelmann et al., 2006), and similar approaches have been used effectively in relapse prevention of addictive behaviors (Marlatt, 1996). However, despite the growing evidence for their effectiveness, several rigorous studies found planning interventions to be ineffective for behavior change (Jackson et al., 2005; Michie et al., 2004; Rutter, Steadman, & Quine, 2006; Skår, Prestwich, Araújo-Soares et al., 2008).

Baseline by Treatment Interactions

One putative reason for inconsistent findings regarding planning interventions are baseline by treatment interactions. Baseline by treatment interactions occur when intervention effects (e.g., on changes in physical activity) are determined not only by the treatment itself (e.g., a planning intervention), but also by different pre-intervention characteristics of the sample (e.g., baseline levels of physical activity). For example, significant increases of activity levels in the intervention group (vs. controls) would indicate main effects of the planning intervention. However, if activity increases to a higher degree in previously inactive individuals as compared to already active individuals in the intervention group, this speaks in favor of interactions between baseline and treatment.

The investigation of baseline by treatment interactions is fundamental before implementing large-scale health promotion programs, as generally conducive interventions may have irrelevant or even detrimental effects depending on the sample's baseline characteristics. For example, greater increases in physical activity in inactive (vs. active) individuals would indicate a beneficial interaction as both subgroups show increases in their activity levels, but they are larger in those in need to change. Contrary, decreases in activity levels in active individuals due to their exposure to a planning treatment would point to a mismatched intervention strategy with detrimental effects. Such adverse interactions may occur when mismatched prevention programs cause reactance, study drop-out, and the likelihood to show undesired behavior (here sedentary behavior) in low-risk individuals (e.g., Prochaska, DiClemente, Velicer, & Rossi, 1993).

Stage-matched interventions

To prevent counter-productive program effects, interventions may be matched to participants' individual needs as proposed by stage theories (Weinstein, Rothman, & Sutton, 1998). Stage theories propose that individuals pass through different stages on their way towards behavior change. Thus, persons at different stages are characterized by different mindsets, delineated by differences in terms of their cognitions, perceived barriers, and action tendencies (Weinstein et al., 1998). Accordingly, specific factors are responsible for progress towards a behavioral goal. This implies that interventions can be matched to a person's stage by targeting stage-specific needs as opposed to 'one-size-fits-all'-treatments. For example, the Health Action Process Approach (HAPA; Schwarzer, 1992; 2008) distinguishes between (a) a preintention stage, including persons ('preintenders') who have not (yet) set the goal to act according to a previously defined criterion, (b) an intention stage, comprising persons motivated to change, but not yet acting ('intenders'), and (c) an action stage, including persons who already attain the behavioral criterion ('actors'). Applied to physical activity, the HAPA proposes that planning interventions are less suitable for preintenders, but that action plans help intenders to initiate a physically active lifestyle, and that coping plans support intenders as well as

actors to maintain their (recently initiated) activity levels. Thus, the effectiveness of a combined action planning and coping planning intervention might be determined by *baseline stage by treatment effects,* with larger increases in physical activity in intenders (vs. actors) due to their low baseline levels of behavior. Scarce experimental evidence attests the differential effectiveness of action plans and coping plans in people with different baseline characteristics (e.g., Lippke et al., 2004; Ziegelmann et al., 2006).

Quantity of Self-Generated Plans

Another reason for inconsistent findings regarding planning interventions might be the quantity of plans that people generate when they undergo the treatment. For example, the WHO (2006) health goal to be active on most days of the week implies that its accomplishment relies on being active on multiple occasions. Accordingly, planning interventions to promote physical activity consistently ask participants to plan not only one, but several suitable situations and activities for goal realization (e.g., Lippke et al., 2004; Sniehotta et al., 2006), because each additional action plan may increase the likelihood that good opportunities to act will be encountered and utilized. Similarly, with increasing numbers of risk-response links more strategic means to overcome barriers are at hand, supposedly resulting in a higher likelihood to act. As the initiation of plans requires hardly any cognitive resources to be effective (e.g., Brandstätter, Lengfelder, & Gollwitzer, 2001), multiple plans might work in orchestration without interference. As a consequence, each additional plan might facilitate behavior change irrespective of preexisting plans, and forming a larger number of plans would be associated with greater changes in behavior. Accordingly, in a study on driving speed, a larger number of plans was associated with higher compliance with speeding limits (Elliott & Armitage, 2006). No effects on behavior change were found in studies with high proportions of people who refrained from generating plans although being instructed to do so (e.g., Michie et al., 2004; Rutter et al., 2006; Skår et al., 2008).

Relation between Stage by Treatment Effects and the Number of Plans

Research on baseline stage by treatment interactions regarding planning interventions and the number of plans is scarce, and the few published studies have treated both conditions as independent predictors of behavior change by testing the predictive value of one or the other in separate studies (e.g., Elliott & Armitage, 2006; Lippke et al., 2004). However, baseline differences (as responsible for stage by treatment interactions) may not only affect behavioral intervention outcomes but also participants' responses to specific intervention contents. In planning interventions, for example, positive responses to the intervention content, as indicated by a high quantity of generated plans, might only realize if the intervention content matches a person's specific need. For example, behavior-initiating action planning is more relevant (i.e., stage-matched) for intenders than for actors (e.g., Schwarzer, 2008). Thus, actors might generate a lower number of action plans, because they are not in need to initiate activity. Both groups, however, would profit from coping planning due to the putative effects on behavioral maintenance. While evidence exists, that personally relevant information receives more attention (Petty & Cacioppo, 1986), no published study so far has investigated whether baseline stage affects the number of generated action plans and coping plans. However, baseline differences might explain why some studies found 20-40% of the participants to refrain from generating plans (Michie et al., 2004; Rutter et al., 2006; Skår et al., 2008). We assume that baseline stage not only impacts on the number of specified plans and the amount of behavioral change, but that such pre-intervention differences indirectly affect change in activity through the number of plans.

Aim and Hypotheses

This randomized controlled trial represents an initial test of the influence of baseline stage differences on primary intervention outcomes (i.e., changes in physical activity) and responses to intervention contents (i.e., the number of generated plans) in a combined action planning and coping planning intervention. Participants' specified number

of plans is presumed to explain the mechanism by which baseline stage influences behavior change.

The following hypotheses were tested:

I. A combined action planning and coping planning intervention leads to larger increases in physical activity as compared to an active control condition (*general intervention effects*).

II. Intenders as compared to actors

a. show larger increases in physical activity (primary intervention outcome) due to the planning intervention (*baseline stage by treatment effects*), and

b. generate more action plans, but the same number of coping plans (primary intervention mediator) in the intervention (*effects of baseline stage on number of generated plans)*.

III. A higher number of action plans, respectively coping plans leads to a higher change in physical activity (*effects of number of plans*).

IV. Baseline stage influences subsequent physical activity indirectly through the number of generated action plans and coping plans (*indirect effects of baseline stage*).

Method

Participants and Procedure

Trained interviewers invited employees of a logistics service company to participate in a computer-based health promotion program. Exclusion criteria were diabetes, an acute myocardial infarction within the last year, a medical condition that conflicts with general recommendations for physical activity and dietary behavior, and not intending to adopt a physically active lifestyle. Participation was voluntary and unpaid.

After giving informed consent, 560 participants completed a questionnaire on behavioral and sociodemographic variables (see Figure 1). Subsequently, a computer algorithm randomly assigned participants (blinded to their allocation) to the planning intervention (n = 496) or the active control condition (n = 64). Follow-up questionnaires

were sent one month after the treatment, and were returned by n = 264 (47.1%) participants (see Figure 1, n = 229 in the experimental group, n = 35 in the control group). The longitudinal sample was composed of 77.3% men, and had a mean age of 43.5 years (SD = 8.2; range 20 to 59).

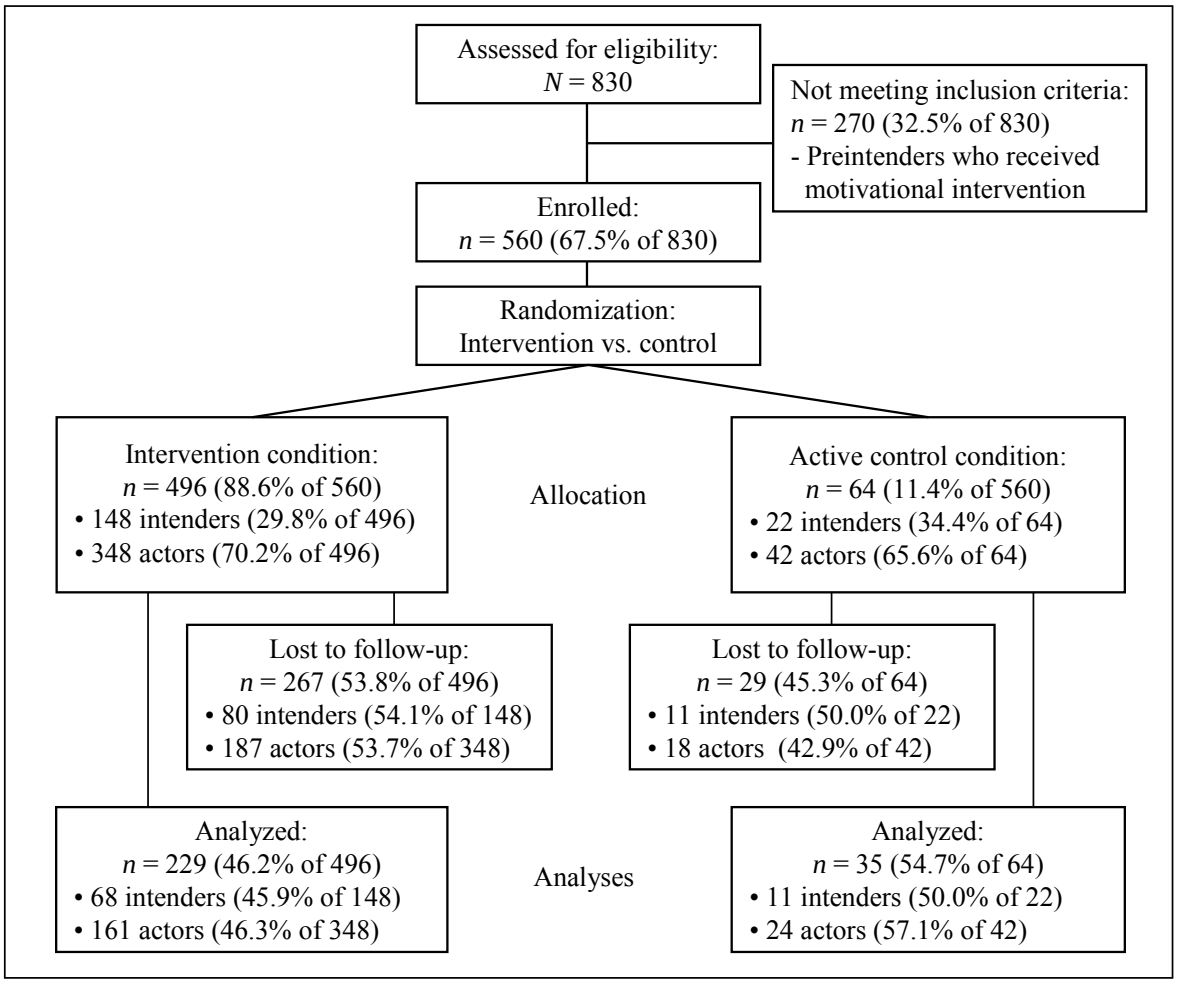

Figure 1. Flowchart of Participant Progress through the Study Phases

Experimental Conditions

Participants were randomly assigned to the planning intervention or the active control condition with a quota of 9 to 1 due to study requirements (see Figure 1). The computer-based program consisted of the questionnaire, information about health authority guidelines for physical activity (WHO, 2006), and the respective experimental component. Trained interviewers assisted in a non-directive manner in case of questions.

Planning intervention. First, participants were asked to generate up to three action plans for action initiation and maintenance (intenders and actors, respectively), i.e., to specify three types of physical activity and to plan when (day of week, and time of day), where, and how long to perform each of these activities in the future. Subsequently, participants specified coping plans, i.e., up to three potential risk situations for behavior maintenance and corresponding coping responses.

Active control condition. The active control condition contained general health information (e.g., on the etiology of obesity), a quiz on healthy dietary behavior, and personalized feedback on participants' body mass index (BMI), such as 'You are slightly overweight. If you have additional ailments, such as problems with your joints or cardiovascular system, you should try to lose weight. Please contact your general practitioner!'

Measures

Primary outcome measure: Physical activity was measured by an adaptation of the validated scale by Godin and Shepard (1985). Participants indicated how often per week and how long per session they performed strenuous physical activity (fast heart rate, sweating, e.g., intensive swimming) and moderate physical activity (hardly exhausting, light sweating, e.g., gymnastics). Total physical activity was the sum of the multiplied sessions per week by minutes per session.

Change in physical activity was calculated as difference score, i.e., by subtracting T1 physical activity from T2 physical activity.

Stage of the Health Action Process Approach was assessed with a validated algorithm (Lippke, Ziegelmann, Schwarzer, & Velicer, in press). The stem 'Are you physically active for at least thirty minutes on at least three days a week?' was followed by mutually exclusive statements representing the intention stage ('No, but I strongly intend to do so'), and the action stage (e.g., 'Yes, and it is easy for me'). Participants classified as preintenders by the stage algorithm (e.g., 'No, and I do not intend to do so') were excluded from the study as they did not receive a planning intervention.

Primary intervention mediator: The number of generated plans was obtained by independent ratings of two trained raters. Plans were only counted if each component was specified, and only if these components matched, as non-completion or misspecification would lead to underestimated effects of planning. Since participants were asked to generate up to three action plans, respectively coping plans, the number of each type of plan could range from 0-3, with a total of six plans. The inter-rater reliability was very high (Cohen's $\kappa = .92$ for action plans, 96 for coping plans). Disagreement between raters was solved by discussion.

Data missing at random (< 10% on all variables) were imputed using the Expectation Maximization algorithm (Enders, 2001) in SPSS, as it has proven more robust than regression imputation (Gold & Bentler, 2000).

Analytical Procedure

Differences between conditions (intervention vs. active control) or stage groups (intenders vs. actors) in changes in physical activity, and differences regarding the number of specified plans between stage groups were examined with analyses of variance (ANOVAs).

The effects of the quantity of generated plans on behavior change was additionally tested by post-hoc regression curve estimation, and the assumption of indirect effects of baseline stage on changes in activity through the number of plans was tested by regression procedures using a SPSS macro (syntax) for Sobel Z (Preacher & Hayes, 2004). All analyses were conducted using SPSS 15.

Results

Preliminary Results

Dropout analyses compared the longitudinal sample to dropouts after T1 using analyses of variance (ANOVAs) for continuous measures, and χ^2-tests for categorical measures. No significant baseline differences were identified regarding physical activity,

gender, age, education status, marital status, and baseline stage, indicating a non-selective study dropout (Table 1).

Randomization checks compared intenders, respectively actors in the intervention group to intenders, respectively actors in the active control group by means of ANOVAs for continuous and χ^2-tests for categorical measures. No baseline differences were found for physical activity (see Table 2), age, gender, education status, and marital status, indicating that the randomization procedure succeeded.

Table 1. Results of dropout analyses

Variable	Longitudinal sample (n = 264)	Dropouts (n = 297)
Gender: female, %	22.7	20.1
Age in years, *M* (*SD*)	43.5 (8.2)	44.2 (8.6)
Education: senior high school degree, %	17.4	21.3
Marital status (married), %	25.8	24.0
Physical activity[a] T1, *M* (*SD*)	188.6 (137.9)	178.6 (154.5)
HAPA stage: Intenders, %	31.0	29.9

Note. Significance tests (ANOVA and χ^2-tests) indicated no significant differences on these variables.
[a]Physical activity in minutes/week; HAPA = Health Action Process Approach.

Validity checks of differences between the stages (intenders vs. actors) on baseline levels of physical activity were conducted using ANOVA, and indicated significantly higher levels in actors (M_{Actors} = 228.2, $M_{\text{Intenders}}$ = 96.1, $F(1,263) = 62.6$, $p < .001$).

Table 2. Pre- and posttest means and standard deviations of physical activity

	Intervention condition				Active control condition			
	Intenders (n = 68)		Actors (n = 161)		Intenders (n = 11)		Actors (n = 24)	
	T1	T2	T1	T2	T1	T2	T1	T2
Physical activity[a]	96.8 (105.5)	150.9 (93.3)	224.6 (130.2)	226.7 (121.8)	91.9 (131.9)	64.1 (59.7)	251.9 (129.6)	221.3 (118.7)

Note. [a]Physical activity in minutes/week. Standard deviations in parentheses.

The number of generated plans was calculated for people in the intervention group. The maximum number of three action plans, respectively coping plans was specified by 12.2% (n = 28), respectively 14.8% (n = 34) of the participants. Only 4.4% (n = 10) generated six plans, i.e., three action plans and three coping plans. No action plan, respectively no coping plan was specified by 63.8% (n = 146), respectively 19.7% (n = 45) of the participants. No plan at all was generated by 14.8% (n = 34) of the sample. Action plan and coping plan ratings were correlated (r = .29, p < .001; see Table 3).

Table 3. Intercorrelations between plan ratings and study variables (n = 229)

	Plan ratings	
Variables	Action plans	Coping plans
HAPA stage T1	-.64**	-.12[ns]
Physical activity[a] T1	-.38**	-.13*
Physical activity[a] T2	-.12[†]	.09[ns]
Change in physical activity[ab]	.26**	.18**
Action plan rating	1.0	.29**
Coping plan rating	.29**	1.0

Note. [a]Physical activity in minutes/week; [b]Difference score T2-T1 physical activity. HAPA = Health Action Process Approach; **p < .01; *p < .05; [†] p < .10.

Main Results

General intervention effects. A repeated-measures ANOVA was conducted to test intervention effects on physical activity in the overall sample, and yielded a marginal significant time by treatment interaction, $F(1, 262) = 3.31$, $p = .07$, $\text{eta}^2 = .02$, but no main effect of time, $F(1, 262) = 0.22$, *ns*, indicating that changes over time differed between the two conditions. The increase of activity in the intervention group averaged 17.7 minutes (SD = 144.8), while the active control condition showed an average decrease of 29.8 minutes (SD = 132.9).

Stage by treatment effects on physical activity. Whether intervention effects differed between the stage groups was tested by repeated-measures ANOVA separately for the intervention and the control group. Changes in physical activity over time occurred in the intervention group, $F(1, 227) = 7.37$, $p < .01$, $eta^2 = .03$, and a significant time by stage interaction indicated that they were larger in intenders ($M = 54.1$, $SD = 136.4$) than in actors ($M = 2.1$, $SD = 145.9$), $F(1, 227) = 6.30$, $p < .05$, $eta^2 = .03$. In the active control group, a non-significant decrease of 29.75 minutes ($SD = 132.89$) over time, $F(1, 33) = 1.41$, *ns*, and no time by stage differences $F(1, 33) = 0.03$, *ns*, were found. Thus, stage by treatment interactions were identified, as increases in activity were partly determined by the planning intervention as well as by baseline stage.

Effects of baseline stage on number of generated plans. Differences between intenders and actors regarding the quantity of generated plans were tested using ANOVAs, and found intenders to generate a higher number of action plans ($M = 1.7$, $SD = 1.2$) as compared to actors ($M = 0.3$, $SD = 0.6$), $F(1, 227) = 160.72$, $p < .001$, $eta^2 = .41$. The number of generated coping plans was marginally higher in intenders ($M = 1.6$, $SD = 0.9$) than in actors ($M = 1.3$, $SD = 1.0$), $F(1, 227) = 3.35$, $p = .07$, $eta^2 = .02$. Figure 2 displays the frequency distribution of action plans for intenders as opposed to actors (left bar),and the frequency distribution of coping plans for intenders as opposed to actors (right bar).

Effects of number of plans on activity changes. To test whether changes in physical activity in the intervention group differed due to the number of generated plans, repeated measures ANOVAs were conducted.

Action plans. With regard to action plans, a significant time by plan interaction was obtained, $F(3, 225) = 7.43$, $p < .001$, $eta^2 = .09$, as well as a significant main effect of time, $F(1, 225) = 16.71$, $p < .001$, $eta^2 = .07$. Post-hoc pairwise comparisons with Bonferroni correction for multiple comparisons indicated differences in behavior change between people generating 0, respectively 1 plan and those generating 2, respectively 3 action plans, $p < .05$ (see Figure 3).

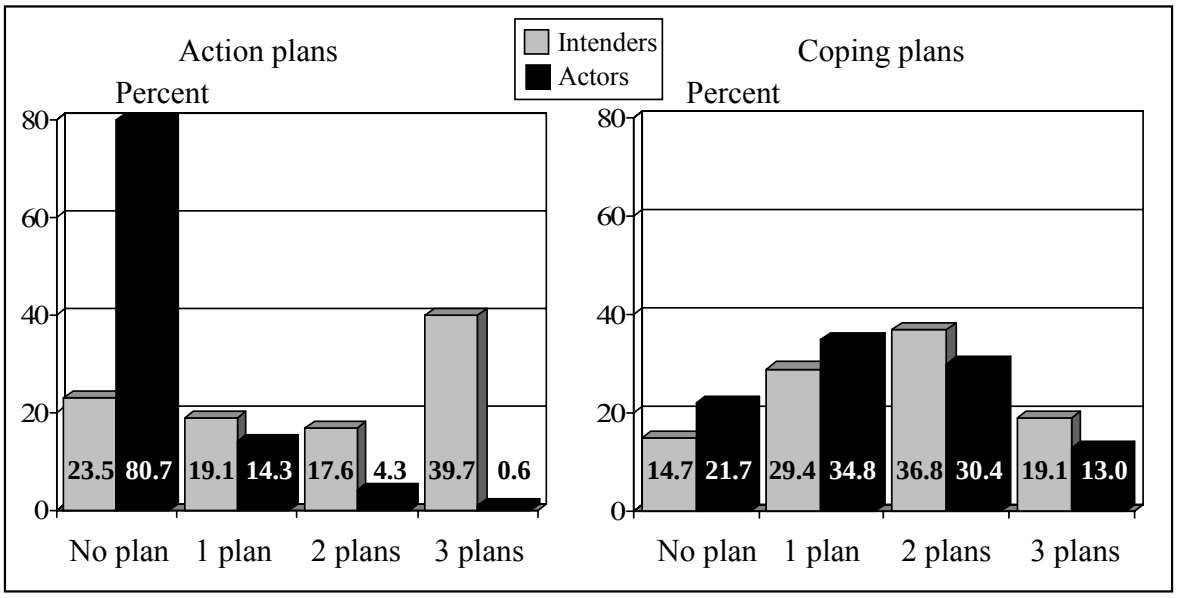

Figure 2. Distribution of the number of generated action plans and coping plans for baseline stage groups

Note. Percent = percent of all intenders, respectively actors in the intervention group.

The relation between the number of action plans and changes in activity suggested a non-linear pattern. Therefore, regression-based curve estimation was conducted with changes in physical activity as dependent variable an d number of action plans as explanatory variable using linear, quadratic, and cubic models. Results demonstrated that all regression models significantly described the data ($p < .001$), and the cubic function explained variance in physical activity change over and above the linear and the quadratic model ($\Delta R^2 = .02$, $p < .05$; overall $R^2 = .09$, $p < .001$).

Coping plans. For coping plans, repeated-measures ANOVA yielded a significant time by plan interaction, $F(3, 225) = 3.14$, $p < .05$, $\text{eta}^2 = .04$, and a significant main effect of time, $F(1, 225) = 5.67$, $p < .05$, $\text{eta}^2 = .03$. Post-hoc pairwise comparisons with Bonferroni correction indicated differences in changes in physical activity between persons generating 0, respectively 1 and those generating 3 coping plans, $p < .05$ (see Figure 3). No indication for curvilinear effects of the number of coping plans on changes in physical activity was obtained. Verifying regression-based curve estimations indicated no superiority of quadratic or cubic models over a linear approach (overall $R^2 = .04$, $p < .01$).

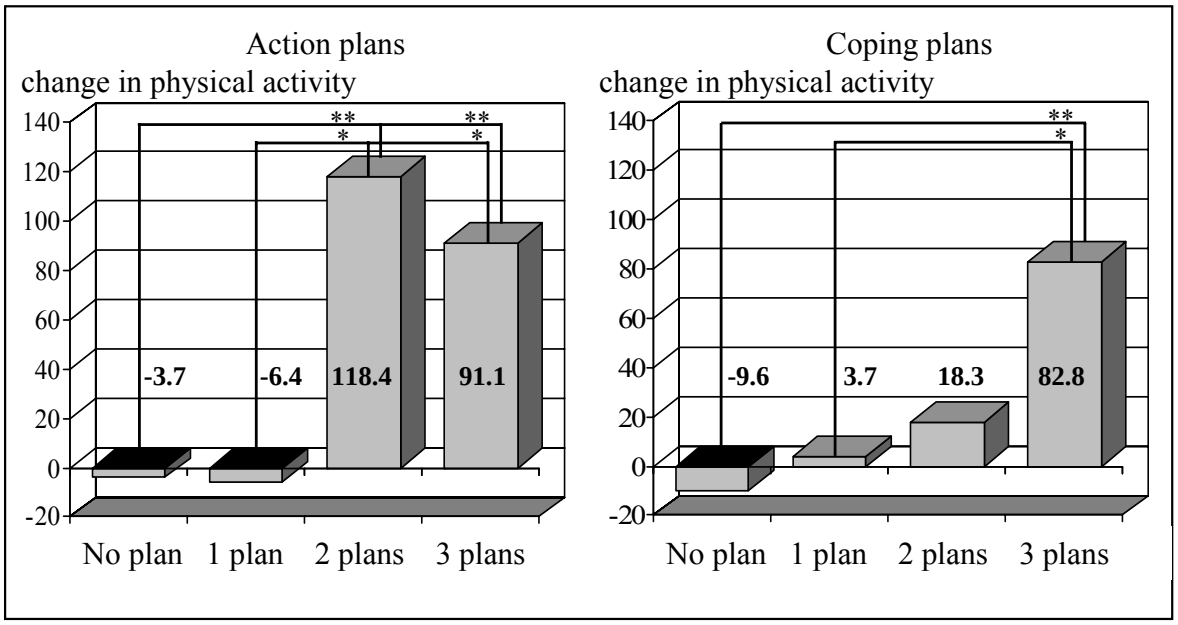

Figure 3. Effect of number of plans on change in physical activity in minutes/per week
Note. $^{**}p < .01$; $^{*}p < .05$. Change in physical activity refers to minutes/week.

Indirect effects of baseline stage

Number of plans as a mediator. The indirect effect of baseline stage via the number of generated plans on changes in physical activity was tested separately for action plans and coping plans by regression-based procedures.

Action plans. Regarding action plans, results demonstrated a significant indirect effect of β = -.17 of baseline stage on changes in physical activity, (Sobel $Z = 6.02$, $p < .01$; intenders coded '0', actors coded '1'). The number of action plans fully mediated the relation between baseline stage and behavior change: Baseline stage affected behavior change directly when the number of plans was not controlled for (β = -.16, $p < .05$), but this effect was not present when controlling for plans (β = .007, *ns*). Decomposed effects of the mediation model are displayed in Figure 4.

Coping plans. For coping plans, results yielded a non-significant indirect effect of baseline stage on changes in physical activity (β = -.02; $p = .16$; intenders coded '0', actors coded '1'), as effects of baseline stage on the number of coping plans were small and only marginal significant (β = -.12, $p = .07$). The direct effect of baseline stage on behavior

change (β = -.16, $p < .05$) remained significant when plans were controlled for (β = -.14, $p < .05$; see Figure 4).

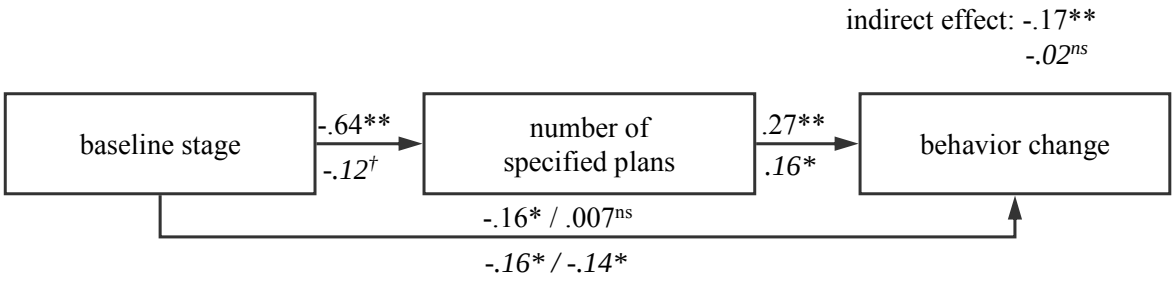

Figure 4. Indirect effects of baseline stage on change in physical activity via the number of generated plans. Number in italics refer to coping plans.

Note. **$p < .01$; *$p < .05$; † $p < .10$; ns = non-significant

Discussion

This study aimed at gaining insight into the inconsistent findings on effects of planning interventions by testing direct and indirect relations between baseline sample characteristics (stage of behavior change), the number of self-generated plans, and changes in physical activity.

In line with the idea of stage by treatment interactions, participation in the planning intervention increased physical activity in the overall sample, but the obtained effect sizes were small. Comparing intervention effects between baseline stage groups, larger effect sizes were found in intenders as compared to actors, as well as compared to the overall sample. This baseline stage by treatment interaction indicates that generating action plans and coping plans has a more profound impact on less active people. The results are in line with the approach of tailored interventions based on stage theories and support previous findings (Lippke et al., 2004; Schwarzer, 2008): Planning interventions are more effective if they are delivered to people where this specific intervention content matches their stage-specific needs. However, the stage by treatment interaction analysis disproves negative effects: neither occurred a decrease of physical activity nor a higher study dropout in the already active group despite mismatched intervention components (action plans for

behavior initiation). This absence of harmful effects on actors makes planning interventions also eligible for a 'one-size-fits-all'-application in contexts where a matching of interventions might not be possible.

A process of 'self-tailoring' (Skår et al., 2008) might partly explain the absence of a negative impact: Actors refused to make use of action plans (81% generated no single action plan), but engaged in the specification of coping plans (78% generated at least one coping plan). In contrast, 76% percent of the intenders generated at least one action plan, and 85% generated at least one coping plan. Thus, intenders and actors participating in the planning intervention seemed to respond to their respective relevant intervention contents only. Other studies presenting the proportions of people that refused to generate action plans and/or coping plans reported similar numbers (Michie et al., 2004; Rutter et al., 2006; Skår et al., 2008). In the present study, the wording of the action planning intervention was adjusted to the particular demands of the two stages. This has the advantage of offering the same content to each of the two stage groups in an optimal format. In a previous study, the wording had been exactly the same for intenders and actors, which yielded results that were in line with the present findings: About 60% of the actors, but only 20% of the intenders did not specify any action plan. This confirms that the stage-specific wording in the present study does not confound the results (Richert, Lippke, & Ziegelmann, 2008a). To date, too few studies have explored the predictors of plan generation to draw final conclusions, but health behavior theories may advise of additional promising candidates, such as intentions and attitudes (Skår et al., 2008).

The present findings also extend the conceptual framework of planning treatments by pointing to the importance of the quantity of plans in the intervention: In general, the more plans participants elaborated, the more likely they were to successfully change their behavior. This finding is consistent with the notion that a rich repertoire of (a) good opportunities to enact specific types of activities and (b) strategies to overcome action barriers facilitates the uptake and maintenance of a physically active lifestyle. However, while a positive linear relation between the number of coping plans and changes in

physical activity was found, higher intervention effects were associated with two rather than three action plans (increase of 118.2 minutes, respectively 91.1 minutes).

Accordingly, a curvilinear (cubic) model for action plans explained additional variance in behavior change over and above a linear model. This suggests the existence of thresholds, i.e., above a certain number of action plans, the magnitude of intervention effects may decrease. Thus, successful behavior change would partly be determined on whether an individual's number of plans is above, below or at a critical threshold. Little research to date has considered the consequences of forming multiple action plans or coping plans. The only study published to our knowledge (Elliott & Armitage, 2006), found a greater number of action plans to be related to higher compliance rates with speed limits, but non-linear effects were disregarded at the theoretical and empirical level.

However, less functional effects of a higher multitude of plans may indicate 'dilution effects' of unique plans (Webb, 2006), because (a) the cognitive load in the planning process may add up with every additional plan, presumably resulting in a diminished encoding process; (b) vigilance for respective situations may be reduced as it has to be shared between several plans, possibly leading to a reduced detection of situations to act, and (c) individual cue-response links may be diminished due to the existence of multiple if-then associations, resulting in a less automatic execution of the planned response (Gollwitzer, 2006; Webb, 2006). Given that forming action plans not fully automates behavior enactment, residual cognitive demands might sum up with each additional plan, and the execution of behavior may fail due to the persons' limited self-regulatory capacity (Baumeister et al., 1998). In sum, generating too many action plans may lead to less effective interventions due to a depletion of cognitive resources. More research needs to test these assumptions.

A main finding of this study is that the number of action plans mediates the influence of baseline stage on changes in physical activity, because it sheds light on the underlying mechanism of the baseline stage by treatment interaction: Intenders as compared to actors are more likely to generate action plans, which are the action-inducing ingredient of the planning intervention. These plans, in turn, are facilitators of behavior

initiation. This indirect effect was not replicated for coping plans: Although the number of coping plans influenced changes in physical activity ($\beta = .16$, $p < .05$), the effect of baseline stage on the number of coping plans was only marginal significant ($\beta = -.12$, $p = .07$), thus chances that the number of coping plans functions as mediator were small on a statistical level.

Replication by studies with larger sample sizes is needed to allow a generalization of the present findings. Further studies might also use objective measures of physical activity, but evidence supports the validity of self-reports and stage algorithms for physical activity (e.g. Miller, Freedson, & Kline, 1994; Lippke et al., in press). Additionally, causality was tentatively derived from correlational analyses of post-hoc ratings of participants' self-generated plans and changes in activity. These interpretations are based on time and theory, but future research might experimentally vary the number of plans. Moreover, action plans and coping plans were analyzed as independent predictors of activity change, although interactions may be plausible as well.

Implications for both theory refinement and the identification of potential points of intervention may cautiously be derived from our findings. The effects of planning in the overall sample were small, but interventions based on planning may still have an important population impact in online-based (i.e., cost- and time-efficient) large-scale interventions. Additionally, the intervention effects were tested against an active control intervention (e.g., including personalized risk feedback), providing evidence that the specification of action plans and coping plans may be of more practical relevance than standard care (i.e., risk communication and general advice). The absence of negative effects in already active persons underlines the usefulness of planning techniques in 'one-size-fits-all'-approaches. Optimally, however, planning interventions would target intenders, and ask them to generate an optimal number of action plans and coping plans. Research on optimal numbers of plans would be a fruitful undertaking from both a theoretical and a practical perspective. First, thresholds for optimal numbers of plans need to be determined by experimentally manipulating the number of plans. Secondly, as non-completion or a low quality of an optimal quantity of plans would endanger intervention success, approaches to

minimize non-adherence to intervention procedures need to be explored, e.g., by enhancing participants' intervention engagement (Richert, Lippke, & Ziegelmann, 2008b). Additional baseline variables such as intentions might influence whether people engage in planning, and whether these plans would support a healthy lifestyle (Reuter et al., 2008). If testing such relations, possible curvilinearity should be taken into account as linear models applied to curvilinear relationships might underestimate the associations.

To conclude, these findings add to the growing support for the efficacy of planning as a means of promoting intended behavior change, and are particularly encouraging as those in need specified the most plans and accordingly changed their behavior, while no harmful effects were found in already active people. Regarding optimal numbers of generated plans, our study may help to refine how planning interventions can be improved to get more effective results.

References

Baumeister, R.F., Bratslavsky, E., Muraven, M., & Tice, D.M. (1998). Ego depletion: Is the active self a limited resource? *Journal of Personality and Social Psychology, 74*, 1252-1265.

Brandstätter, V., Lengfelder, A., & Gollwitzer, P. M. (2001). Implementation intentions and efficient action initiation. *Journal of Personality and Social Psychology*, *81*, 946-960.

Elliott, M. A., & Armitage, C. J. (2006). Effects of implementation intentions on the self-reported frequency of drivers' compliance with speed limits. *Journal of Experimental Psychology: Applied, 12*, 108-117.

Enders, C. K. (2001). A primer on maximum likelihood algorithms available for use with missing data.*Structural Equation Modeling, 8*, 128-141.

Godin, G., & Shephard, R. J. (1985). A simple method to assess exercise behavior in the community. *Canadian Journal of Applied Sport Sciences, 10*, 141-146.

Gold, M. S., & Bentler, P. M. (2000). Treatments of missing data: A Monte Carlo comparison of RBHDI, iterative stochastic regression imputation, and expectation-maximization. *Structural Equation Modeling, 7,* 319-355.

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

Gollwitzer, P. M. (2006). Open questions in implementation intention research. *Social Psychological Review*, *8*, 14-18.

Gollwitzer, P. M., & Sheeran, P. (2006). Implementation intentions and goal achievement: A meta-analysis of effects and processes. *Advances in Experimental Social Psychology*, *38*, 70-110.

Jackson, C., Lawton, R. J., Raynor, D. K., Knapp, P., Conner, M. T., Lowe, C. J., et al. (2006). Promoting adherence to antibiotics: A test of implementation intentions. *Patient Education and Counseling, 61*, 212-218.

Lippke, S., Ziegelmann, J. P., & Schwarzer, R. (2004). Initiation and maintenance of physical exercise: Stage-specific effects of a planning intervention. *Research in Sports Medicine, 12*, 221-240.

Lippke, S., Ziegelmann, J. P., Schwarzer, R., & Velicer, W. (in press). Validity of stage assessment in the adoption and maintenance of physical activity and fruit and vegetable consumption. *Health Psychology*.

Marlatt, G. A. (1996). Taxonomy of high-risk situations for alcohol relapse: Evolution and development of a cognitive-behavioral model. *Addiction, 91*, 37-50.

Michie, S., Dormandy, E., & Marteau, T. M. (2004). Increasing screening uptake amongst those intending to be screened: The use of action plans. *Patient Education and Counseling, 55*, 218-222.

Miller, D. J., Freedson, P.S., & Kline, G.M. (1994). Comparison of activity levels using the Caltrac accelerometer and five questionnaires. *Medicine and Science in Sports and Exercise, 26*, 376-382.

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,* 163-184.

Petty, R. E., & Cacioppo, J. T. (1986). *Communication and persuasion: Central and peripheral routes to attitude change.* New York: Springer.

Pillow, D. R., Sandler, I. N., Braver, S. L., Wolchik, S. A., & Gersten, J. C. (1991). Theory-based screening for prevention: Focusing on mediating processes in children of divorce. *American Journal of Community Psychology, 19*, 809-836.

Preacher, K. J., & Hayes, A. F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, Instruments, & Computers, 36*, 717-731.

Prochaska, J. O., DiClemente, C. C., Velicer, W. F., and Rossi, J. S. (1993). Standardized, individualized, interactive, and personalized self-help programs for smoking cessation. *Health Psychology, 12*, 399-405.

Reuter, T., Ziegelmann, J. P., Wiedemann, A. U., Lippke, S., Schüz, B., Geiser, C., & Schwarzer, R. (2008). Dynamics in Health Behavior Change: An Application of Latent True Change Modeling. *Manuscript submitted for publication*.

Richert, J. M., Lippke, S., & Ziegelmann, J. P. (2008a). *Unpublished data.* Freie Universität Berlin, Germany.

Richert, J. M., Lippke, S., & Ziegelmann, J. P. (2008b). Intervention-engagement and its role in the effectiveness of stage-matched interventions promoting physical exercise. *Manuscript under review*.

Rutter, D. R., Steadman, L., & Quine, L. (2006). An implementation intentions intervention to increase uptake of mammography. *Annals of Behavioral Medicine, 32*, 127-134.

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. 217-43). Washington, DC: Hemisphere.

Schwarzer, R. (2008). Modeling health behavior change: How to predict and modify the adoption and maintenance of health behaviors. *Applied Psychology, 57*(1), 1-29.

Skår, S., Prestwich, A., Araújo-Soares, V., Molloy, G. J., Lawton, R., Conner, M., & Sniehotta, F. F. (2008). Do brief online planning interventions embedded in lifestyle surveys change health behaviour? Two randomised controlled trials. *Manuscript under review.*

Sniehotta, F. F., Scholz, U., & Schwarzer, R. (2006). Action plans and coping plans for physical exercise: A longitudinal intervention study in cardiac rehabilitation. *British Journal of Health Psychology, 11*, 23-37.

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,* 565-576.

Van Osch, L., Lechner, L., Reubsaet, A., Wigger, S., & de Vries, H. (2008). Relapse prevention in a national smoking cessation contest: Effects of coping planning. *British Journal of Health Psychology, 13*, 525-535.

Webb, T. L. (2006) Getting things done: Self-regulatory processes in goal pursuit. *Social Psychological Review, 8*, 2-13.

Webb, T. L., & Sheeran, P. (2006). Does changing behavioural intentions engender behavior change? A meta-analysis of the experimental evidence. *Psychological Bulletin, 132*, 249-268.

Webb, T. L., & Sheeran, P. (2007). How do implementation intentions promote goal attainment? A test of component processes. *Journal of Experimental Social Psychology, 43*, 295-302.

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

WHO (2006). Physical activity and health in Europe: Evidence for action, Retrieved September 30, 2008, http://www.euro.who.int/ Information Sources/Publications/Catalogue/ 20061115_2.

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

5

Prediction of Stage Transitions in Fruit and Vegetable Intake

Amelie U. Wiedemann[1], Sonia Lippke[1], Tabea Reuter[1],
Benjamin Schüz[2], Jochen P. Ziegelmann[1], & Ralf Schwarzer[1]

[1]Freie Universität Berlin,
[2] Deutsches Zentrum für Altersfragen (German Centre of Gerontology)

Wiedemann, A. U., Lippke, S., Reuter, T., Schüz, B., Ziegelmann, J. P., & Schwarzer, R. (in press). Prediction of stage transitions in fruit and vegetable intake. *Health Education Research.* Advance online publication. Retrieved December 15, 2008. doi: 10.1093/her/cyn061.

Abstract

Stage theories propose that individuals pass through different stages on their way toward behavior change. The present study examines stage-specific prediction patterns of social-cognitive variables (risk perception, outcome expectancies, perceived self-efficacy, action planning and social support) regarding transitions between the three stages of the Health Action Process Approach (HAPA; preintention, intention and action stage). In an online study (n = 494) on fruit and vegetable intake, social-cognitive variables and stages were assessed at baseline and stage transitions 4 weeks later. Transitions between the preintention, intention and action stage were predicted by social-cognitive variables using binary and multinomial logistic regression analyses. Stage-specific prediction patterns emerged for stage progression and stage regression. Outcome expectancies predicted progression from the preintention stage, whereas social support predicted progression to the action stage. Low levels of planning were associated with relapse to the preintention and the intention stage. Self-efficacy emerged as a universal predictor of stage transitions. Findings support not only the usefulness of the stage construct for describing health behavior change but also the validity of the HAPA variables as predictors of stage transitions. Stage-matched interventions targeting the variables identified as stage-specific predictors might support stage progression toward the goal behavior.

Keywords: stages of change, stage transition, fruit and vegetable intake, planning, social support, self-efficacy

Introduction

Stage theories of health behavior change posit that people pass through several mindsets (stages) with certain cognitive and behavioral characteristics on their course of health behavior change [1]. This study aims at identifying stage-specific predictors of transitions between stages of health behavior change in fruit and vegetable intake. In particular, this study has the purpose to extend prior research by examining the role of volitional variables, namely planning and social support, in the adoption and maintenance of health behavior. The three-stage Health Action Process Approach (HAPA) [2, 3] serves as a theoretical background of this longitudinal study with two measurement points in time, 4 weeks apart.

Stage models of behavior change

Continuum theories, such as the Theory of Planned Behavior [4] posit that the same parsimonious set of social-cognitive factors induces movement along a continuum of action likelihood in all persons. Accordingly, interventions based on continuum models would try to increase levels of all change inducing factors by 'one-size-fits-all' treatments. In contrast, stage theories, such as the Transtheoretical Model (TTM) [5], construe behavior change as a transition through an ordered series of discrete stages. Thus, persons at different stages are characterized by different mind-sets, delineated by differences in terms of their cognitions, perceived barriers and action tendencies [1, 5]. The process of actual behavior change is reflected by a person's forward and backward transitions (progression and regression) between the stages: individuals may progress toward a behavioral goal, for example by initiating behavior change, but they might also face backdrops or lapses, for example by failing to maintain a regular regimen of health behaviors. The idea of stages implies that for each stage, specific factors are responsible for remaining in this stage, progressing to the next one or regressing to the previous one.

Interventions based on stage theories, therefore, can be matched to a person's stage by targeting stage-specific needs. If such stage-matched interventions turn out to be more effective than untailored ones, then the stage construct will have proven useful. According

to a meta-analysis by Noar et al. [6], interventions matched to the stages of change proposed by the TTM [5] yielded better results than unmatched ones, but these additional effects were rather small (Fisher's $r+ = 0.09$, sample size-weighted mean effect size for the comparison between interventions tailored to TTM stages of change or not). However, the effectiveness of interventions, whether stage-matched or not, largely depends on the factors being targeted [6, 7]. Therefore, it is essential to identify which variables are facilitators of stage transitions.

Predictors of stage transitions

Crucial for understanding the mechanisms of behavior change is the specification of the critical factors that move people from one stage to another. According to stage models, the change-inducing social-cognitive variables that generate transitions from Stage A to Stage B differ from those that move people from Stage B to Stage C [1, 8].

Empirical support for such stage-specific determinants of transitions is still rare and mostly inconsistent [9-12], and there is little theoretical and empirical work available to suggest whether the factors predicting transitions to the adjacent (i.e. the subsequent) stage differ from those predicting transitions to more distal stages. Accordingly, a Delphi study exploring subjective theories of experts on the determinants of stage transitions yielded little consensus in terms of stage-specific predictors, especially with regard to the earlier stages of behavior change [9]. Additionally, further research on predictors of the key shift from inactive to active stages is required, since prior studies often faced difficulties to identify them [12]. The HAPA [3] proposes such predictors of transitions between the stages.

The Health Action Process Approach

The Health Process Action Approach [3] specifies stages and specific predictors for transitions between these stages. It suggests a three-stage distinction between (i) a preintention stage, including persons who have not (yet) set a goal to act (preintenders), (ii) an intention stage, comprising persons with the goal to change their behavior, but who are

not yet acting (intenders) and (iii) an action stage, including those persons who already perform the behavior in question (actors). The HAPA specifies the following stage-specific sets of predictors.

Stage progressions

Progression from the preintention stage to the intention stage: setting a goal

Determinants of goal setting are the subjective risk to recognize a serious health condition (risk perception), the perceived consequences of health actions (outcome expectancies) and the perceived ability to perform a behavior (self-efficacy) [3]. There is convincing evidence for the prominent role of these factors for individual goal setting [3, 13].

Progression from the intention stage to the action stage: initiating the behavior

The specification of predictors of transitions from the intention stage to the action stage is particularly important, as it marks the crucial shift from cognition to action. Proximal factors that might explain the initiation of health behavior are self-efficacy, planning and external facilitators such as social support [2, 3]. Planning facilitates action initiation by specifying 'when', 'where' and 'how' to perform the goal behavior [14-16]. The few published studies examining planning as a predictor of stage transitions provide inconsistent results [11, 17], but the effectiveness of planning to promote behavior particularly among intenders has been underlined by experimental studies [18]. Social support has rarely been examined as a predictor of stage progression, too. However, some promising results suggest including this resource factor. For example, in a study on physical activity by Courneya et al. [19], higher levels of social support were predictive of progression out of a preaction stage, whereas lower levels of social support were predictive of regression out of action stages. The role of self-efficacy as a prerequisite for action has been consistently confirmed [10, 20].

Stage regressions

As outlined above, high scores on the specified social-cognitive factors are assumed to facilitate stage progression to definite stages. Conversely, low scores on these

facilitators of progression are supposed to make regression out of this stage more likely. For example, individuals who cease to believe that they are susceptible to a specific disease (e.g. by getting a vaccination or taking specific medication) and accordingly lower their risk perceptions [21], are assumingly more likely to reduce their intentions to change their behavior and thus to regress from the intention stage to the preintention stage. Self-efficacy, for example, predicts progression into as well as regression out of the intention and the action stage, with high self-efficacious persons being more likely to progress and persons with low levels of self-efficacy being more likely to regress [11, 19, 20, 22-24]. As self-efficacy predicts transitions between more than two stages and in both directions (progression and regression), it is proposed to be a universal facilitator of transitions, regardless of baseline stage, whereas the other social-cognitive variables are seen as stage-specific predictors of transitions [25].

Aims and Hypotheses

One of the key protective factors against premature morbidity and mortality is a balanced diet [26]. The present study focuses on fruit and vegetable intake, which is associated with lower fat and higher fiber intake, an improved antioxidant status, and thus, a lower risk for ill health such as cardiovascular disease [27]. Despite these beneficial effects, the majority of people do not meet the recommendations of a minimum intake of 400 g (five servings) of fruit and vegetable per day [27]. Theory-based interventions to improve this aspect of dietary behavior are needed because the establishment of a theoretical basis is a precondition for successful intervention development. Therefore, this study aims at examining stage-specific predictors of stage transitions in the domain of fruit and vegetable intake. The following hypotheses were derived from the HAPA:

(i) High levels of self-efficacy, outcome expectancies and risk perception predict progression from the preintention stage to a further stage.

(ii) High levels of self-efficacy, planning and social support predict progression from the intention stage to the action stage.

(iii) Low levels of self-efficacy, risk perception and outcome expectancies predict regression from the intention stage to the preintention stage.

(iv) Low levels of self-efficacy, planning and social support predict regression from the action stage to an earlier stage.

Methods

Participants and Procedure

An online panel study was conducted because online studies have the potential to reach large samples of persons with diverse socioeconomic status and age and from different geographic regions. The present online study on fruit and vegetable intake was advertised by press releases (magazine reports and university press), announcements on university Web sites and mailing lists. The online procedure was generated with the software dynQuest [28]. In accordance with previous studies on stage transitions [11], the follow-up measures at Time 2 (T2) were taken 4 weeks after baseline (Time 1; T1). Persons with medical conditions that conflict with eating five portions of fruit and vegetable were not eligible to participate. The initial sample comprised the persons who completed the T1 assessments; those answering the follow-up questionnaire constituted the longitudinal sample (n = 494; 44.8% of baseline). The longitudinal sample comprised 77.5% women and had a mean age of 37.3 years, SD = 12.70, range = 18-72 years. About 53.2% of this sample were unmarried and 79.6% were senior high school graduates.

Fruit and vegetable intake averaged 3.21 servings per day, SD = 1.64, with 80.4% of the participants not meeting the World Health Organization recommendations for fruit and vegetable intake [27]. The body mass index (BMI) averaged 24.62, SD = 4.72, range = 16.98-36.66.

Dropout analysis

A MANOVA dropout analysis yielded no significant baseline differences between the longitudinal sample and those who dropped out after T1 regarding age, fruit and

vegetable intake, BMI (see Table 1), marital status, employment status, social-cognitive variables (self-efficacy, outcome expectancies, risk perception, planning and social support) and baseline stage, indicating the representativeness of the longitudinal sample for the T1 sample on these variables. However, less women, χ^2 (1) = 6.23, $p < .05$, and less study participants with a senior high school degree or higher education, χ^2 (1) = 12.04, $p < .01$, dropped out. Missing data on all social-cognitive variables (< 5% on all variables) were imputed using the expectation maximization algorithm in SPSS [29].

Representativeness check

As an estimate of the external validity of the present findings, the longitudinal sample was compared with the average German online population [30, 31] and the German general population [32-34] on recent sociodemographic and behavioral data (Table 1). People with a higher education and women were overrepresented in the present study. This might be due to the study's advertisement on a university Web site and a higher interest of women in topics concerning nutrition [35]. However, the present sample was representative for the German population regarding age, fruit and vegetable intake and BMI.

Table 1. Results of dropout-analyses and representativeness check

Variable	Dropouts	Longitudinal sample	Online population	General population
Gender: female (%)	70.9*	77.5	44.6[30]	51.1[32]
Age in years (*M*)	37.9	37.3	39.8[31]	42.33[32]
Education: senior high school degree (%)	70.9*	79.6	28.9[30]	21.6[32]
Fruit and vegetable intake (% not meeting the guidelines)	83.5	80.4	-	~80.0[33]
Body mass index	24.8	24.6	-	24.8[34]

Note. *$p < .05$. All data refer to Germany. Dashes symbolize non-available data.

Measures

Predictors were measured at T1, and stage was assessed at both T1 and T2. Unless otherwise stated, items had four-point Likert scales, ranging from *completely disagree* (1) to *completely agree* (4). Measures had been validated in previous studies [11, 18, 25, 36, 37]. Item examples were translated from German.

The *self-efficacy* scale comprised three items, such as 'I am confident that I can eat five servings of fruit and vegetables a day' (Cronbach's α = .94). *Outcome expectancies* were measured by two positively framed items, such as Eating five servings of fruit and vegetables a day would be good for my health' (Cronbach's α = .72). *Risk perception* was assessed by asking 'How likely is it that you will ever get a severe disease (e.g. diabetes, cardiovascular disease)?' on a five-point Likert scale ranging from *very unlikely* (1) to *very likely* (5).

Planning was measured with two items, such as 'I have already precisely planned when, where, and how to eat five servings of fruit or vegetables throughout the day' (Cronbach's α = .88). *Social support* was assessed by two items, for example, 'My relatives help me to lead a healthy lifestyle' (Cronbach's α = .70).

Stage was assessed with a validated algorithm for the stages of the HAPA, 'Do you eat five servings of fruit and vegetables on an average day?' The response format allowed a mutually exclusive answer on one of five statements, with 'No, and I do not intend to do so' and 'No, but I am thinking about it' representing the preintention stage, 'No, but I strongly intend to do so' representing the intention stage and 'Yes, but it is difficult for me' and 'Yes, and it is easy for me' representing the action stage. 'Stage transitions' were calculated by subtracting T1 stage from T2 stage.

Fruit and vegetable intake was measured using an open-ended item: 'How many servings of fruit and vegetable do you eat on an average day?' The item followed the definition of 'one serving', i.e. 'one handful of fruit (e.g. grapes) and vegetable (e.g. lettuce)'.

Analytical procedure

To analyze whether the number of forward and backward transitions varied as a function of baseline stage and whether social-cognitive variables allowed a better classification into persons with different transition patterns than could be expected by chance, χ^2 tests were conducted.

The prediction of stage transitions was examined by use of multiple binary logistic regression (BLR) and multiple multinomial logistic regression (MLR) analyses separately for the different baseline stages (BLR: T1 preintender, T1 actor; MLR: T1 intender). BLR analyses were conducted to predict progression out of the T1 preintention stage and regression out of the T1 action stage with stage transition as dependent variable and T1 social-cognitive variables as independent variables. The dichotomous stage transition variables were coded as follows: for individuals in the preintention stage at T1, '0'indicated remaining in the preintention stage and '1' indicated progression. For actors, regression was coded '0' and '1' indicated remaining in the action stage. MLR was conducted simultaneously for all three possible stage transitions out of the intention stage: thus, the dependent variable (stage transition) was trichotomous, with remaining in the intention stage (reference group) coded '0', progression coded '1' and regression coded '-1'.

Odds ratios (ORs) with a 95% confidence interval are reported as effect size estimates and the Wald statistic as indicator of the significance of each regression coefficient in BLR and MLR. The rate of correct classifications into the respective groups of people progressing, regressing or those remaining in the same stage is used as an indicator of the accuracy of the prediction model. All analyses were conducted using SPSS 15.0.

Results

Preliminary results

T1 stage distribution and stage transitions are displayed in Table 2. Across all possible transitions, the majority remained in the same stage (61.1%), and more

participants progressed (27.9%) than regressed (10.9%). It was tested whether the number of forward and backward transitions varied as function of baseline stage. More preintenders than intenders progressed, χ^2 (1) = 4.16, $p < .05$. Intenders and actors did not differ in the number of regressions, χ^2 (1) = 2.13, non-significant (*ns*).

Stage groups differed significantly regarding their fruit and vegetable intake [F(2, 491) = 206.65, $p < .001$]: preintenders had an average intake of 2.2 servings (SD = 1.0) and intenders consumed 3.1 servings (SD = 1.1) per day. Actors showed the highest intake on average and almost met the recommendations of five servings per day (Mean = 4.9, SD = 1.5). Preintenders progressing to further stages showed an increase in their average fruit and vegetable intake (T1 Mean = 2.5, T2 Mean = 3.4). Intenders progressing to action increased their fruit and vegetable consumption as well and almost met the recommended levels at follow-up (T1 Mean = 3.4, T2 Mean = 4.9). Intenders regressing to preintention did not change their fruit and vegetable intake (T1 Mean = 2.7, T2 Mean = 2.7), indicating that the backward transition occurred on a cognitive but not on a behavioral level. Actors regressing to earlier stages did not meet the criterion of five servings of fruit and vegetable intake at baseline and showed an additional decrease in their fruit and vegetable intake at follow-up (T1 Mean = 4.0, T2 Mean = 3.3). In sum, transitions to and from action were corresponding with behavioral changes (i.e. increase or decrease in fruit and vegetable intake), while this held not true for transition from the rather cognitively defined regression from the intention stage to the preintention stage.

Table 2. Intercorrelations between T1 social-cognitive variables

	Self-efficacy	Risk perception	Planning	Social support
Outcome expectancies	.52**	-.02	.39**	.04
Self-efficacy	1	-.09*	.53**	.15**
Risk perception		1	-.003	-.08
Planning			1	.12**

Note. $^{**}p < .01$, $^{*}p < .05$.

At follow-up, significant differences in fruit and vegetable intake between people in the three HAPA stages were identified [$F(2, 491) = 332.71$, $p < .001$] and intake paralleled the average number of servings obtained at T1 (preintenders, Mean = 2.4, 41, SD = 1.1; intenders, Mean = 3.3, SD = 1.0; actors, Mean = 5.0, SD = 1.5). Actors were meeting the recommendations for daily fruit and vegetable intake at T2. Correlations of social-cognitive variables are displayed in Table 2. None of the correlations exceeds $r = .80$, thus multicollinearity should not occur [38].

Table 3. HAPA stage distributions and transitions of the longitudinal sample (N=494)

		Time 2 (4 weeks after time 1)			
		Preintention stage	Intention stage	Action stage	Total
Time 1	Preintention stage	145 (29.4)	56 (11.3)	34 (6.9)	235 (47.6)
	Intention stage	22 (4.4)	47 (9.5)	48 (9.7)	117 (23.7)
	Action stage	11 (2.2)	21 (4.3)	110 (22.3)	142 (28.7)
	Total	178 (36.0)	124 (25.1)	192 (38.9)	494 (100)

Note. Numbers in parentheses represent percent of $N = 494$.

Predictors of stage transitions

Uneven distribution patterns of participants across the stages and uneven transition patterns between the stages resulted in small cell sizes which would have led to underpowered analyses when fully decomposing transitions by T1 and T2 HAPA stage (cf. Table 3). Thus, progression out of the preintention stage includes progression to both the intention stage and the action stage, and regression out of the action stage includes regression to both the intention stage and the preintention stage.

Table 4. Summary of results from logistic regression analyses, and descriptive data for social-cognitive variables predicting stage transitions in fruit and vegetable intake

Predictors	Wald	OR	95% CI_{OR}	Remaining in baseline stage		Transition	
				M	*SD*	*M*	*SD*
Preintention stage: remaining (0) vs. progression (1)							
Outcome expectancies	7.44**	1.91	1.20-3.03	2.94	0.77	3.34	0.62
Self-efficacy	4.66*	1.56	1.04-2.33	2.00	0.76	2.40	0.74
Risk perception	0.49	0.89	0.64-1.23	2.86	0.93	2.81	0.85
Planning	3.43	1.69	0.97-2.95	1.25	0.44	1.47	0.61
Social support	2.24	1.33	0.91-1.93	2.11	0.73	2.24	0.82
Intention stage: remaining (0) vs. progression (1)							
Outcome expectancies	0.47	1.47	0.47-4.49	3.67	0.38	3.74	0.40
Self-efficacy	0.85	1.44	0.66-3.14	2.99	0.51	3.16	0.62
Risk perception	0.47	1.18	0.75-1.87	2.89	0.94	2.94	0.95
Planning	0.35	1.20	0.65-2.20	2.03	0.64	2.10	0.75
Social support	4.21*	2.02	1.03-3.94	2.23	0.67	2.52	0.66
Intention stage: regression (0) vs. remaining (1)							
Outcome expectancies	0.75	1.77	0.48-6.49	3.67	0.38	3.48	0.50
Self-efficacy	10.07**	7.01	2.11- 23.11	2.99	0.51	2.35	0.47
Risk perception	0.75	1.33	0.69-2.59	2.89	0.94	2.78	0.77
Planning	0.53	1.47	0.52-4.17	2.03	0.64	1.80	0.63
Social support	0.59	1.43	0.57-3.56	2.23	0.67	2.00	0.69
Action stage: regression (0) vs. remaining (1)							
Outcome expectancies	0.03	1.03	0.34-3.08	3.75	0.38	3.64	0.44
Self-efficacy	8.23**	3.41	1.48-7.90	3.75	0.41	3.35	0.71
Risk perception	0.21	0.89	0.54-1.46	2.62	0.85	2.72	1.05
Planning	4.04*	1.64	1.01-2.67	2.63	1.02	2.06	0.89
Social support	0.60	0.80	0.46-1.40	2.40	0.82	2.36	0.74

Note. $^{**}p < .01$, $^{*}p < .05$; OR = odds ratio; CI_{OR} = 95% confidence interval of OR.

Preintention Stage: Progression

The rate of correct classifications of participants into those remaining in the preintention stage versus those progressing using social-cognitive predictors was 68.1%, which was higher than could be expected by chance (50%), χ^2 (1) = 64.14, $p < .01$.

The results of BLR analyses indicated that self-efficacy and outcome expectancies were significant predictors of stage transition in fruit and vegetable intake. Risk perception was not predictive of stage progression. Odds ratios, Wald statistics, and descriptive data are summarized in Table 4.

Intention stage: Progression and Regression

The correct classification rate by social-cognitive variables was 58.1%, which is significantly higher than expected by chance (33.3%), χ^2 (1) = 135.45, $p < .01$.

MLR was conducted for all three possible stage transitions (remaining in the intention stage, progression and regression) simultaneously. For the ease of interpretation, the results of MLR analyses in the text and Table 4 are reported as comparisons between (i) persons remaining in the intention stage and those progressing, respectively, (ii) persons remaining in the intention stage and those regressing (with ORs reported as if regression was coded '0' and remaining in the intention stage coded '1': that is, the more ORs exceed '1', the more likely it is to remain in the intention stage compared with regression due to the influence of the respective variable; Table 4).

Stage progression out of the intention stage was significantly predicted by social support. Neither planning nor self-efficacy predicted forward stage transition out of the intention stage. Results indicated that self-efficacy was predictive of remaining in the intention stage (vs. regression). Neither risk perception nor outcome expectancies were predictive of backward stage transition out of the intention stage.

Action stage: Regression

The correct classification rate by social-cognitive variables was 76.8%, which is significantly higher than classification by chance (50%), $\chi^2(1) = 141.08$, $p < .01$. The

results of BLR analyses indicated that self-efficacy and planning predicted remaining in the action stage. Social support was not predictive for backward stage transitions. Figure 1 summarizes the discontinuous prediction pattern of social-cognitive variables for fruit and vegetable intake.

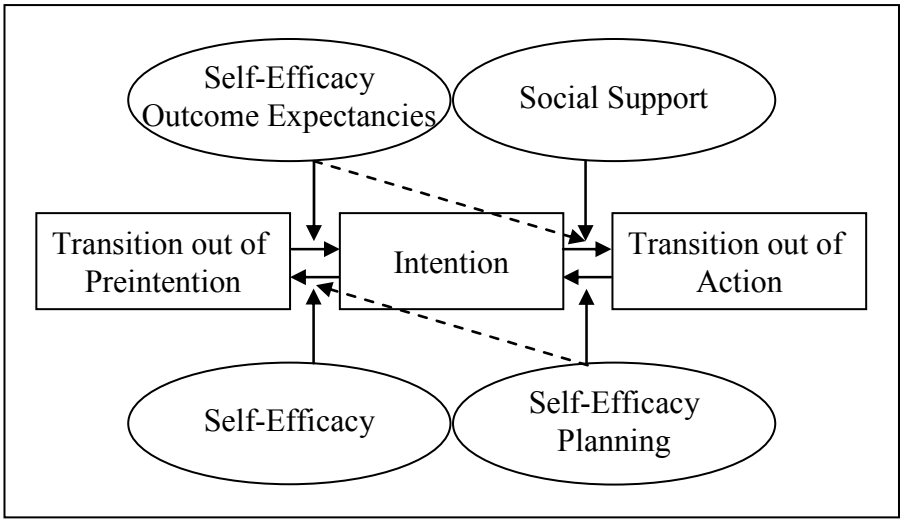

Figure 1. Summary of results of logistic regression analyses: Three stages of the Health Action Process Approach with stage-specific predictors

Note. Upper circles contain predictors of stage progression; lower circles contain predictors of stage regression. Dotted arrows indicate predictors of two-stage transitions**.**

Discussion

The aim of our study was to identify stage-specific predictors of transitions between the three stages of the HAPA. To our knowledge, this set of social-cognitive variables, including the volitional variables planning and social support, was tested as predictor of stage transitions for the first time. The results suggest stage-specific prediction patterns for stage transitions and thus implications for stage-matched interventions to enhance fruit and vegetable intake.

In the present study, most participants remained in the same stage as at baseline. In all, 27.9% of the participants progressed and only 10.9% regressed (Table 3). While the proportion of people progressing appears to be high, non-experimental studies with a similar time frame show similar proportions of stage transitions. For example, a study on fruit (F) and vegetable (V) intake found 21% (F) and 17% (V) of the participants

progressing, 22% (F) and 19% (V) regressing, and 57% (F) and 64% (V) remaining in the same stage [39]. Participants of the present study were self-selected to be in a study on health behavior and, thus, probably more inclined to make positive changes, reflecting a higher 'readiness to change'. The higher percentage of progressions than regressions might also depend on the baseline stage distribution: a larger number of individuals resided in the preintention stage (47.6%) as compared with the action stage (28.7%), which allowed more of them to progress than to regress.

The transitions in this study included movement to adjacent stages and two-stage transitions. Latter ones are transitions through the intention stage: thus, by definition people in this stage intend to change. As fruit and vegetable intake not necessarily requires a long time for preparation, residence in the intention stage may last for a few moments only and two-stage transitions are likely to occur in short time intervals. Accordingly, prior research found preintention stages and action stages to be more stable over time than preparation (intention) stages [39].

Some of the social-cognitive variables derived from the HAPA do not operate equivalently across all stage transitions. This is in line with the assumption of different stages of behavior change. Some variables predict transitions between the earlier stages of health behavior change, while others predict later transitions. In the following, the usefulness of specific variables as predictors is discussed in more detail.

In line with theoretical assumptions [3], higher levels of planning predicted remaining in the action stage. The mediating factors for such effects on behavioral maintenance have been examined in laboratory studies: planning (i.e. forming implementation intentions) inhibits counterproductive behavioral responses by suppressing fatigue, tempting distractions and ego depletion [40]. However, in contrast to the assumptions, planning failed to predict progression out of the intention stage. Experimental research suggests stronger effects of planning in intenders. In a study by Lippke et al. [18], planning was experimentally manipulated in all stages and its effect was moderated by stage: the planning intervention facilitated the uptake of physical activity in intenders and, to a smaller extent, maintenance in actors, while preintenders did not benefit from the

intervention. In a study on low-fat diet, experimentally induced planning facilitated stage progression from all preaction TTM stages, including progression from preparation (i.e. HAPA intention stage) to action [17]. This suggests differences with regard to the operationalization of planning: While experimentally manipulated planning might promote progression to action, self-induced planning as measured in the present study might not be sufficient. Additionally, psychometrically measured planning has been found to be predictive of behavior change only if values of moderating variables such self-efficacy [41] or intentions [42] lay beyond certain thresholds.

The finding that social support predicted progress to the action stage corresponds with the assumption that social support promotes goal pursuit among intenders. It might be subject to future studies to examine whether the beneficial effects of social support are context specific or source specific (e.g. by relatives or friends). That is, social support might facilitate behavior initiation particularly in behavior domains such as fruit and vegetable intake that are frequently performed in environments where social support might be more easily available than in other contexts [9, 43].

Outcome expectancies were a significant predictor of transitions out of the preintentional stage. The failure of risk perception to predict stage transitions in preintenders was not in line with the theory, but might be due to the unspecific operationalization of risk perception: Strong conceptual links between specific risk perceptions and corresponding behaviors, such as refraining from eating red meat and the subjective risk perception for livestock-related diseases, yield stronger correlations and predictive values of risk perception [44] than conceptual links between unspecific risk perception items and measures of specific behaviors as used in the present study.

Self-efficacy predicted most stage transitions in fruit and vegetable intake. These results are in line with the theoretical assumptions and evidence outlined above: The confidence to overcome problems and obstacles due to one's own competency is a crucial factor for the initiation and maintenance of behavior changes [3, 23, 24]. Accordingly, self-efficacy can be considered a universal determinant rather than a stage-specific driver of change: The prediction pattern suggests interpretations in line with a continuum approach,

since self-efficacy predicted three out of four transitions. Such a consistent function of self-efficacy is in line with meta-analyses on cross-sectional TTM studies [45]. However, it has been recommended to differentiate phase-specific self-efficacy scales that differ in their wording, depending on the stage of the participants [24]. When self-efficacy is differentiated in terms of stages, it can be assumed that this modified construct would be capable of predicting transitions in a stage-specific manner. Additionally, different types of planning, such as action planning and coping planning [37] and negative outcome expectancies regarding healthy nutrition [46], warrant further examination.

Some limitations of the current study need to be addressed. First, the attrition rate was very high. This dropout, however, was in line with an average 40% response rate that was obtained in a meta-analysis on internet-based studies [47], in which participation is usually voluntary and without financial compensation. The longitudinal sample was representative of the baseline sample with regard to behavioral and social-cognitive variables, but overrepresented women and individuals with higher education. Thus, replication in other samples with a special emphasis on recruiting more men and individuals from lower socioeconomic backgrounds is needed to gauge the generalizability of the present findings. Second, two predictors (risk perception and social support) were assessed with behavior-unspecific items, which is suboptimal for the correspondence with the outcome. In addition, significant predictions provide no evidence for causal effects of the specified variables on stage transitions, but rather indicate that scores on these variables correlate longitudinally with changes in stage. These changes in stage may not only represent shifts in mind-sets or behavioral tendencies but may also be caused by measurement instability due to a low reliability and validity of the staging algorithms. However, evidence exists for the reliability and validity of staging algorithms such as the one used in our study [36].

Our study focused on dynamic variables, that is, variables that are open to change [8]. Thus, the stage-specific results may not only improve the understanding of the process of health behavior change but also suggest implications for theory-based interventions to promote health behavior change. Stage-matched interventions targeting the variables

significantly predicting transitions from a specific stage (as suggested by the stage-specific prediction pattern identified in this study) might support stage progression toward the goal behavior. For instance, intervention components might target social support in intenders rather than in preintenders due to its unique effect in the intention stage. Only if such stage-matched interventions would turn out to be more effective than unmatched interventions, then the stage construct would prove useful as a theoretical foundation for interventions and transitions between the three stages could be used as intermediate indicators of the effectiveness of such interventions.

The present findings on specific predictors of stage transitions need to be corroborated to make qualified assumptions on factors relevant for behavior change (i.e. stage transitions). Further research might, for example, compare effect sizes for progressions and regressions across studies on fruit and vegetable intake. The effect sizes in the present study ranged from 1.56 (self-efficacy; progression out of the preintention stage) to 7.01 (self-efficacy; regression out of the intention stage), raising questions about practically meaningful effect sizes. Some authors refer to ORs ~ 2 to be meaningful [20], but no clear interpretation guidelines exist for OR in logistic regression analyses. Before practical implications may be drawn, however, experimental tests are needed to support the different relative importance of the HAPA constructs. If these tests support the relevance of the hypothesized constructs, even small effect sizes may have a high population impact if interventions are delivered to high numbers of persons, e.g. via internet. In this line of reasoning, such studies might place more emphasis on practical significance (i.e. effect size) than on statistical significance (i.e., *p*-values). If the empirical support for the theoretical assumptions would generalize across different behaviors, a stronger evidence base would be accumulated than from single-behavior studies [48]. Furthermore, robust evidence for determinants of stage transitions can only be drawn from experimental studies with a matched/mismatched design, which provide the strongest evidence for the usefulness of stage-specific determinants of change [1]. Even stronger evidence could be provided by employing intervention designs with matched/mismatched intervention content and matched/mismatched intervention sequences.

To conclude, the results of our study lend support for the usefulness of the stage construct to describe health behavior change as stage-specific predictors of transitions. The stage-specific importance of variables such as planning and social support might inspire future research on stage-matched interventions for fruit and vegetable intake.

References

1. Weinstein ND, Rothman AJ, Sutton S. Stage theories of health behavior: Conceptual and methodological issues. *Health Psychol* 1998;17:290-299.
2. Schwarzer R. Self-efficacy in the adoption and maintenance of health behaviors: Theoretical approaches and a new model. In: Schwarzer R (ed.). *Self-Efficacy: Thought Control of Action*. Washington, DC: Hemisphere, 1992, 217-243.
3. Schwarzer R. Modeling health behavior change: how to predict and modify the adoption and maintenance of health behaviors. *Appl Psychol Int Rev* 2008;57(1):1-29.
4. Ajzen I. The Theory of Planned Behavior. *Organ Behav Hum Dec* 1991;50:179-211.
5. Prochaska JO, DiClemente CC, Norcross JC. In search of how people change: applications to addictive behaviors. *Am Psychol* 1992;47:1102-1114.
6. Noar SM, Benac C, Harris M. Does tailoring matter? Meta-analytic review of tailored print health behavior change interventions. *Psychol Bull* 2007;133:673-693.
7. De Vet E, De Nooijer J, De Vries NK *et al*. Comparing stage of change and behavioral intention to understand fruit intake. *Health Educ Res* 2007;22:599-608.
8. Velicer WF, Prochaska JO. Stage and non-stage theories of behavior and behavior change: a comment on Schwarzer. *Appl Psychol Int Rev* 2008;57:75-83.e
9. Vet E, Brug J, De Nooijer J *et al*. Determinants of forward stage transitions: a Delphi study. *Health Educ Res* 2005;20:195-205.
10. Dijkstra A, Tromp D, Conijn B. Stage-specific psychological determinants of stage transition. *Br J Health Psychol* 2003;8:423-437.
11. Schüz B, Sniehotta FF, Wiedemann AU *et al*. Predicting transitions from preintentional, intentional and actional stages. *Health Educ Res* January 31, 2008:10.1093/her/cym092.
12. Armitage CJ, Sheeran P, Conner M *et al*. Stages of change or changes of stage? Predicting transitions in transtheoretical model stages in relation to healthy food choice. *J Consult Clin Psychol* 2004;72:491-499.
13. Conner M, Norman P. Predicting health behaviour: a social cognition approach. In: Conner M, Norman P. (eds.). *Predicting Health Behaviour: Research and Practice With Social Cognition Models* (2 ed). Buckingham: Open University Press, 2005, 1-28.
14. Gollwitzer PM, Sheeran P. Implementation intentions and goal achievement: a meta-analysis of effects and processes. *Adv Exp Soc Psychol* 2006;38:69-119.
15. Ziegelmann JP, Lippke S, Schwarzer R. Adoption and maintenance of physical activity: planning interventions in young, middle-aged, and older adults. *Psychol Health* 2006;21:145-163.

16. Reuter T, Ziegelmann JP, Wiedemann AU *et al*. Dietary planning as a mediator of the intention-behavior relation: an experimental-causal-chain design. *Appl Psychol Int Rev* 2008;57(Suppl.):194-207.

17. Armitage CJ. Evidence that implementation intentions promote transitions between the stages of change. *J Consult Clin Psychol* 2006;74:141-151.

18. Lippke S, Ziegelmann JP, Schwarzer R. Initiation and maintenance of physical exercise: Stage-specific effects of a planning intervention. *Res Sports Med* 2004;12:221-240.

19. Courneya KS, Plotnikoff RC, Hotz SB *et al.* Predicting exercise stage transitions over two consecutive six month periods: a test of the theory of planned behavior in a population-based sample. *Br J Health Psychol* 2001;6:135-150.

20. De Vet E, de Nooijer J, de Vries NK *et al*. The transtheoretical model for fruit, vegetable and fish consumption: associations between intakes, stages of change and stage transition determinants. *Int J Behav Nutr Phys Act* June 19, 2006:10.1186/1479-5868-3-13.

21. Brewer NT, Weinstein ND, Cuite CL *et al.* Risk perceptions and their relation to risk behavior. *Ann Behav Med* 2004;27:125-130.

22. Courneya KS, Estabrooks PA, Nigg CR. Predicting change in exercise stage over a three year period: an application of the theory of planned behavior. *Avante* 1997;3:1-14.

23. Luszczynska A, Mazurkiewicz M, Ziegelmann JP *et al.* Recovery self-efficacy and intention as predictors of running or jogging behavior: a cross-lagged panel analysis over a two-year period. *Psychol Sport Exerc* 2007;8:247-260.

24. Scholz U, Sniehotta FF, Schwarzer R. Predicting physical exercise in cardiac rehabilitation: The role of phase-specific self-efficacy beliefs. *J Sport Exerc Psychol* 2005;27:135-151.

25. Schwarzer R, Schüz B, Ziegelmann JP *et al*. Adoption and maintenance of four health behaviours: theory-guided longitudinal studies on dental flossing, seat belt use, dietary behavior, and physical activity. *Ann Behav Med* 2007;33:156-166.

26. Khaw KT, Wareham N, Bingham S *et al*. Combined impact of health behaviours and mortality in men and women: the EPIC-Norfolk prospective population study. *PLoS Med* 2008;5:12.

27. *The World Health Report 2002. Reducing Risks, Promoting Healthy Life.* Geneva: WHO, 2002.

28. Rademacher JDM, Lippke S. Dynamic online surveys and experiments with the free open source software dynQuest. *Behav Res Meth* 2007;39:415-426.

29. Enders CK. A primer on maximum likelihood algorithms available for use with missing data. *Struct Equat Model* 2001;8:128-141.

30. Arbeitsgemeinschaft Online-Forschung e.V. *Internet facts 2007-IV*. Darmstadt, Germany: AGOF e.V., 2008.

31. TNS Infratest. *(N)Onliner-Atlas 2007*. Berlin, Germany: TNS Infratest, 2007.

32. Grobecker C, Krack-Roberg E, Sommer E. *Bevölkerungsentwicklung 2004 [Population development].* Wiesbaden, Germany: Statistisches Bundesamt, 2006.

33. Deutsche Gesellschaft für Ernährung e. V. *Obst und Gemüse in der Prävention chronischer Krankheiten [Fruit and vegetable in the prevention of chronic diseases].* Bonn, Germany: Deutsche Gesellschaft für Ernährung e. V., 2007.

34. Robert Koch-Institut. *Übergewicht und Adipositas, Gesundheitsberichterstattung des Bundes [Overweight and obesity. National health report]*. Berlin, Germany: Statistisches Bundesamt, 2003.

35. Baker A, Wardle J. Sex differences in fruit and vegetable intake. *Appetite* 2003;40: 269-275.

36. Lippke S, Ziegelmann JP, Schwarzer R *et al.* Validity of stage assessment in the adoption and maintenance of physical activity and fruit and vegetable consumption. *Health Psychology*; in press.

37. Sniehotta FF, Schwarzer R, Scholz U *et al.* Action planning and coping planning for long-term lifestyle change: theory and assessment. *Eur J Soc Psychol* 2005;35:565-576.

38. Field A. P. *Discovering statistics using SPSS* (2nd edition). London: Sage, 2005.

39. De Nooijer J, Van Assema P, De Vet E *et al.* How stable are stages of change for nutrition behaviors in the Netherlands? *Health Prom Int* 2005;20:27-32.

40. Gollwitzer PM, Bayer UC, McCulloch KC. The control of the unwanted. In: Bargh JA, Uleman J, Hassin R (eds.). *Unintended Thought.* New York: Guilford Press, 2005, 485-515.

41. Lippke S, Wiedemann AU, Ziegelmann JP *et al.* Self-efficacy moderates the mediation of intentions into behavior via plans. *Am J Health Behav;* in press.

42. Wiedemann AU, Schüz B, Sniehotta FF *et al*. Disentangling the relation between intentions, planning, and behaviour: A moderated mediation analysis. *Psychol Health;* in press.

43. Emmons KM, Barbeau EM, Gutheil C *et al.* Social influences, social context, and health behaviors among working-class, multi-ethnic adults. *Health Educ Behav* 2007;34:315-334.

44. Renner B, Schüz B, Sniehotta FF. Preventive health behavior and adaptive accuracy of risk perceptions. *Risk Analysis* 2008;28:741-748.

45. Marshall SJ, Biddle SJH. The transtheoretical model of behavior change: a meta-analysis of applications to physical activity and exercise. *Ann Behav Med* 2001;23:229-246.

46. Wright JA, Velicer WF, Prochaska JP. Testing the predictive power of the transtheoretical model of behavior change applied to dietary fat intake. *Health Educ Res* April 8, 2008: 10.1093/her/cyn014.

47. Cook C, Heath F, Thompson RL. A Meta-analysis of response rates in web- or Internet-based surveys. *Educ Psychol Meas* 2000;60:821-836.

48. Nigg CR, Allegrante JP, Ory M. Theory-comparison and multiple-behavior research: common themes advancing health behavior research. *Health Educ Res* 2002;17:670-679.

6

General Discussion

General Discussion

People often fail to change intended health behaviours because they lack the self-regulatory competencies to overcome problems of goal pursuit (Baumeister, Heatherton, & Tice, 1994). Theoretical approaches that focus on behavioural self-regulation, i.e., on post-intentional processes of *goal striving* (e.g., Carver & Scheier, 1998; Gollwitzer & Sheeran, 2006; Schwarzer, 2008) have augmented social-cognitive theories that focus on preceding processes of *goal setting*. Theorizing on the self-regulation of behaviour has specifically been stimulated by research on *planning strategies* (implementation intentions; Gollwitzer, 1999; Leventhal, Singer, & Jones, 1965; Sniehotta, Schwarzer, Scholz, & Schüz, 2005): Planning is a prospective self-regulatory process that facilitates behavioural performance by preparing individuals for forthcoming action by linking precisely specified situations to intended responses (Gollwitzer & Sheeran, 2006).

This thesis aimed at contributing to the research on differential effects of planning processes: First, the theoretically predicted interrelations between intentions, planning, and regular health behaviours were modelled by integrating previous lines of research on moderating and mediating influences (*Chapter 2*). Second, the effectiveness of planning interventions for behaviour change was examined (*Chapters 3 & 4*) with a focus on factors that may explain differential intervention effects in field settings: (a) The interplay of planning sub-facets as account of the underlying working mechanism of planning interventions was investigated (*Chapter 3*), and (b) the number of generated plans in an intervention (*Chapter 4*). Furthermore, planning cognitions were examined alongside with other HAPA-derived factors within a stage theoretical approach (*Chapter 5*).

The following discussion is guided by the research aims outlined in the introductory *Chapter 1*: The accumulated findings of the empirical chapters will be summarised, discussed, and embedded into theory of health behaviour change under the consideration of continuum and stage assumptions. Based on the findings, implications for further research and practice are proposed: Methodological, theoretical and practical issues are discussed to stimulate theory refinement, and improvements in the development and evaluation of theory-based interventions. The main findings of this thesis are summarised in Table 1.

Table 1: Summary of the main results of the thesis

Chapter	Aim	Findings	Conclusions
2	To test whether mediating effects of planning between intentions and behaviour are influenced by intentions as moderators of the planning-behaviour relation in two behaviours.	Intentions moderated the mediation effect of planning (moderated mediation). Indirect effects of intentions gradually increased along with its levels as moderator. Thresholds of intentions beyond which mediation established differed between the two investigated behaviours.	The interplay between intention, planning, and behaviour may not be captured by simple mediation assumptions. Intentions directly and indirectly influence behaviour, and different levels may determine the success of planning processes.
3	To examine the effects and working mechanism of a planning intervention. Volitional variables i.e. planning and the interaction of its sub-facets, but not motivational variables were hypothesized to account for the effects.	Intervention effects on behaviour were mediated by change in action planning and coping planning (multiple parallel mediation), and predicted by their interaction. Motivational variables were not predictive. Planning and behaviour mediated effects on body mass index (three-path mediation).	Action planning and coping planning may have additive and synergistic effects on behaviour change. Interventions may stimulate the use of planning strategies outside the intervention. Mediators of intervention effects may differ between field and laboratory settings.
4	To examine differential effects of a planning intervention in intenders and actors. To test the relation between baseline stage and the number of generated plans, and their influence on behaviour change.	Intenders generated more action plans than actors, but their generated number of coping plans did not differ. The quantity of plans showed curvilinear (action plans) and linear (coping plans) relations to behaviour change and mediated between baseline stage and change in behaviour.	Planning interventions promote action initiation and maintenance, and their effects rely on the number of generated plans. Individuals may 'self-tailor' interventions to their needs. The maximal number of plans may not be the optimum.
5	To examine stage-specific prediction patterns of social-cognitive variables including planning and social support on transitions between HAPA stages.	Prediction patterns for stage progression and stage regression were stage-specific regarding outcome expectancies, planning, and social support. Self-efficacy emerged as a universal predictor of stage transitions.	The HAPA variables are valid predictors of stage transitions. Stage-specific predictors might foster stage progression towards goal behaviours depending on the stage individuals are in. Social support might facilitate action initiation, and planning relapse prevention.

Can the interrelations between intentions, action planning, and regular health behaviours be modelled as theoretically predicted?

The *Health Action Process Approach* (Schwarzer, 1992; 2008) proposes planning processes as proximal determinants of health behaviour. In this thesis, support for this assumption may be derived from the finding, that psychometrically measured planning cognitions are predictors of behaviour (change) across multiple behavioural domains, namely physical activity (*Chapter 2*), interdental hygiene (*Chapter 2*), and fruit and vegetable intake (*Chapters 3 & 5*). Moreover, in *Chapter 2*, two lines of research on the function of planning processes were integrated for the first time: First, the proposed role of planning as *mediator* between intentions and behaviour was supported. Such a mediation process is in line with the theoretical assumption: Intentions engender planning processes, which in turn entail behaviour change, which has been supported by a large body of empirical evidence (e.g., Norman & Conner, 2005, Study 2; Reuter, Ziegelmann, Wiedemann, & Lippke, 2008; Scholz, Schüz, Ziegelmann, Lippke, & Schwarzer, 2008; Schwarzer et al., 2007). Secondly, the assumption that planning as post-intentional process has differential effects on behaviour in individuals with different levels of intentions to act was supported (*moderation*; Sheeran, Webb, & Gollwitzer, 2005). Moreover, adding to previous findings, the moderating and mediating relations were combined, and their interplay tested in *moderated mediation models* (Preacher, Rucker, & Hayes, 2007) in two studies in *Chapter 2*. Behaviour was assessed three (*Study 2*) and four (*Study 1*) months after planning and intentions. The latter two constructs were measured cross-sectionally. However, empirical evidence has been established that supports intentions as precedents of planning processes (e.g., Reuter, Ziegelmann, Wiedemann, & Lippke, 2008; Webb & Sheeran, 2006). The similar results in two behaviours (*Study 1*: physical activity; *Study 2*: interdental hygiene) underscore the validity of the finding: By moderating the planning-behaviour relation, intentions led to differences in the strength of the indirect effect of intentions on behaviour via planning processes (*Chapter 2*). Thus, the use of planning strategies may not translate intentions into action in everyone in the same way by '*strategic automaticity*', i.e., a reflexive triggering of the behaviour due to a previous process of

precise planning (Gollwitzer & Sheeran, 2006): The strength of one's intentions determines whether intentions are carried out by planning processes (Sheeran et al., 2005). A differential action-inducing threshold for intentions was identified, which was at a higher level for physical activity than for interdental hygiene. This was discussed in light of the different complexity of the two behaviours under investigation (*Chapter 2*).

In sum, the obtained moderated mediation confirmed that two perspectives on the relations between intentions, planning, and behaviour can be successfully integrated into a complex, but parsimonious model of moderated mediation. Moreover, the findings supported *multiple influential pathways* of intentions: They influenced behaviour directly (planning not fully explained the intention-behaviour relation), and indirectly as starting point of the mediation chain and via the moderating effect. Individuals with a high intention may plan how to attain their behavioural goal, and whether these plans are enacted depends on the levels of the intentions that stimulated the planning process. This might speculatively be explained by a higher quality or quantity of generated plans in people with different levels of intentions, which in turn, enabled them to perform the behaviour or not (cf. *Chapter 4*, for findings regarding the number of plans). To conclude, moderated mediation may allow a better description of the differential mechanisms by which intentions influence behaviour, and may speak against a clear-cut separation of a motivational and a volitional phase of behaviour change, as intentions may still impact on goal striving processes.

Are planning interventions effective to facilitate change in health-related outcomes, and how can differential effects be explained in field settings?

Extending *Chapter 2*, in *Chapters 3* and *4*, the planning construct was subdivided into *action planning* (cf. *Chapter 2*) and *coping planning* (Sniehotta, Schwarzer et al., 2005). As further extension to *Chapter 2*, these sub-facets of planning were targeted in interventions with respective *action planning* and *coping planning components* in *Chapters 3* and *4*: In the action planning component, participants were asked to link suitable situations to act to specific behavioural responses, and in the coping planning component

they were asked to link anticipated personal risk situations with suitable coping responses to enable the behavioural performance in face of barriers to action (see *Chapter 3*, for a detailed differentiation). In both reported studies, the field setting, mode of delivery, and time frame were alike, but the target behaviour differed (*Chapter 3*: fruit and vegetable intake; *Chapter 4*: physical activity). Since the interventions were designed according to current recommendations for health behaviour (cf. *Chapter 1*), individuals were asked to generate up to three action plans for physical activity, respectively five action plans for fruit and vegetable intake, and up to three coping plans. The focus of *Chapters 3* and *4* was on the factors that account for behaviour change in applied settings. Before elaborating on these factors, the interventions' effects on behaviour change (*Chapters 3 & 4*) and BMI (body mass index; *Chapter 3*) are summarised.

Are planning interventions effective to facilitate change in health-related outcomes?

The planning interventions reported in *Chapters 3* and *4*, corroborated the correlational findings of *Chapter 2* on planning as a determinant of behaviour change. In both *Chapters 3* and *4*, the effects of the combined action planning and coping planning interventions led to improvements in the target behaviours when tested in RCTs against active control conditions. The obtained effect sizes on behaviour change in the overall samples were small (e.g., $d = 0.34$, in *Chapter 3;* Cohen, 1988) but common for effective psychological interventions (d-values = 0.20 to 0.40; Hunter & Schmidt, 1990). In *Chapter 4*, the overall sample was further subdivided into intenders and actors. Though planning strategies are proposed as key facilitators of action initiation and maintenance (Schwarzer, 2008; Sniehotta, Schwarzer et al., 2005; Ziegelmann, Lippke, & Schwarzer, 2006), most research so far has focused on action initiation (Conner, 2008). In *Chapter 4*, the intervention led to differential effects in individuals in different stage groups: The intervention facilitated increases in physical activity in *intenders*, i.e., the crucial shift from intention to behaviour. Thus, planning is assumed to bridge the *intention-behaviour gap*. In *actors*, behavioural maintenance was supported, i.e., the intervention prevented post-interventional decreases of physical activity over a one-month period, which may be

interpreted as *relapse prevention* effects. Larger increases in behaviour were found in intenders as compared to actors, which may be explained by saturation effect in actors (baseline stage by treatment effect; *Chapter 4*). A large proportion of people who already attain the target criterion of an intervention may thus contribute to the explanation of small effects of some planning interventions in volitional samples.

In addition to the intervention effects on health behaviour, *Chapter 3* reports a small reduction of participants' *BMI* (body mass index). However, no larger effects were aspired in the time frame under study due to health-impairing effects of fast weight loss (e.g., Yang, Petersen, Roth, Schoenfield, & Marks, 1992).

In sum, the findings of *Chapters 3* and *4* contribute to the evidence of the effects of planning interventions outside the laboratory, and in particular for both the initiation and maintenance of regular health behaviours (cf. Gollwitzer & Sheeran, 2006). For regular health behaviours, however, the long-term maintenance is critical as well, as most health benefits occur after a prolonged period of regular performance (National Heart, Lung, and Blood Institute, 1998). In this thesis, effects over a one-month period were studied, but some evidence exists that a longer-term maintenance of behaviour may be attributed to self-regulatory planning processes, and specifically coping planning (Sniehotta, Scholz, Schwarzer et al., 2005; Ziegelmann et al., 2006).

How can the effects of planning interventions be explained in field settings?

The identification of the underlying working mechanisms of theory-based interventions is critical for theory refinement and intervention improvement. The question on factors that account for intervention effects in field settings was addressed in two ways, (a) by investigating the underlying working mechanism of a planning intervention (*Chapter 3*), and (b) by relating intervention effects to the number of generated plans in the intervention (*Chapter 4*).

(a) The underlying working mechanism of a planning intervention

The contribution of the HAPA to the understanding of health behaviour change was probed by mediation analyses of intervention-induced behaviour change: The HAPA

specifies that volitional factors (i.e., planning), and not motivational ones (i.e., intentions, motivational self-efficacy) encourage behaviour change after intention formation (e.g., Schwarzer et al., 2007; 2008). Whether changes in these theory-derived cognitions can explain behaviour change was the focus of the intervention study on fruit and vegetable intake described above (*Chapter 3*).

The intervention led to increases in the self-reported use of action planning and coping planning of moderate effect size, which supported the assumption that an initial act of learning how to form precise plans in the intervention may affect the use of planning strategies in every day life (e.g., Luszczynska, 2006). In line with *Chapter 2*, these changes in action planning were predictive of behaviour change, while in extension of *Chapter 2*, main effects of coping planning were identified as well, and added to the explained variance in behaviour (*Chapter 3*). This may cautiously be interpreted as *additive effects* of both planning processes: Action planning builds up *new associations* between suitable situations to act and intentional behaviour, but it does not necessarily change *existing associations* between situations and behaviour (e.g., learned cue-response links; Sniehotta, in press): Effects of coping planning may dissolve such links by creating new associations between these 'risk' situations with potential for self-regulation problems and intended behavioural responses (cf. Sniehotta, Schwarzer et al., 2005). Thus, individuals who form coping plans on top of action plans may be more likely to accomplish health behavioural goals. Along with these main effects, the interaction between action planning and coping planning predicted behaviour change (*Chapter 3*), which may be indicative for a *synergistic effect*: Coping planning may amplify effects of action planning, because it can continuously shield the execution of action plans against counter-productive tendencies, e.g., in changing environments (Araújo-Soares, McIntyre, & Sniehotta, in press). Moreover, a *threshold analysis* identified that the intervention had to engender increases in both planning processes (vs. no changes or decreases) to result in interactive effects on behaviour change.

Furthermore, the planning intervention left motivational variables (motivational self-efficacy, intentions) unchanged. This supports that after intention formation, volitional

and not motivational variables are responsible for behaviour change as produced by the volitional intervention. Particularly intentions supposedly precede planning processes, and should thus be a precondition for participation in volitional interventions rather than an effect (e.g., Schwarzer, 2008).

Whether action planning and coping planning processes simultaneously explain the intervention effect on behaviour was tested for the first time in a *multiple mediator model* (*Chapter 3*; cf. Luszczynska, 2006; Scholz, Sniehotta, Burkert, & Schwarzer, 2007). Changes in both planning processes fully mediated the intervention's effect on behaviour change, which supports that they are responsible for the intervention-induced behaviour change. The unique association between action planning and behaviour was diminished when coping planning was introduced as simultaneous mediator, which may indicate an overlap of their action-inducing function. Such a similarity of their perceptual, attentional, and mnemonic processes despite differences in content, function, and scope has been recently addressed (Sniehotta, Schwarzer et al., 2005).

The theory-derived chain of processes was further extended with BMI as index for a health outcome (*Chapter 3*): In a *three-path mediation model*, changes in BMI were, however, only partially explained by effects of the intervention on behaviour through planning. This residual direct intervention effect indicates further unmeasured influences (see *Chapter 3*, for a discussion).

In sum, the effects of planning interventions in field settings may rather be explained by a stimulation of a continuous use of self-regulatory strategies beyond the intervention: Changing complex behaviours in everyday life, i.e., in face of changing situational demands with the potential for self-regulatory failure, may require prospective self-regulatory effort beyond a single act of wilfully creating cue-response links in an intervention (e.g., Luszczynska, 2006). Thus, effects of planning interventions may engender their effects differently in laboratory and field settings, and the concept of 'strategic automaticity' (Gollwitzer & Sheeran, 2006) may rather apply to simple tasks in laboratory studies. However, whether certain findings from laboratory task-solving studies,

such as of specific effects of prospective memory performance (e.g., Cohen, Jaudas, & Gollwitzer, 2008), may be transferred to field settings is open for future research.

(b) Relation between intervention effects and the number of generated plans

One reason that may account for the overall small results in *Chapter 3* and *4*, as well as for the lack of effects of some planning interventions in applied settings (e.g., Jackson et al., 2005; Michie, Dormandy, & Marteau, 2004; Rutter, Steadman, & Quine, 2006; Skår et al., 2008) *is the quantity of plans*. Post-hoc ratings of the plans participants specified in the planning intervention reported in *Chapter 4* supported this idea: In general, a higher number of plans was related to larger benefits from the intervention, similar to research on levels of plan completeness (Ziegelmann et al., 2006). This is in line with the correlational results from *Chapter 2* and *3* that found higher levels of psychometrically measured planning cognitions to be related to higher levels of behaviour (change). More precisely, however, regression curve estimation identified a threshold for increases in intervention effects after two (of three) generated action plans. This curvilinear effect may be interpreted as 'dilution effect' of the unique plans (cf. *Chapter 4*; Gollwitzer, 2006; Webb, 2006). On closer inspection of the results, intenders were found react differently to the intervention: They generated more action plans than actors, while both stage groups generated the same number of coping plans. In particular, the different number of generated action plans in the intervention mediated the differences in intervention effects between intenders and actors (cf. previous paragraph): This differential effect may be due to *self-tailoring*: Intenders may have struggled with intention implementation and thus, forming action plans may have matched their need for support regarding the initiation of behaviour. Coping plans, however, may be useful for both stage groups: Their supposed effect on breaking formerly established cue-response links (Sniehotta, Schwarzer et al., 2005) may be matched to both the initiation and maintenance of behaviour. Other studies suggest action planning to be more relevant for action initiation, and coping planning for both, behaviour initiation and maintenance (Sniehotta, Schwarzer et al., 2005; Ziegelmann et al., 2006).

In sum, it may be derived from the present findings that the stimulation of planning processes outside of interventions (*Chapter 3*) and the number of plans specified in the intervention (*Chapter 4*) contribute to the explanation of effects of planning interventions in field settings. If such interventions stimulate both action planning and coping planning, these processes may unfold the proposed additive and synergistic effects, and support the translation of intentions into action (*Chapter 3*). To ensure larger intervention effects, an optimal number of plans should be identified and formed by those in need for such support. To date, little attention has been paid to the number of plans generated which may corroborate the assumptions. The present findings rely on post-hoc ratings of generated plans. Further tests are required to identify how the number of generated plans affects behaviour change in randomized controlled trials, i.e., without baseline differences of participants affecting the number of generated plans. An ongoing study aspires to shed more light into this domain by experimentally manipulating the number of plans (Wiedemann, 2008).

More generally, the prediction patterns support the assumption that action planning may bridge the intention-behaviour gap, and has larger effects on behaviour (change) in people with high intentions (*Chapter 2*) and coping planning (*Chapter 3*). This is in line with the theoretical considerations, that also advised to deliver such volitional planning interventions only to individuals in the intention stage or action stage - as done in the studies reported in this thesis (*Chapters 3 & 4*; Sheeran, Webb, & Gollwitzer, 2005) - as these individuals are supposed to have high intentions (see *Chapter 3* for supportive findings). The main and interaction effects of action planning and coping planning identified in *Chapter 3* support the presumed benefit of targeting both processes in interventions as done in the experimental studies in *Chapter 3* and *4*. Taking the identified interrelations into account may allow for a better explanation and refined theoretical modelling of the psychosocial processes that govern health behaviour change.

Are the social-cognitive factors derived from the HAPA stage-specific predictors of change processes, i.e., stage transitions?

The study reported in *Chapter 5* extended the approaches of *Chapters 2, 3,* and *4* that were based on *continuous behaviour measures* by setting planning into relation to participants' *stage of behaviour change* (i.e., responses to a stage algorithm). Along with other social-cognitive variables, a combined action planning and coping planning variable was investigated as predictor for stage progression and stage regression. In general, *Chapter 5* confirmed that the three stages and the set of social-cognitive predictors of transitions proposed by the HAPA are useful to describe health behaviour change within a stage approach: Differential, i.e., stage-specific prediction patterns for transitions between the HAPA stages regarding fruit and vegetable intake by a *motivational variable* (outcome expectations), *volitional variables* (planning, social support), and a *universal factor* (self-efficacy) were identified by use of binary, respectively multinomial logistic regression analyses.

Contrary to the theoretical assumptions, planning failed to predict action initiation in terms of a progression from the intention stage to the action stage. This was unexpected in virtue of the compelling experimental evidence for the effects of planning on behaviour initiation (e.g., *Chapter 4*; Lippke, Ziegelmann, & Schwarzer, 2004), and contradicts the prediction of behaviour change by planning processes in *Chapter 3*. However, in *Chapter 3* cross-sectional planning and behaviour measures were regarded, which may generally show a closer association than time-lagged ones, and furthermore, a static measure of planning was set into relation to a change variable (i.e., stage transition; *Chapter 5*; cf. Scholz, Nagy, Göhner, Luszczynska, & Kliegel, in press). Additionally, continuous behaviour measures (*Chapter 3*) may be more sensitive to capture small changes in behaviour than the stage measure: The stage algorithm was based on the WHO (2003) recommendation of consuming five servings of fruit or vegetable per day, and thus roughly differentiates between adherence and non-adherence to this criterion (*Chapter 5*). Although stage transitions were accompanied by continuously measured behaviour change, the fairly strict cut-off in the stage algorithm obscures changes to less-than-recommended levels of

behaviour, which might have been differently related to the planning measure. Although no main effects of planning were captured, planning processes may still be predictive of stage progression through interactions with other variables such as intentions (*Chapter 2*) or as interaction term of distinct planning processes (*Chapter 3*). Though presumably worthwhile, only one study was identified that took interactions between predictors of stage transitions into account (Lippke & Plotnikoff, in press). The non-conformity of the finding with theory and empirical findings may also question the validity of the stage algorithm (cf. Lippke, Ziegelmann, Schwarzer, & Velicer, in press). However, valid stage algorithms may be good estimates of behaviour change, and have been found to be closely related to blood glucose and weight loss data (Jones et al., 2003).

In line with the assumptions, higher levels of planning were associated with remaining in the action stage, indicating a differential relation regarding action initiation and maintenance (*Chapter 5*). The findings are based on correlative associations, and thus provide no evidence for causal effects. However, they are in line with the positive effects of the planning intervention on behavioural maintenance in terms of relapse prevention in *Chapter 4*, which may be interpreted in the view of stage theory.

Outcome expectancies were predictive for transitions from the pre-intention stage to the intention stage only, and social support predicted progression from the intention stage to the action stage, locating them into the motivational, respectively volitional stage of health behaviour change. This is in line with the HAPA as theoretical framework (Schwarzer, 2007; 2008): While outcome expectancies are concretely specified within the model, social support may be assigned to the heuristic ‘resources and barriers’ factor as influential for action. Previous research demonstrated effects of social support on health behaviour change as well (e.g., Sallis, Hovell, Hofstetter, & Barrington, 1992), but stage-specific findings are rare. A correlational study by Fuchs (1996), however, corroborated the present findings: social support was predictive for the adoption of physical activity, while no relation to behavioural maintenance was identified. The mechanisms by which various facets of social support might contribute to health behaviour change are complex, and may not be derived from the present study. In particular, as social support has also

been identified as predictor of self-efficacy beliefs to perform physical activity, and might thus have indirect effects on behaviour as well (Fuchs, 1996).

Risk perception was not predictive of stage transitions. However, as outlined above regarding planning as predictor of transitions, including interaction terms might provide more detailed information about putative predictors (Lippke & Plotnikoff, in press).

Self-efficacy was predictive of transitions between all HAPA stages, and may be discussed as universal facilitator of health behaviour change (Schwarzer, 2008). Integrating this thesis' findings with those from previous research, the role of self-efficacy for behaviour change might be further described within the moderated mediation framework as modelled in *Chapter 2*: Self-efficacy is assumed to influence behaviour directly (*Chapter 5*), indirectly as starting point of a mediation chain through planning (Sniehotta, Scholz, & Schwarzer, 2005), and as moderator of the planning-behaviour relation (Lippke, Wiedemann, Ziegelmann, Reuter, & Schwarzer, in press). This has not been tested before, but recent attempts to integrate self-efficacy as moderator of mediating processes were successful (e.g., Lippke et al., in press). No conclusive effects of planning on self-efficacy were identified here or in previous research which would be supportive of this influential pathway (*Chapter* 3; Webb & Sheeran, 2008). The measure of self-efficacy in *Chapter 5* was unspecific regarding the tasks that have to be mastered within the different stages of behaviour change, such as behaviour initiation or maintenance. It might, however, be valuable to differentiate stage-specific self-efficacy scales that directly refer to these different tasks to probe the role of self-efficacy as stage-specific predictor of transitions (cf. Scholz, Sniehotta, & Schwarzer, 2005; Schwarzer, 2008).

In sum, the findings reported in *Chapter 5* support the usefulness of the stage construct for describing health behaviour change, as well as the predictive validity of the HAPA variables as predictors of stage transitions towards a goal behaviour. Though of correlative nature, the stage-specific influence patterns might point to potentially effective targets of stage-matched interventions.

Implications for research

The findings reported in the four empirical chapters support the relevance of planning processes for describing and facilitating health behaviour change. The findings and the employed methodological approaches propose pathways for future research on planning processes: In the following, methodological implications for intervention design and evaluation are proposed, as well as theoretical implications that may function as a heuristic for progress on the conceptualisation of planning processes within health behaviour change.

Methodological implications

Study Design

The differentiation between action planning and coping planning is necessary to elucidate the effects of planning processes and to refine behaviour change theory and interventions. The studies reported in *Chapters 3* and *4* relied on multi-component interventions, i.e., action planning and coping planning prompts were combined in one intervention. Their joint application was based on theory regarding their interrelated effects (*Chapter 3*), and seemed appropriate for the samples at risk for morbidity. However, the study design implies the impossibility of elucidating the main effects of the single components as compared to their interaction effects. Only the experimental examination of separate and combined action planning and coping planning interventions in 2x2 factorial design studies can identify the specific change-generating processes by which different planning facets induce behaviour change (see *Chapter 3* for further considerations). Most previous intervention studies targeted merely action planning (cf. Gollwitzer & Sheeran, 2006), or combined action planning and coping planning interventions as in the present thesis (*Chapter 3 & 4*; Lippke et al., 2004; Sniehotta, Schwarzer et al., 2005; Ziegelmann et al., 2006). However, no study so far tested them in a strict 2x2 factorial design including a separate coping planning intervention. Hence, future studies would benefit from such a factorial experimental design that allows testing the assumption that coping planning

depends on preexisting action plans, respectively the more general supposition of main and interactive effects of both sub-facets on planning processes in everyday life, as well as on behaviour change.

Evaluation methods and statistical applications

Mediation analyses may describe complex relations between variables of interest (*Chapter 2*; Reuter, Ziegelmann, Wiedemann, Lippke et al., 2008). In *theory-based intervention studies*, mediation analyses can test whether the intervention changes psychological processes as specified by theory, and whether these processes engender behaviour change, but to date, such tests are rather an exception than the rule (cf. *Chapter 3*; Michie & Abraham, 2004). Sophisticated mediation approaches have been applied in this thesis, i.e., multiple parallel mediation, three-path mediation (both *Chapter 3*), and moderated mediation (*Chapter 2*). They extend the well-known mediator model, and may help to advance the understanding of the psychological processes in general, and, moreover, those underlying intervention effects. An illustrative example for each applied method will be given to inform the evaluation of future intervention studies.

Multiple mediation (*Chapter 3*). Health behaviour change interventions are often directed at multiple mediating processes to provoke behaviour change. Exemplarily, an intervention may aim at stimulating physical activity through intention formation and enhancing self-efficacy. Using a multiple mediation model (Preacher & Hayes, 2008) to analyze its working mechanism is superior to multiple single mediation analyses because it enables (a) additional estimates of the *total indirect effect* of the intervention through several psychological processes at the same time (e.g., intentions, self-efficacy), of (b) the *indirect effects* through *specific processes* (e.g., changes in intentions) while controlling for other indirect effects (e.g., changes in self-efficacy; which can reduce methodological issues such as the omitted variable problem; Judd & Kenny, 1981), and c) to contrast indirect effects if the respective mediators are uncorrelated. Finally, the direct and total intervention effect on physical activity may be estimated similar to simple mediation models.

Three-path mediation (*Chapter 3*). An intervention theory may also be based on a longer hypothesized sequence of causal effects. For example, the above goal setting intervention is assumed to stimulate intentions, which in turn affect planning processes, which finally promote physical activity. Thus, to evaluate intervention effects through these *two subsequent mediators* a three-path model may be estimated, which is termed according to the three sequential paths in the mediation chain (Taylor, MacKinnon, & Tein, 2008). Three-path mediation models allow comprehensive tests of a sequence of processes as specified by theories of behaviour change instead of single sections. Sticking to the example, one might identify that the goal setting intervention exerts its influence through changes in intentions, followed by changes in planning that engender behaviour change. At best, fully longitudinal models would be estimated with multiple time-lagged measurement points that allow growth in the variables after the exposure to the experimental conditions.

Moderated mediation (*Chapter 2*)**.** The moderated mediation approach tested in *Chapter 2* can be applied to intervention evaluation as well. Moderated mediation may, for instance, identify how the intervention effect on behaviour change through proposed mediating processes varies across subgroups of individuals in different stage groups, or with different levels on cognitive or socio-demographic variables. Several models of moderated mediation may be specified with a different number of moderators that influence different paths within the mediation chain (see Muller, Judd, & Yzerbyt, 2005; and Preacher et al., 2007, for an overview). Such analyses allow a more precise interpretation of the underlying mediating effects of interventions, as levels of moderators may explain whether mediating processes materialize or not. The intervention example given above may, for example, improve behaviour via intention formation only in those individuals who engage in action planning, which moderates the intention-behaviour relation (cf. *Chapter 2*).

Intervention evaluation as based on such mediation models may point to promising targets for interventions, and help to unveil an intervention's working mechanism: Integrating mediation and moderation assumptions, and estimating multiple mediating

processes simultaneously or sequentially may assist (a) in accumulating research findings on separately tested assumptions in more comprehensive theoretical frameworks, b) in identifying conditions under which intervention effects are particularly beneficial, c) in identifying mediating psychological processes which may point to critical intervention components, and thus d) in developing effective evidence-based interventions based on refined theories.

Different kinds of outcome measures

Findings in this thesis relied on self-reports of behavioural and health outcomes. *Objective behaviour measures* may be preferred as they overcome problems of self-reports such as response shifts, recall bias, or social desirability (Howard, 1980; Michie & Abraham, 2004). However, objective behaviour measures as derived from monitoring devices (e.g., accelerometers) may be biased by signal errors, non-compliance to wear them, and demand characteristics (Steele et al., 2000). *Objective health parameters*, in turn, may subsume influences of other behaviours and lifestyle factors (Michie & Abraham, 2004). Thus, generally available measures often seem to include trade-offs. Replication studies might therefore gain from the consideration of multiple measurement methods that complement each other (Stone & Shiffman, 2002).

Theoretical implications

Action planning and coping planning, their interrelations, and their relations to motivational factors were integrated into theory of health behaviour change and found to aid the understanding of how intentions are translated into action in this thesis. Furthermore, perceived social support was suggested as further factor to bridge the intention-behaviour gap. In the following, two points of consideration are raised that may inform future theoretical considerations: The differentiation of action planning and coping planning in an explicit stage theoretical framework and the consideration of an extended conceptualisation of action planning and coping planning that takes social processes into account.

Planning within a stage-theoretical approach

Chapter 4 discussed whether action planning is more relevant for intenders, and whether coping planning is relevant for both, intenders and actors, based on their responses to the intervention content. The findings are in line with a stage-theoretical interpretation of previous research, which proposed that *action planning* is more relevant for *action initiation* (i.e., intenders), while *coping planning* is more relevant for *behavioural maintenance* (i.e., actors; e.g., Sniehotta, Schwarzer et al., 2005). Within the HAPA (e.g., Schwarzer, 2008), action planning and coping planning are specified as volitional facilitators of behavioural performance, i.e., as factors relevant for intention implementation, and not for intention formation. However, no differential role of these two planning processes as *stage-specific determinants* for *either action initiation* (intention stage), *maintenance* (action stage), or *both* is proposed within the stage approach.

Previous research supports the volitional character of planning strategies (e.g., Lippke et al., 2004; Sheeran, Webb, & Gollwitzer, 2005), but does not provide a conclusive answer whether action planning and coping planning have stage-specific roles for action initiation or maintenance: Single action planning interventions were found to be effective for behaviour change, but not tested against coping planning interventions (cf. Gollwitzer & Sheeran, 2006). Combined action planning and coping planning interventions were identified as mainly influential for the *initiation of action*, i.e., they produced larger behaviour changes in intenders than in actors, respectively preintenders (Lippke et al., 2004; cf. *Chapter 4*). However, whether the action planning or the coping planning component was responsible for this effect remained unanswered.

However, such a differential role of action planning and coping planning in health behaviour initiation, respectively maintenance can be tested against the background of stage models: According to Weinstein, Rothman, and Sutton (1998), experimental studies with *stage-matched* and *stage-mismatched* interventions provide the strictest test for the assumptions that people in different stages benefit from different factors, i.e., whether, for example, intenders would benefit more from action planning, and actors more from coping planning ant not vice versa. That is, such stage-matched/mismatched interventions would

test whether in a certain stage of behaviour change a proposed *stage-matched factor* promotes stage transitions towards the goal behaviour (e.g., action planning promotes progression from the intention stage), while other *'mismatched' factors* are ineffective to promote changes in this stage (e.g., coping planning). These factors, however, might have a different stage-specific pattern of influence (e.g., coping planning would be matched to the action stage and not the intention stage). According to the existing evidence, neither action planning or coping planning would be mismatched to the intention stage or the action stage. In terms of stage-specific effects, rather a stage-specific difference in terms of effect sizes may be assumed. Demonstrating in *experimental studies* following a matched/mismatched design that a certain planning strategy unfolds larger effects in a theoretically proposed stage than in other stages (e.g., action planning in the intention stage) might be an important and useful contribution to the understanding of the initiation and maintenance of health behaviours. Thus, it seems worthwhile to investigate their stage-specific influence in such an explicit stage approach in more detail in future research.

Dyadic planning

An extension of the conceptualisation of action planning and coping planning, as applied in this thesis, is the idea of *dyadic planning* (Burkert, Knoll & Scholz, 2005): Dyadic planning refers the integration of another person into the planning process (Burkert et al., 2005). Thus, the concept relies on the interaction between individuals while specifying the plan, while the plan content not necessarily has to include a partner (i.e., that the intended act is actually performed together with another person). In a similar interpersonal planning approach, individuals were asked to form '*collaborative plans*' which required participants not only to plan with a partner but also to include this partner into the behavioural performance, i.e., breast examination (Prestwich et al., 2005). However, this approach does hardly allow inferences on whether putative differential effects are caused by the interactive planning procedure or parther involvement in processes related to its execution.

While previous research has generally supported benefits of dyadic processes in health psychology (e.g., dyadic coping with severe disease, Schwarzer & Knoll, 2007), there is hardly any published research on the effects of dyadic planning so far (Burkert et al., 2005), and its role in models of social support (cf. Knoll & Schwarzer, 2005) is open for future research. However, in a study on smoking by Burkert et al. (2005), measures of dyadic action planning and coping planning (e.g., for action planning: 'I have already precisely planned with my partner when to stop smoking') showed a differential pattern of relationships to other social-cognitive variables than individual planning measures. This finding tentatively supports the conceptual difference between individual and dyadic planning measures. Moreover, dyadic planning was related to measures of smoking-specific intentions, received social support and social control, as well as the number of attempts to stop smoking. In *Chapter 5*, social support was predictive of stage transitions from the intention stage to the action stage. Further research may disentangle the relation between social support and dyadic planning, and indicate whether dyadic planning, separately or in conjunction with various kinds of social support, helps to successfully overcome the barriers to action in intenders, and thus contributes to the understanding of behaviour change within a comprehensive theoretical framework.

Implications for practice

Based on the findings of *Chapters 3* and *4*, the delivery of planning interventions in field setting may yield promising results. Health behaviour change is a complex undertaking, because various internal and external barriers pose a great challenge to the self-regulatory skills of individuals with the intention to lead a healthy lifestyle (e.g., Baumeister et al, 1994). Behaviour change interventions should therefore be based on theory and evidence that allow targeting the specific, action-inducing ingredients of an intervention (Michie, Sheeran & Rothman, 2007).

According to criteria established by Michie and Abraham (2004), the planning interventions may be termed '*theory-based*', as an account for the processes that underlie

the intervention effects is provided by theory (e.g., the HAPA), and as these theoretical assumptions are corroborated by experimental findings, such the ones derived from the study reported in *Chapter 3* and previous research (e.g., Reuter, Ziegelmann, Wiedemann, & Lippke, 2008). Thus, findings from this thesis contributed to the conceptualisation and evidence basis for the proposed theoretical model of health behaviour change. In particular, the mediation chain specified in the HAPA and supported in *Chapter 2* implies that intentions automatically and without external intervention engender planning processes, which in turn affect behaviour (Sutton, 2008). However, planning interventions may intervene into this chain of processes by strengthening the relations between intentions, planning, and behaviour. Thus, they may diminish 'attenuation effects' in terms of a reduction of effect sizes through weak links within a mediation chain without intervening measures (Sniehotta, in press).

Planning interventions:

'*Do they work?, How well do they work?, When do they work?, & How do they work?'*

To identify whether the present and previous findings would support a dissemination of planning interventions in large scale trials, their relevance for health behaviour change was probed by questioning their general effectiveness, the conditions under which they prove effective, and the mechanisms through which they unfold their effects (Michie & Abraham, 2004; Zanna & Fazio, 1982):

Effects of planning interventions may generalize across regular health-enhancing behaviours, as their effects were demonstrated across several health behavioural domains (*Chapter 3, 4;* e.g., Gollwitzer & Sheeran, 2006; Schwarzer el al., 2007, 2008). Based on the present findings, the overall effects may be expected to be small to moderate regarding health behaviour (*Chapter 3 & 4;* cf. Gollwitzer & Sheeran, 2006), small regarding BMI as health index (*Chapter 3*), and small to moderate regarding planning processes (*Chapter 3*). Differential effects may be expected in individuals in different stage groups, and are presumably higher in those the intention stage as compared to those in the action stage (*Chapter 4*; e.g., Lippke et al., 2004). The intervention effects, however, seem noteworthy

as in the reported studies effect sizes were obtained in comparison to active control conditions.

However, for planning interventions to be successful, participants have to follow the instructions and to actually generate plans, which may not be the taken for granted in field settings (*Chapter 4*). If interventions are delivered face-to-face, interviewers might supervise the generation of plans. Interviewer presence or actual supervision might be one reason for larger effects of planning interventions in laboratory studies as compared to applied settings (cf. Gollwitzer & Sheeran, 2006; Ziegelmann et al., 2006). Though not considered within this thesis, the content of generated plans might make a difference as well: If individuals participate in interventions to improve behaviours like physical activity, that are performed to some extend but below the recommendations (*Chapter 1*) by most people, they may include activities that they regularly performed in the past in their plans for future performance. Such a 'plan', however, is unlikely to promote behaviour, and might be controlled for by supervision as well. The interventions may unfold their effects by stimulating the use of action planning and coping planning processes outside the intervention, and not by motivational processes (intentions, self-efficacy: *Chapter 3*) and might rely on additive and synergistic effects of planning processes (*Chapter 3*). Thus, interventions might profit from encouraging the generalization of planning strategies to everyday life.

In this thesis, effects have been investigated over the period of one month as is most health behaviour change studies (e.g., Prestwich, Lawton & Conner, 2003; Jackson et al., 2005), but the sparse existing research for long-term effects is promising (e.g., Sniehotta, Scholz, Schwarzer, et al., 2005). The intervention impact (product of intervention efficacy and recruitment rate; Velicer & Prochaska, 1999) may be high as planning interventions can be cost- and time efficiently disseminated by lean computer-based interventions to a large number of people via mass media (van Den Berg, Schoones & Vliet Vlieland, 2007). Though these and previous findings are promising, more empirical tests of different kinds of planning interventions, and across different behaviours, contexts and samples are needed to corroborate these findings.

Stage-matched interventions

The matching of health behaviour interventions to stages of behaviour change is an appealing approach. The underlying idea of this approach is that stage-matched interventions are supposed to be more effective as the intervention content is directly tailored to the needs of participants in their phase of health behaviour change. If confronted only with personally relevant information, individuals may pay more attention to this information, process it more intensively, and show better memory effects (cf. *Elaboration Likelihood Model*; Petty & Cacioppo, 1986). Additionally, irrelevant intervention components may be discarded, and thus the time and delivery costs spent for the implementation of the interventions reduced. Finally, the success of the intervention may not only be evaluated by behaviour change, but also by stage transitions towards the goal behaviour as intermediate outcome. To date, the effects of matching interventions to stages are contentious: Interventions matched to the stages of change of the TTM added little to the intervention effectiveness of unmatched interventions (see Noar, Benac, & Harris, 2007, for a meta-analysis). However, intervention effectiveness largely depends on the factors being targeted. Planning, which proved effective for action initiation and maintenance (*Chapter 4*), for example is not included in the processes that are proposed to be responsible for change within the TTM. *Chapter 5* identified a stage-specific prediction pattern of social-cognitive factors that are open for change. It may cautiously be inferred that targeting the factors that were identified as relevant for stage transitions in this thesis and previous research regarding stage-specific factors included in the HAPA (Schüz, Sniehotta, Mallach, Wiedemann, & Schwarzer, 2008) might improve the effectiveness of stage-matched interventions. Though this is a question for future experimental research, some considerations will be outlined in the following.

In all stages of behaviour change, strengthening self-efficacy seems be promising (*Chapter 5*). The strongest source of self-efficacy that might be targeted is *mastery experience* (Bandura, 1997). Mastery experience could be targeted by prompting a transfer of self-efficacy beliefs from other successfully mastered tasks that were similar to the challenges that the individual faces in the respective stage of behaviour change (e.g., the

initiation of a difficult task in intenders). Causes for this earlier mastery experience have to be attributed as being stable and internal (Bandura, 1997). Preintenders might additionally profit from interventions that emphasize positive consequences of the target behaviour to shape individuals positive outcome expectancies (*Chapter 5*; e.g., see Prestwich et al., 2003 for stage-unspecific effects on physical activity).

Chapter 4 and previous research (e.g., Lippke et al., 2004; Sheeran et al., 2005) suggest that individuals intending to adopt a health behaviour would benefit from action planning and coping planning interventions, and the intervention design reported in *Chapters 3* and *4* might guide future computer-based planning interventions. Findings from *Chapter 5* suggest targeting social support as additional resource factor. Social support components may be critical in interventions targeting health behaviour change (e.g., Schwarzer, Knoll, & Rieckmann, 2004; van Dam et al., 2005). However, the diversity of conceptualizations, sources, and types of social support complicates the accumulation of the existing knowledge to derive specific implications on how to match social support to stages. Further research might therefore aim to advance knowledge on how social support may be matched to stages. In the TTM, helping relationships are conceptualized vaguely as being more relevant in later stages of change (Adams & White, 2003).

According to findings from *Chapters 4*, actors would benefit from combined action planning and coping planning interventions. According to the supposed 'self-tailoring' process observed in the study reported in *Chapter 4*, and previous research (Sniehotta, Schwarzer et al., 2005; Ziegelmann et al., 2006) specifically coping planning might match the needs of actors that need to self-regulate the maintenance of their behaviour. In particular, their 'expert knowledge' on personal risk situations and realistic, suitable coping responses might help them to generate effective coping plans.

To conclude, the findings in this dissertation are important for research and practice: The interplay between volitional planning processes, and their relation to motivational processes was further elucidated, and theory-based planning interventions probed regarding their effects under different conditions, and with a focus on their working mechanism in a field setting. Furthermore, planning was explicitly tested within a stage

approach. Further studies may follow the theoretical rationale of the empirical studies, and apply the presented evaluation strategies to further the understanding of behaviour change, and the development of effective theory-based and evidence-driven interventions.

References

Adams, J., & White, M. (2003) Are activity promotion interventions based on the transtheoretical model effective? A critical review *British Journal of Sports Medicine*, **37**, 106-114.

Araújo-Soares, V., McIntyre, T., & Sniehotta, F. F. (in press). Predicting changes in physical activity amongst adolescents: The role of self-efficacy, intention, action planning and coping planning. *Health Education Research*.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.

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.

Burkert, S., Knoll, N., & Scholz, U. (2005). Korrelate der Rauchgewohnheiten von Studierenden und jungen Akademikern: Das Konzept der dyadischen Planung [Correlates of smoking habits among students and young academics: The concept of dyadic planning]. *Psychomed, 17,* 240-246.

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

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Earlbaum Associates.

Cohen, A.- L., Jaudas, A., & Gollwitzer, P. M. (2008). Number of cues influences the cost of remembering to remember. *Memory & Cognition, 36*, 149-156.

Conner, M. T., (2008). Initiation and maintenance of health behaviours. *Applied Psychology, 57*(1), 42-50.

Fuchs, R. (1996). Causal models of physical exercise participation: Testing the predictive power of the construct 'Pressure to change'. *Journal of Applied Social Psychology, 21*, 1931-1960.

Gollwitzer, P. M. (2006). Open questions in implementation intention research. *Social Psychological Review*, *8*, 14-18.

Gollwitzer, P. M., & Sheeran, P. (2006). Implementation intentions and goal achievement: A meta-analysis of effects and processes. *Advances in Experimental Social Psychology*, *38*, 70-110.

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

Howard, G. S. (1980), "Response-shift bias: a problem in evaluating interventions with pre/post self-reports", *Evaluation Review, 4*(1), 93-106.

Hunter, J. E. & Schmidt, F. L. (1990). Methods of meta-analysis: Correcting error and bias in research findings. Newbury Park, CA: Sage.

Jackson, C., Lawton, R., Knapp, P., Raynor, D. K., Conner, M., Lowe, C., et al. (2005). Beyond intention: Do specific plans increase health behaviors in patients in primary care? A study of fruit and vegetable consumption. *Social Science and Medicine, 60*, 2383-2391.

Jones, H., Edwards, L., Vallis, T. M., Ruggiero, L., Rossi, S. R., Rossi, J., et al. (2003). Changes in diabetes self-care behaviors make a difference in glycemic control: The diabetes stages of change (DiSC) study. *Diabetes Care, 26,* 732-737.

Judd, C. M., & Kenny, D. A. (1981). Process analysis: Estimating mediation in treatment evaluations. *Evaluation Review*, 5, 602-619.

Knoll, N, & Schwarzer, R. (2005). Soziale Unterstützung [Social support]. In N. Birbaumer, D. Frey, J. Kuhl, W. Schneider, & R. Schwarzer (Eds.) & R. Schwarzer (Vol. Ed.), *Enzyklopädie der Psychologie, Series X, Vol. 1: Gesundheitspsychologie* (pp. 333-349). Göttingen, Germany: Hogrefe.

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

Lippke, S., & Plotnikoff, R. C. (in press). The protection motivation theory within the stages of the transtheoretical model - Stage-specific interplay of variables and prediction of stage transitions. *British Journal of Health Psychology.*

Lippke, S., Wiedemann, A. U., Ziegelmann, J. P., Reuter, T., & Schwarzer, R. (in press). Self-efficacy moderates the mediation of intentions into behavior via plans. *American Journal of Health Behavior.*

Lippke, S., Ziegelmann, J. P., & Schwarzer, R. (2004). Initiation and maintenance of physical exercise: Stage-specific effects of a planning intervention. *Research in Sports Medicine, 12*, 221-240.

Lippke, S., Ziegelmann, J. P., Schwarzer, R., & Velicer, W. F. (in press). Validity of stage assessment in the adoption and maintenance of physical activity and fruit and vegetable consumption. *Health Psychology.*

Luszczynska, A. (2006). An implementation intention interventions, the use of a planning strategy, and physical activity after myocard infarction. *Social Science and Medicine, 62*, 900-908.

Michie, S., Sheeran, P., & Rothman, A. (2007). Advancing the science of behaviour change. *Psychology & Health, 22,* 249-253.

Michie, S., & Abraham, C. (2004). Interventions to change health behaviours: Evidence-based or evidence inspired? *Psychology & Health, 19,* 29-49.

Michie, S., Dormandy, E., & Marteau, T. M. (2004). Increasing screening uptake amongst those intending to be screened: The use of action plans. *Patient Education and Counseling, 55*, 218-222.

Muller D., Judd C. M., & Yzerbyt V. Y. (2005). When moderation is mediated and mediation is moderated. *Journal of Personality and Social Psychology, 89,* 852-863.

National Heart, Lung, and Blood Institute (1998). *Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults: The Evidence Report.* Bethesda, MD: National Institutes of Health.

Noar, S. M., Benac, C., & Harris, M. (2007). Does tailoring matter? Meta-analytic review of tailored print health behavior change interventions. *Psychological Bulletin, 133*, 673-693.

Norman, P., & Conner, M. (2005). The theory of planned behavior and exercise: Evidence for the mediating and moderating roles of planning on intention-behavior relationships. *Journal of Sport & Exercise Psychology, 27*, 488-504.

Petty, R. E., & Cacioppo, J. T. (1986) *Communication and persuasion: Central and peripheral routes to attitude change.* New York: Springer.

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods, 40*, 879-891.

Preacher, K. J., Rucker, D. D., & Hayes, A.F. (2007). Addressing moderated mediation hypotheses: Theory, methods, and prescriptions. *Multivariate Behavioral Research, 42*, 185-227.

Prestwich, A., Conner, M. T., Lawton, R. J., Bailey, W., Litman, J., & Molyneaux, V. (2005). Individual and collaborative implementation intentions and the promotion of breast self-examination. *Psychology & Health, 20*, 743-760.

Prestwich, A., Lawton, R.J., & Conner, M.T. (2003). The use of implementation intentions and the decision balance sheet in promoting exercise behaviour. *Psychology & Health, 18*, 707-721.

Reuter, T., Ziegelmann, J. P., Wiedemann, A. U., & Lippke, S. (2008). Dietary planning as a mediator of the intention-behavior relation: An experimental-causal-chain design. *Applied Psychology: An International Review. Special Issue: Health and Well-Being, 57*, 194-207.

Reuter, T., Ziegelmann, J. P., Wiedemann. A. U., Lippke, S., Schüz, B., & Aiken, L. S. (2008). *Planning bridges the intention-behavior ggap: Age makes a difference and strategy use explains why.* Manuscript submitted for publication.

Rutter, D. R., Steadman, L., & Quine, L. (2006). An implementation intentions intervention to increase uptake of mammography. *Annals of Behavioral Medicine, 32*, 127-134.

Sallis, J. F., Hovell, M. F., Hofstetter, C. R., & Barrington, E. (1992). Explanation of vigorous physical activity during two years using social learning variables. *Social Science and Medicine, 34*, 25-32.

Scholz, U., Nagy, G., Göhner, W., Luszczynska, A., & Kliegel, M. (in press). Changes in self-regulatory cognitions as predictors of changes in smoking and nutrition behaviour. *Psychology & Health*.

Scholz, U., Schüz, B., Ziegelmann, J.P., Lippke, S., & Schwarzer, R. (2008). Beyond behavioral intentions: planning mediates between intentions and physical activity. *British Journal of Health Psychology, 13*, 479-494.

Scholz, U., Sniehotta, F. F., Burkert, S., & Schwarzer, R. (2007). Increasing physical exercise levels: Age-specific benefits of planning. *Journal of Aging and Health, 19*, 851-866.

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,* 135-151.

Schüz, B., Sniehotta, F. F., Mallach, N., Wiedemann, A. U., & Schwarzer, R. (2008). Predicting transitions from preintentional, intentional and actional stages of change: Adherence to Oral Self-Care Recommendations. *Health Education Research.* Advance online publication. DOI: 10.1093/her/cym092.

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. 217-243). Washington, DC: Hemisphere.

Schwarzer, R., Schüz, B., Ziegelmann, J. P., Lippke, S., Luszczynska, A., & Scholz, U. (2007). Adoption and maintenance of four health behaviors: Theory-guided longitudinal studies on dental flossing, seat belt use, dietary behavior, and physical activity. *Annals of Behavioral Medicine, 33,* 156-166. DOI: 10.1007/BF02879897

Schwarzer, R. (2008). Modeling health behavior change: How to predict and modify the adoption and maintenance of health behaviors. *Applied Psychology, 57*(1), 1-29.

Schwarzer, R., & Knoll, N. (2007). Functional roles of social support within the stress and coping process: A theoretical and empirical overview. *International Journal of Psychology, 42*, 243-252.

Schwarzer, R., Knoll, N., & Rieckmann, N. (2004). Social support. In A. Kaptein & J. Weinman (Eds.), *Health Psychology* (pp. 158-182). Oxford, England: Blackwell.

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

Skår, S., Prestwich, A., Araújo-Soares, V., Molloy, G. J., Lawton, R., Conner, M., & Sniehotta, F. F. (2008). *Do brief online planning interventions embedded in lifestyle surveys change health behaviour? Two randomised controlled trials.* Manuscript under review.

Sniehotta, F. F. (in press). Towards a theory of intentional behaviour change: Plans, planning and self-regulation. *British Journal of Health Psychology.*

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 & Health, 20*, 143-160.

Sniehotta, F. F., Scholz U, Schwarzer R, Behr H, Fuhrmann B, Kiwus U, & Völler H. (2005). Long-term effects of two psychological interventions on physical exercise and self-regulation after coronary rehabilitation. *International Journal of Behavioral Medicine*, *12*, 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,* 565-576.

Steele, B. C., Holt, L., Belza, B., Ferris, S., Lakshminaryan, S., & Buchner, D. M. (2000). Quantitating physical activity in COPD using a triaxial accelerometer. *Chest, 117*, 1359-1367.

Stone, A. A., & Shiffman, S. (2002). Capturing momentary self-report data: a proposal for reporting guidelines. *Annals of Behavioral Medicine, 24*, 236-143.

Sutton, S. (2008). How does the Health Action Process Approach (HAPA) bridge the intention-behavior gap? An examination of the model's causal structure. *Applied Psychology, 57*, 66-74.

Taylor, A. B., MacKinnon, D. P., & Tein, J. Y. (2008). Tests of the three-path mediated effect. *Organizational Research Methods, 11,* 241-269.

van Dam, H. A., van der Horst, F. G., Knoops, L., Ryckman, R. M., Crebolder, H. F., & van den Borne, B. H. (2005). Social support in diabetes: A systematic review of controlled intervention studies. *Patient Education and Counseling, 59*(1), 1-12.

van den Berg, M. H., Schoones, J. W., & Vliet Vlieland, T. P. (2007). Internet-based physical activity interventions: A systematic review of the literature. *Journal of Medical Internet Research, 9*(3): e26.

Velicer,W.F., & Prochaska, J.O. (1999). An expert system intervention for smoking cessation. *Patient Education and Counseling. 36*, 119-129.

Webb, T. L. (2006) Getting things done: Self-regulatory processes in goal pursuit. *Social Psychological Review, 8*, 2-13.

Webb, T. L., & Sheeran, P. (2006). Does changing behavioural intentions engender behavior change? A meta-analysis of the experimental evidence. *Psychological Bulletin*, *132*, 249-268.

WHO (2003). *Diet, nutrition and the prevention of chronic diseases. Report of a joint WHO/FAO expert consultation.* Retrieved December 10th, 2008, www.who.int/hpr/NPH/docs/who_fao_expert_report.pdf.

Wiedemann, A. U. (2008). *Experimental variation of the quantityof plans - RCT on fruit and vegetable intake (Research project: Wiedemann, A. U., Richert, J. M., Lippke, S., & Schwarzer, R.).* Berlin: Freie Universität Berlin.

Yang, H., Petersen, G. M., Roth, M.-P., Schoenfield, L. J., & Marks, J. W. (1992). Risk factors for gallstone formation during rapid loss of weight. *Digestive Diseases and Sciences, 37*, 912-918.

Zanna, M. P., & Fazio, R. H. (1982). The attitude-behavior relation: Moving toward the third generation of research. In M. P. Zanna, E. T. Higgins, & C. P. Herman (Eds.), Consistency in social behavior: The Ontario Symposium (Vol. 2, pp. 283-301). Hillsdale, NJ: Erlbaum.

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

Curriculum Vitae

Amelie U. Wiedemann

Der Lebenslauf ist in dieser Online-Version der Arbeit
aus Gründen des Datenschutzes nicht enthalten.

List of Publications

* indicates papers which are part of the dissertation.

Journal articles (2006-2008)

Lippke, S., & Wiedemann, A. U. (2007). Sozial-kognitive Theorien und Modelle zur Beschreibung und Veränderung von Sport und körperlicher Bewegung - ein Überblick [Social-cognitive theories and models to describe and change sport and physical activity]. *Zeitschrift für Sportpsychologie, 14,* 139-148.

Lippke, S., Wiedemann, A. U., Ziegelmann, J. P., Reuter, T., & Schwarzer, R. (in press). Self-efficacy moderates the mediation of intentions into behavior via plans. *American Journal of Health Behavior.*

Reuter, T., Ziegelmann, J. P., Wiedemann, A. U., & Lippke, S. (2008). Dietary planning as a mediator of the intention-behavior relation: An experimental-causal-chain design. *Applied Psychology: An International Review. Special Issue: Health and Well-Being, 57*, 194-207.

Schüz, B., Sniehotta, F. F., Mallach, N., Wiedemann, A. U., & Schwarzer, R. (2008). Predicting transitions from preintentional, intentional and actional stages of change: Adherence to Oral Self-Care Recommendations. *Health Education Research.* Advance online publication. DOI: 10.1093/her/cym092.

Schüz, B., Sniehotta, F.F., Wiedemann, A. U., & Seemann, R. (2006). Adherence to a daily flossing regimen: Effects of planning when, where, how, and what to do in the face of barriers. *Journal of Clinical Periodontology, 33*, 612-619.

*Wiedemann, A. U., Schüz, B., Sniehotta, F. F., Scholz, U., & Schwarzer, R. (2008). Disentangling the relation between intentions, planning, and behaviour: A moderated mediation analysis. *Psychology & Health.* Advance online publication. DOI: 10.1080/08870440801958214.

*Wiedemann, A. U., Lippke, S., Reuter, T., Schüz, B., Ziegelmann, J. P., & Schwarzer, R. (2008). Prediction of Stage Transitions in Fruit and Vegetable Intake. *Health Education Research.* Advance online publication. DOI: 10.1093/her/cyn061.

Paper under review

Reuter, T., Ziegelmann, J. P., Wiedemann, A. U., Lippke, S., Schüz, B., & Aiken, L. S. (2008). *Planning bridges the intention-behavior gap: Age makes a difference and strategy use explains why.* Manuscript submitted for publication.

Reuter, T., Ziegelmann, J. P., Wiedemann, A. U., Lippke, S., Schüz, B., Geiser, C., & Schwarzer, R. (2008). *Dynamics in health behavior change: An application of latent true change modeling.* Manuscript submitted for publication.

Schüz, B., Wiedemann, A. U., Mallach, N., & Scholz, U. (2008). *Effects of a behavioural intervention for dental flossing: RCT on planning when, where and how.* Manuscript submitted for publication.

*Wiedemann, A. U., Lippke, S., & Schwarzer, R. (2008). *Intervention effects on physical activity in different stage groups: The number of action plans and coping plans.* Manuscript submitted for publication.

*Wiedemann, A. U., Lippke, S., Reuter, T., Ziegelmann, J. P., & Schwarzer, R. (2008). *How planning facilitates behaviour change: Additive and interactive effects.* Manuscript submitted for publication.

Book chapters

Wiedemann, A. U. (in press). Zahnhygiene [Dental Hygiene]. In J. Bengel & M. Jerusalem (Eds.), *Handbuch der Psychologie (Band: Gesundheitspsychologie und Medizinische Psychologie)*. Göttingen, Germany: Hogrefe.

Wiedemann, A. U., & Lippke, S. (2008). Gesundheitspsychologische Sportförderung [Promotion of physical activity guided by health psychology]. In M. Schweer (Ed.). *Sport in Deutschland - Bestandsaufnahme und Perspektiven* . Frankfurt a. M., Germany: Peter Lang.

Miscellaneous

Schwarzer, R., Luszczynska, A., & Wiedemann, A. U. (in press). Perceived self-efficacy in health behaviour change. *Proceedings of the Fifth Self Biennial International Conference.*

Wiedemann, A. U., & Reuter, T. (2007). Voller Energie durch's Leben. Mit körperlicher Aktivität und gesunder Ernährung [A life full of energy - with physical activity and a healthy diet]. *Fundiert. Das Wissenschaftsmagazin der Freien Universität Berlin*, 1/2007, 18-23.

Selected presentations (first authorships only)

Wiedemann, A. U., Lippke, S., Reuter, T., Ziegelmann, J., Schüz, B., & Schwarzer, R. (2008). *Healthy eating: Effects of a self-regulation intervention.* Annual Meeting of the British Psychological Society (Division of Health Psychology) & the European Health Psychology Society, Bath, UK.

Wiedemann, A. U., Lippke, S., Reuter, T., Ziegelmann, J. P., & Schüz, B. (2008). *Effects of self-regulation on healthy dietary behavior and physical activity tested in a randomized controlled trial.* XXIX International Congress of Psychology, Berlin, Germany.

Wiedemann, A. U., Schüz, B., Schwarzer, R., Sniehotta, F. F. & Scholz, U. (2008). *Who benefits from planning?* XXIX International Congress of Psychology, Berlin, Germany.

Wiedemann, A. U., Schüz, B., Schwarzer, R., Sniehotta, F. F. & Scholz, U. (2007). *Intentions, Planning and Health Behaviour Change: Evidence for Moderated Mediation*. Health Psychology Review, 1 (Suppl.1), 162-163.

Wiedemann, A. U., Lippke, S., Reuter, T., Ziegelmann, J. P., & Schüz, B. (2007). *Stage-specific Effects of Strategic Planning on Fruit and Vegetable Consumption.* 6th Conference of the International Society of Behavioral Nutrition and Physical Activity, Oslo, Norway.

Wiedemann, A. U., Schüz, B., Schwarzer, R., Sniehotta, F. F. & Scholz, U. (2007). *Intentionen moderieren Mediationseffekte.* 8th Conference of the Division of Health Psychology of the German Psychological Society, Schwäbisch Gmünd, Germany.

Wiedemann, A. U., Schüz, B., & Sniehotta, F. F. (2006). *Probing Phase-Specific Self-Efficacy.* Psychology & Health, 21 (Suppl. 1), 162.

Wiedemann, A. U., & Lippke, S. (2006). *Gesundheitspsychologische Sportförderung.* Invited talk, University of Vechta, Germany.

Wiedemann, A. U., Schüz, B., & Sniehotta, F.F. (2005). *The Influence of Volitional Factors on Interdental Hygiene: Self-regulatory Strategies and Phase-specific Self-Efficacy*. Psychology & Health, 20 (Suppl. 1), 292.

Wiedemann, A. U., Schüz, B., & Sniehotta, F. F. (2005). *Der Einfluss volitionaler Faktoren auf Gesundheitsverhalten: Selbstregulative Strategien und phasenspezifische Selbstwirksamkeit.* In A. Helmes (Ed.) Lebensstiländerung in Prävention und Rehabilitation (p. 132). Lengerich: Pabst.

Erklärung

Hiermit versichere ich, dass ich die vorgelegte Arbeit selbständig verfasst habe. Andere als die angegebenen Hilfsmittel habe ich nicht verwendet. Die Arbeit ist in keinem früheren Promotionsverfahren angenommen oder abgelehnt worden.

Amelie U. Wiedemann

Berlin, Dezember 2008