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Self-Regulation of Health Behavior Change: A Developmental and Dynamic Perspective

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SELF-MANAGEMENT IS GOOD MEDICINE.

ALBERT BANDURA (2005)

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Abstract

Changing health behaviors involves more than a strong will. Self-regulatory skills and strategies are needed for the successful adoption and maintenance of health behaviors. However, the complex manner in which these factors relate to each other is not well understood. The aim of this thesis was to unravel the mechanisms that determine goal striving in the volitional phase of the process of health behavior change. The studies presented in this thesis focused on elaborating the simplistic intention-behavior relation and thus shedding light on postintentional factors that promote the translation of intentions into behavior.

Three main research questions were addressed: (1) Adopting a dynamic perspective, whether previous findings concerning the predictive power of volitional factors for health behavior change could be replicated by applying latent true change modeling, and thus, provide first answers on a long-standing question in health behavior change research on interindividual differences in intraindividual change and their determinants. (2) Whether there is experimental evidence for the causal assumption that planning mediates the intention-behavior relation employing an experimental-causal-chain design. (3) Taking a developmental perspective, whether age modifies the functional dependencies in the mediation of the intention-behavior relation through planning and whether given age differences can be explained by strategy use.

This thesis also aims to further advance theory, method and intervention development in the research field of health behavior change by applying recent state-of-the-art methodologies for analyzing longitudinal data that allow examining questions about dynamic relationships in the self-regulation framework of health behavior change and by employing an innovative experimental design for testing mediation hypotheses.

Zusammenfassung

Die Veränderung gesundheitsrelevanter Verhaltensweisen ist ein komplexer, selbstregulativer Prozess, in dem zahlreiche psychologische Einflussgrößen zusammenwirken. Eine starke Absicht das eigene Verhalten zu ändern, ist oft nicht ausreichend für die Aufnahme und Aufrechterhaltung einer neuen Verhaltensweisen. Die Frage, wie Menschen ihre Absichten in konkretes Verhalten umsetzen, bildet den Ausgangspunkt der vorliegenden Arbeit. Das sozial-kognitive Prozessmodell gesundheitlichen Handelns (Health Action Process Approach; HAPA; Schwarzer, 1992, 2008) stellt dabei den theoretischer Bezugsrahmen dar. Es legt besonderen Wert auf volitionale Mechanismen und führt eine explizite Selbstregulationsperspektive ein (siehe Abbildung 1).

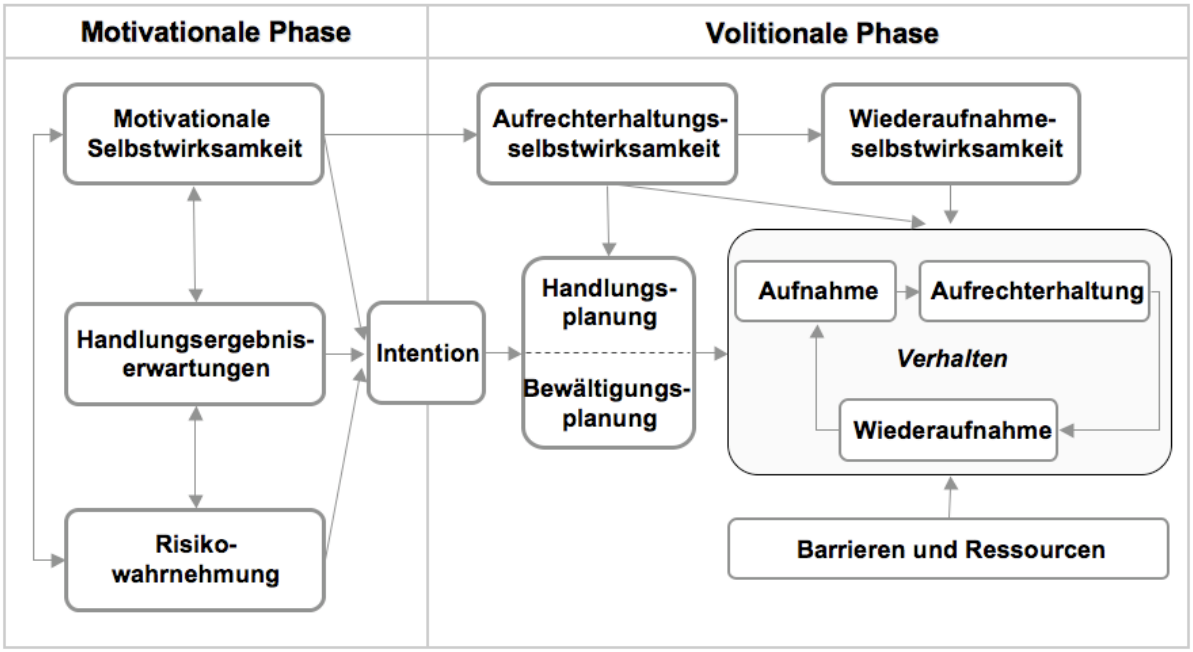

Abbildung 1. Das sozial-kognitive Prozessmodell des Gesundheitsverhaltens (Schwarzer, 1992, 2008)

Es wird angenommen, dass Menschen zunächst einen Entscheidungs- und Motivierungsprozess durchlaufen, der in einer Zielsetzung mündet (motivationale Phase). Daraufhin wird das intendierte Verhalten geplant, ausprobiert und gegebenenfalls dauerhaft in den Alltag integriert (volitionale Phase).

Bevor Menschen ihr Verhalten ändern, müssen sie eine Intention in Bezug auf ein bestimmtes Verhalten bilden. In dieser ersten, motivationalen Phase werden Menschen von Überzeugungen und Einstellungen geleitet. Dabei spielen die *Risikowahrnehmung* (die subjektive Einschätzung des Schweregrads von Erkrankungen sowie der eigenen Verwundbarkeit), die *Handlungs-Ergebnis-Erwartungen* (wahrgenommene Kontingenzen zwischen den eigenen Handlungen und deren Konsequenzen) und die Selbstwirksamkeitserwartungen (die Überzeugung, ein schwieriges Problem aufgrund eigener Handlungskompetenz erfolgreich lösen zu können) eine besondere Rolle. Die Motivationsphase mündet in der Bildung einer Intention.

In der volitionalen Phase spielen zwei Faktoren eine zentrale Rolle: Die Planung des Verhaltens und die Selbstwirksamkeitserwartung. Die Planung kann in zwei Facetten unterteilt werden: Die Handlungsplanung ist die Spezifizierung einer Intention durch Bestimmung des Zeitpunktes (wann), des Ortes (wo) und der Art (wie) der Handlung (Gollwitzer, 1999). Die Bewältigungsplanung stellt eine mentale Verknüpfung zwischen antizipierten Handlungsbarrieren und Strategien zur Überwindung dieser Barrieren her (Sniehotta, Scholz, & Schwarzer, 2006; Ziegelmann, Lippke, & Schwarzer, 2006). Die mentale Repräsentation zukünftiger Situationen erleichtert es dem Individuum, günstige Gelegenheiten der Verhaltensinitiierung eher und schneller wahrzunehmen und erhöht somit die Auftretenswahrscheinlichkeit des intendierten Verhaltens (Gollwitzer & Sheeran, 2006).

Eine weiterer zentraler Faktor ist die volitionale Selbstwirksamkeit, d.h. das Vertrauen in die eigene Fähigkeit, ein Verhalten trotz möglicher Barrieren aufrechtzuerhalten (Aufrechterhaltungsselbstwirksamkeit) und das Vertrauen in die eigene Fähigkeit, nach Rückfällen in alte Gewohnheiten oder Pausen ein Verhalten wieder aufzunehmen (Wiederaufnahmeselbstwirksamkeit). Menschen mit hoher Selbstwirksamkeitserwartung vertrauen stärker darauf, über effektive Handlungsressourcen zu verfügen, als Menschen mit niedriger Selbstwirksamkeitserwartung. Dies beeinflusst wiederum, wie Barrieren und

Hindernisse wahrgenommen werden. Somit steigen mit zunehmender Selbstwirksamkeitserwartung die Zielvorgaben und die Bereitschaft, diese Ziele zu verfolgen (Bandura, 1997).

Die Bedeutsamkeit der getrennten Betrachtung motivationaler und volitionaler Prozesse hat eine lange Tradition in der psychologischen Forschung zielorientierten Handelns (Heckhausen & Gollwitzer, 1987; Lewin, Dembo, Festinger, & Sears, 1944). Während die motivationalen Prozesse der *Intentionsbildung* bereits recht gut mit Theorien der Gesundheitspsychologie beschrieben werden können, sind die volitionalen Prozesse der *Intentionsrealisierung* noch weitgehend unerforscht. Die vorliegende Arbeit untersucht das komplexe Zusammenwirken insbesondere volitionaler Faktoren auf die Verhaltensänderung. Dabei wird eine Prozessperspektive eingenommen, indem das komplexe und dynamische Zusammenspiel volitionaler Faktoren modelliert wird. Mit der Einbettung der handlungstheoretischen Lebensmanagementstrategien der Selektion, Optimierung und Kompensation (SOK; Freund & Baltes, 2002) in das volitionale Selbstregulationsmodell der Gesundheitsverhaltensänderung wird ferner eine entwicklungstheoretische Perspektive eingenommen (vgl. Ziegelmann et al., 2006).

Der Schwerpunkt der vorliegenden Arbeit liegt auf den folgenden Forschungsfragen: (1) Lassen sich die Annahmen zum Zusammenwirken von Intentionen, Selbstwirksamkeitserwartungen, Planung und Verhalten unterstützen, wenn Assoziationen zwischen Veränderungen dieser Variablen modelliert werden? (2) Gibt es experimentelle Evidenz für die Annahme, dass die Handlungsplanung eine vermittelnde Variable (Mediatorvariable) in der Intentions-Verhaltens-Beziehung darstellt? (3) Gibt es altersspezifische Effekte in der Umsetzung von Intentionen in Verhalten über Planungsaktivitäten und wenn ja, welche zugrunde liegenden Mechanismen erklären diese Altersunterschiede? Die Untersuchung dieser Forschungsfragen wird in den Kapiteln 2-4 dargestellt.

Das erste Kapitel bietet eine Einführung in den theoretischen Hintergrund der vorliegenden Arbeit. *Kapitel 2* nimmt eine dynamische Perspektive ein und untersucht das Wirkmodell volitionaler Faktoren der Gesundheitsverhaltensänderung als dynamischen Prozess von Veränderungsbeziehungen ab. Eine gängige Praxis bisheriger längsschnittlicher Forschung war es, ein Verhalten mit Ausprägungen in Prädiktoren, die zu einem früheren Zeitpunkt gemessen wurden (Baseline-Werten), vorherzusagen. So wurde zum Beispiel mit der Verhaltensintention zum ersten Zeitpunkt und der Planung zum zweiten Zeitpunkt das Verhalten zum dritten Zeitpunkt prädiziert. Aus den statischen Assoziationen dieser Variablen wurde geschlussfolgert, dass Veränderungen in Intentionen und Planung mit Veränderungen im Verhalten einhergehen. Eine derartige Schlussfolgerung lässt sich aber nur ziehen, wenn tatsächlich Veränderungen zwischen diesen Variablen gemessen und modelliert werden. Mit latenten Veränderungsmodellen (latent true change models; Steyer, Eid, & Schwenkmezger, 1997; Steyer, Partchev, & Shanahan, 2000) konnte in der vorliegenden Längsschnittstudie gezeigt werden, dass Veränderungen im Verhalten (körperliche Aktivität und Obst- und Gemüsekonsum) mit Veränderungen in Intentionen, Selbstwirksamkeitserwartungen und Planung vorhergesagt werden können. Weiterhin wurde deutlich, dass der Einfluss der Veränderungen in Intentionen und Selbstwirksamkeit auf Veränderung im Verhalten durch Veränderungen in Planung mediiert wird.

Kapitel 3 beschreibt die experimentelle Überprüfung der Annahme, dass die Handlungsplanung den Zusammenhang zwischen Intentionen und Verhalten mediiert. Bei einer Mediation wird der Einfluss eines distalen Faktors (z.B. Intention) über proximale Faktoren (z.B. Planung) auf ein Verhalten vermittelt. Die Rolle der Planung als Mediator der Intentions-Verhaltens-Beziehung wird mit Hilfe eines Experimental-Causal-Chain Designs (Spencer, Zanna, & Fong, 2005) untersucht. In einem solchen Design wird sowohl die unabhängige Variable (Intention) als auch die Mediatorvariable (Planung) experimentell manipuliert. Am Beispiel des Obst- und Gemüseverzehrs wurden zwei randomisierte längsschnittliche Experi-

mentalstudien durchgeführt. Beide Studien fanden im betrieblichen Setting im Rahmen der betriebsärztlichen Untersuchung von Beschäftigten der Deutschen Bahn AG statt. In der ersten Studie wurden die Teilnehmer, die keine Absicht hatten, ihren Obst- und Gemüsekonsum zu verändern, nach dem Zufallsprinzip einer Experimental- oder einer Kontrollbedingung zugeteilt. Bei den Teilnehmern der Experimentalgruppe wurden Risikowahrnehmung, Handlungsergebniserwartungen und Selbstwirksamkeitserwartungen angesprochen. Vier Wochen nach der Ersterhebung wurden die Teilnehmer mit postalisch zugesandten Nachfolgefragebogen nach ihren Planungsaktivitäten befragt. Es zeigte sich, dass Personen der Experimentalgruppe mehr Planungsaktivitäten berichteten als Personen der Kontrollgruppe. Die Ergebnisse einer hierarchischen Regressionsanalyse weisen darauf hin, dass in der Experimentalgruppe Veränderungen in Intentionen mit Veränderungen in Planungsaktivitäten einhergehen.

In einer zweiten Studie wurden die Teilnehmer, die bereits die Absicht hatten, täglich fünf Portionen Obst und Gemüse zu verzehren, zufällig einer Planungsgruppe oder einer Kontrollgruppe zugeordnet. In der Planungsgruppe planten die Teilnehmer wann, wo und wie sie fünf Portionen Obst und Gemüse am Tag zu sich nehmen wollen. Einen Monat nach der Ersterhebung erhielten die Teilnehmer Nachfolgefragebogen, mit denen der Obst- und Gemüseverzehr erfasst wurde. Die Ergebnisse zeigen, dass Personen der Experimentalgruppe mehr Obst- und Gemüseverzehr berichteten als Personen der Kontrollgruppe. Wiederum bestätigt eine hierarchische Regressionsanalyse, dass Veränderungen in Planungsaktivitäten mit Veränderungen im Verhalten einhergehen.

Kapitel 4 nimmt eine Entwicklungsperspektive ein und untersucht, ob sich die Mediatorfunktion der Planung über verschiedene Altersgruppen als konstant erweist. In einem moderierten Mediationsmodell wurde untersucht, ob das Alter den Mediatoreffekt der Planung in der Intentions-Verhalten-Beziehung moderiert. Angenommen wurde, dass Individuen mit zunehmendem Alter ihre Handlungs- und Bewältigungspläne effektiver in Verhalten umsetzen

können. Als zugrunde liegender Mechanismus für diesen Altersunterschied wird vermutet, dass älteren Erwachsene mehr Wissen über eigene Ressourcen und Handlungsbarrieren zur Verfügung steht und sie Strategien der Selektion, Optimierung und Kompensation (SOK; Baltes & Baltes, 1990) nutzen, um ihre Pläne erfolgreich auszuführen. In einem ersten Analyseschritt zeigte die Analyse einen kontinuierlichen Anstieg des indirekten Effekts des Einflusses von Intention auf Verhalten über Planung mit zunehmendem Alter. In einem zweiten Pfadmodell zeigte sich, dass Strategienutzung den Interaktionseffekt von Alter und Planung auf das Verhalten erklärt. Die Ergebnisse weisen darauf hin, dass Individuen im mittleren Erwachsenenalter besonders von Planung profitieren, da sie Strategien nutzen, um ihre Pläne zu realisieren. Daher scheint es sinnvoll zu sein, Planungsinterventionen mit Strategietrainings zu kombinieren, um die Umsetzung von Plänen in Handlung zu erleichtern.

Das abschließende fünfte Kapitel ist der Diskussion und Interpretation der Ergebnisse gewidmet, die weiterführende Planungen zur zukünftigen Forschung insbesondere volitionaler Mechanismen der Gesundheitsverhaltensänderung implizieren.

In methodischer Hinsicht lagen die Schwerpunkte der Arbeit in (1) der Analyse von Assoziationsbeziehungen zwischen latenten Differenzvariablen mit Hilfe von Latent True Change Modellen (Steyer et al., 1997; 2000), (2) der erstmaligen Anwendung eines experimentellen Designs (experimental-causal-chain design; Spencer et al., 2005) zur Überprüfung der Annahme, dass Planung die Intentions-Verhaltens Beziehung mediiert und (3) zur Überprüfung von Alter als Moderator dieses Mediationseffekts (moderierte Mediation; Preacher, Rucker, & Hayes, 2007) und von Strategienutzung als Mediator des Interaktionseffekts zwischen Planung und Alter (mediierte Moderation; Morgan-Lopez & MacKinnon, 2006).

Zusammengefasst konnten mit den Ergebnissen aus den drei Kapiteln die Befunde bisheriger Forschung gestützt werden. Für die erfolgreiche Aufnahme oder Änderung gesundheitsbezogenen Handelns ist es entscheidend, dass es gelingt, sich günstige Situationen für die

Handlungsrealisierung vor Augen zu führen und Bewältigungsoptionen für Risikosituationen zur Verfügung zu haben. Hier spielen sowohl die Handlungsplanung und Bewältigungsplanung als auch die Strategienutzung eine besondere Rolle. Die wahrgenommene Selbstwirksamkeit ist während der Handlungsversuche unter anderem dazu erforderlich, Hindernisse zu überwinden, und sich immer wieder, auch bei Rückschlägen, zu erneuten Versuchen zu motivieren.

Die Betrachtung der Prozesse der Gesundheitsverhaltensänderung aus der Perspektive der Lebensspanne (cf. Ziegelmann et al., 2006) kann zu wertvollen Erkenntnisfortschritten führen. Zahlreiche Entwicklungsprozesse sind direkt mit Gewinnen und Verlusten und somit mit einhergehenden Ressourcen und Barrieren für die Gesundheitsverhaltensänderung verbunden. Die gesundheitspsychologische Forschung kann davon profitieren, den adaptiven Umgang mit diesen Veränderungen über die Lebensspanne genauer zu untersuchen. Die Nutzung von Strategien der Zielauswahl und -verfolgung kann Menschen jeden Alters das Erreichen von Gesundheitszielen erleichtern. Beispielhaft sei hier die Nutzung von Selektionsstrategien im Sinne eines fokussierten Investierens von Ressourcen in ausgewählte Ziele oder Kompensationsstrategien zur Erreichung ausgewählter Ziele trotz mangelnder Ressourcen oder bei Verlusten erwähnt. Für das Verstehen der Prozesse der Gesundheitsverhaltensänderung kann die Strategienutzung neben den gut untersuchten volitionalen Konstrukten der Handlungs- und Bewältigungsplanung sowie der Selbstwirksamkeitserwartungen einen zusätzlichen Beitrag liefern.

Chapter 1

Introduction

Introduction

Changing health behaviors involves dynamic and complex self-regulation processes. Various self-regulatory cognitions and skills have been identified that are relevant for the adoption and maintenance of health behaviors. However, the complex manner in which these factors relate to each other is not well understood. The present thesis will explore the interplay of predictors derived from theories of health behavior and present empirical evidence for a causal chain in the process of health behavior change. Furthermore, it aims to investigate age as a moderator in the self-regulatory framework as well as explanatory variables for underlying age differences.

Theories of Health Behavior

Most health behavior theories are limited to the processes of goal setting (i.e., intention formation), assuming that the behavioral intention is the most immediate and important predictor of behavior. According to these theories, the development of an intention is determined by certain cognitions, for instance, beliefs and attitudes (e.g., Fishbein & Ajzen, 1975). Therefore, in the past, the focus of health behavior theories has been on identifying a parsimonious set of factors in order to predict a person's intention and subsequent behavior. These predictors include constructs such as perceived barriers, social norms, disease severity, personal vulnerability, or perceived self-efficacy. The most prominent approaches are the Theory of Reasoned Action, the Theory of Planned Behavior, and the Protection Motivation Theory (for an overview and critique of these and other models, see Armitage & Conner, 2000; Schwarzer, 1992). In such models, the phenomenon of health behavior change is often reduced to only motivational processes that lead to the formation of an intention.

Only few theories take into account processes by which an individual's health behavior may evolve over time. Individuals cycle in between phases of goal setting, goal pursuit, and goal attainment (and maintenance) or, goal disengagement (Maes & Karoly, 2005). The contention that the process of goal-oriented action involves at least two different phases,

namely a motivation phase and a volition phase, was introduced by Lewin, Dembo, Festinger, and Sears (1944). This concept of action phases implies a temporal order in the behavior change process. The motivation phase of goal setting is followed by a volition phase of goal pursuit. Consequently, goal setting (or forming an intention) is a necessary but not sufficient prerequisite for goal attainment. Volitional self-regulatory skills and strategies are assumed to foster the successful translation of intentions into action (Gollwitzer, 1999). A model that construes health behavior change as a process of goal setting and goal pursuit rather than a single decision to change is the Health Action Process Approach (HAPA; Schwarzer, 1992, 2008). At first, motivational processes (i.e., risk perception, outcome expectancies, self-efficacy) lead to a setting of a behavioral intention. Subsequently, volitional processes (i.e., planning and self-efficacy) lead to the adoption and maintenance of a specific health behavior (see Figure 1).

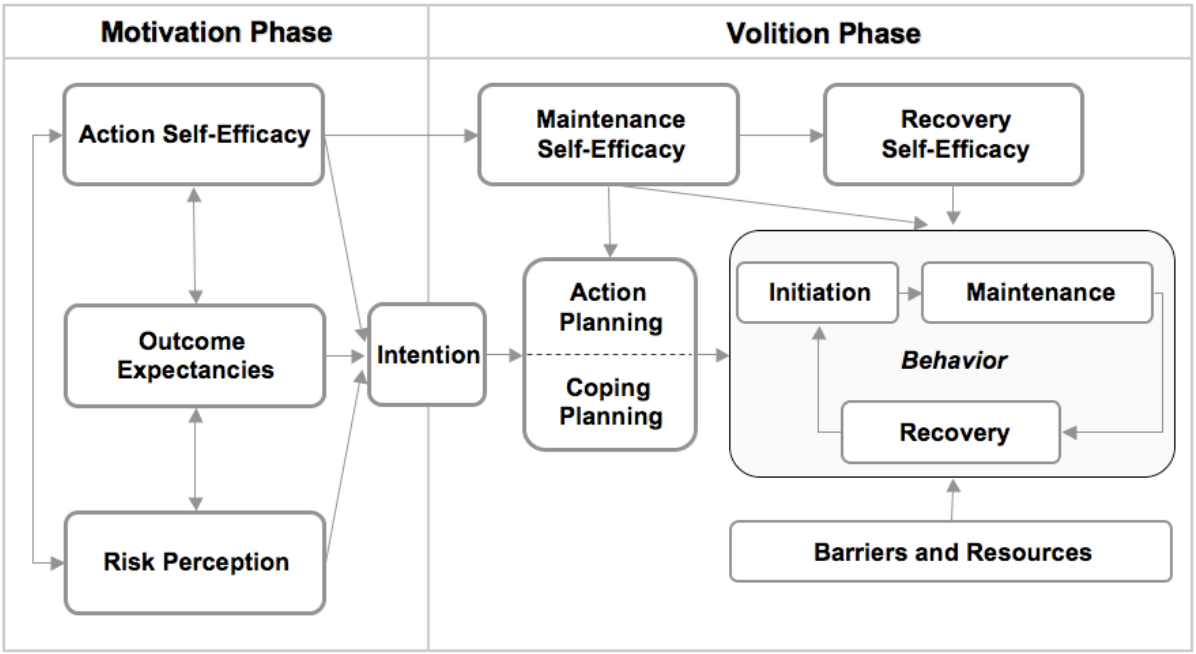

Figure 1. Action phases and determinants according to the Health Action Process Approach.

The notion of action phases in the process of health behavior change implies that individuals proceed through at least two qualitatively distinct phases when changing their

behaviors: a motivation phase and a volition phase. In the following, the two action phases as well as the most important constructs are described in more detail.

In the motivation phase, risk perception - a person's perceived vulnerability to a certain disease - induces a person to reflect upon consequences and competencies concerning the behavior in question. According to the HAPA model, a person mentally balances positive and negative consequences of realizing the behavior. That elaboration process leads to positive or negative outcome expectancies that determine the strength of an intention to adopt the behavior. Furthermore, the belief in one's own capability (i.e., motivational self-efficacy) to perform a new or difficult behavior is a prerequisite for intention formation.

Once a behavioral intention is formed, an individual is assumed to enter a volition phase of active goal pursuit and goal maintenance. Individuals face various obstacles when pursuing a goal such as distractions (Locke & Latham, 2002, 2006; Metcalfe & Mischel, 1999), forgetting (Orbell, Hodgkins, & Sheeran, 1997), or conflicting bad habits (Verplanken & Faes, 1999). Research on the role of planning in health behavior change began with Leventhal, Singer, and Jones (1965) who suggested that fear appeals may only be effective in producing a health behavior when specific parameters of the situation (when, where) and an action sequence (how) are provided.

More recently, the concept of implementation intentions has been introduced (Gollwitzer, 1999). In the process of if-then planning (i.e., forming an implementation intention), an action sequence is linked to specific parameters of a situation in terms of when, where, and how to perform a behavior. Holding such a mental representation in a critical situation is assumed to lead to an immediate and efficient behavioral response without conscious awareness. As underlying working mechanisms of implementation intentions, increased information processing mechanisms in terms of increased accessibility, recall, detection, and discrimination of critical cues have been identified (Webb & Sheeran, 2007, 2008).

Planning can also be addressed to anticipated obstacles. The mental simulation of how to deal with barriers is called coping planning (Sniehotta, Scholz, & Schwarzer, 2006; Ziegelmann, Lippke, & Schwarzer, 2006). Empirical evidence suggests that the combination of action and coping planning is beneficial: Sniehotta and colleagues (2006) found that an increase in physical exercise could be achieved by an intervention that combined action and coping plans but not with an intervention based on action plans alone.

Furthermore, the HAPA introduces the concept of perceived volitional self-efficacy such as the beliefs in one's capabilities to maintain a desired action (maintenance self-efficacy) and to recover from lapses (recovery self-efficacy). Whereas maintenance self-efficacy is specified to have a direct effect and indirect effects (through planning and recovery self-efficacy) on behavior, recovery self-efficacy is assumed to directly influence behavior.

Individuals with high levels of perceived maintenance and recovery self-efficacy are more likely to expend effort and to sustain in the face of obstacles and failures (Luszczynska & Schwarzer, 2003; Scholz, Sniehotta, & Schwarzer, 2005). These phase-specific self-efficacy beliefs reflect the different mindsets as well as the different tasks that have to be mastered in different phases of the health behavior change process. A person who is confident to be able to initiate a new behavior (motivational self-efficacy) is not necessarily confident to be able to maintain the newly acquired behavior over time or to re-initiate the behavior after lapses (Scholz et al., 2005).

The integration of volitional factors helps to better understand the process of health behavior change and allows for a better account of behavior variance (Luszczynska & Schwarzer, 2003; Sniehotta, Scholz, & Schwarzer, 2005). In addition, those volitional factors can be targeted in interventions to foster sustained health behavior change over six months (Ziegelmann et al., 2006).

A Developmental Perspective

"Extending longevity: Dignity gain - or dignity drain?" is an article's title by Paul B. Baltes (2003) which summarizes precisely the Janus-faced view on aging. Most of us want to become old, but not be old. Despite major increases in life expectancy, the aging population is characterized by an increasing prevalence of dysfunctionality and morbidity. Aging is related to physical and mental decline, which is in turn associated with losses in subjective functioning such as the sense of wellbeing and psychological autonomy.

However, the foundations of successful aging can be laid early in life (Baltes & Smith, 2003). According to Rowe and Kahn (1987, 1997) not aging per se but rather a sedentary lifestyle, personal habits, diet, and a variety of psychosocial factors are held to be the major components of age-related decline. This notion is supported by longitudinal studies that show four times less cumulative lifetime disability and a postponed onset of disability for several years in individuals that show few behavioral health risks compared to individuals with more risk factors even after adjusting for a wide range of possible confounding variables (Vita, Terry, Hubert, & Fries, 1998; Wang, Ramey, Schettler, Hubert, & Fries, 2002).

Changing health-risk behaviors is therefore crucial for reducing risk factors for lifetime cumulative morbidity, disability, and functional decline and for the maintenance and recovery of functioning when approaching the maximum lifespan. By means of prevention strategies, an aim of gerontological research can be pursued: to add life to years instead of merely adding years to life. A self-determined healthy lifestyle might offer promising potentialities for Baltes and Smith's (2003) request for new theoretical and practical endeavors to deal with the aforementioned societal challenges.

In the last years, research in the field of health psychology has increasingly been undertaken from a life-span developmental perspective (e.g., H. Leventhal, E. A. Leventhal, & Schaefer, 1991; Scholz, Sniehotta, Burkert, & Schwarzer, 2007; Ziegelmann et al., 2006). Especially, young and middle adulthood received an increased attention as a particularly

important period in life to investigate health behaviors (e.g., Aldwin & Levenson, 2001). It is during this phase of life when losses in the health domains are impending. Thus, health-related goals become increasingly influential in midlife (Hooker & Kaus, 1994).

The processes that underlie the adoption and maintenance of health behaviors may vary over age. For both theory development and the design of age-sensitive intervention, it is important to consider age-associated changes in self-regulation of health behaviors. Previous studies have tested whether the theoretical assumptions of the HAPA are applicable to different age groups. For instance, Ziegelmann and Lippke (2007) investigated the functional dependencies among the social-cognitive determinants and their direct and indirect effects on physical exercise in structural equation models. The authors found that the HAPA model accounts for the same amount of explained variance in physical exercise applying for younger (18-49 years) and older adults (50-80 years). However, this study was conducted in an orthopedic rehabilitation setting, in which older as well as younger adults have encountered serious health conditions. Experience with health problems and disease may increase health concerns that influence motivational and volitional processes of health-promoting behaviors.

In a general sample from a public health screening of young, middle-aged, and old adults, Renner, Spivak, Kwon, and Schwarzer (2007) found that intentional and volitional factors (i.e., planning and coping self-efficacy) accounted for 20% of variance in physical activity among middle-aged and older adults (36-90 years), but only for 6% among younger adults (16-35 years). The authors conclude that the explanatory power of the HAPA is greater for older adults (who are more likely to experience health problems) than for relatively young and healthy adults. Thus, the extent to which models of health behavior change generalize to different age groups has to be examined in further studies.

Methodological considerations

Aside from theoretical concerns, there are desiderata for methodological improvements in the field of health behavior research. Traditional research has been concerned with

predicting between-person variation using health behavior theories (Sutton, 2004). In this line, a typical question might be “Why do some individuals engage in a particular behavior while others do not?” However, much less is known about within-person change, for instance, “Is an increase in perceived self-efficacy associated with an increase in behavior across occasions within an individual?”

Empirical research is often restricted to analyzing static relations, i.e., behavior at Time 2 is regressed on a predictor at Time 1, rather than dynamic relations such as status-change or even change-change associations (e.g., change in one variable may trigger change in other variables). Thus, inappropriate methods of analysis are used to draw inferences about processes that occur within individuals over time (Sutton, 2002). This assumption can only be tested with prospective research designs and models that depict differences in change across measurement occasions. Such models of change can be used to examine factors that predict growth and decline in particular health behaviors.

The extent to which documented between-person differences in health behavior can be applied to within-individual variation in health behavior over time remains an open question. Research on interindividual differences in intraindividual change offers to provide insights on promoting and impeding factors that may contribute to differential change.

Furthermore, empirical research consists predominantly of observational, non-experimental studies to test theories of health behavior (Lippke & Ziegelmann, 2008; Sutton, 2002). Experimental evidence in health behavior research is still sparse. Especially, the analysis of causal chains or mediation hypotheses, i.e., the assumption that causal effects are carried over by mediating variables, lacks experimental evidence. Mediation analysis is commonly employed to gather support for a causal sequence of relationships (e.g., "intention causes planning causes initiation of health behavior"). However, the typical approach of applying statistical mediation analysis to observational data through regression analysis models is increasingly criticized (cf. Spencer, Zanna, & Fong, 2005). Such statistical

mediational analysis as proposed by Baron and Kenny (1986) is fundamentally correlational analysis; any causal inference from such analysis requires that a demanding set of assumptions be met (Cohen, Cohen, West, & Aiken, 2003). However, even if observational data are ordered in time through the use of longitudinal panel data (e.g., predictor at Time 1, mediator at Time 2, criterion at Time 3), associations of variables over time do not necessarily imply causal sequences. There are other possible explanations of correlations of longitudinal data, among them spuriousness (Link & Shrout, 1992; MacKinnon, 2008; MacKinnon & Luecken, 2008).

Spencer, Zanna, and Fong (2005) argue that a series of experiments that demonstrates the putative causal chain is superior to a statistical mediation analysis. In such ”experimental-causal-chain designs” (Spencer et al., 2005), both the independent variable and the mediating variable are manipulated, which allows causal inferences about the chain of events.

Aims of the present thesis and outline

A number of self-regulatory skills and beliefs have been identified that promote the translation of intentions into behavior. However, the complex interplay between these constructs is not yet well understood. The present dissertation aims to apply methodological advances in longitudinal data analysis and to employ an innovative research design for investigating the relatively young research field of volitional goal striving in health behavior change. The findings may be helpful to further advance theory and intervention development in the research field of health behavior change.

First, recent methodological advances of analyzing longitudinal data allow examining some longstanding questions in health behavior change theory about dynamic (i.e., change-change relationships) rather than static relationships and thus identifying processes that occur within individuals. The first study aims to examine the value of interindividual differences in intraindividual change in volitional factors for predicting interindividual differences of within-person change in two health behaviors (*Chapter 2*).

The second study relates to the application of an experimental-causal-chain design that allows an experimental test of intervening variables (i.e., mediators) in the process of health behavior change. A special focus will be placed on planning as a powerful self-regulatory tool when it comes to translate intentions into behavior (*Chapter 3*).

A third aim relates to the identification of moderators in the self-regulation framework of health behavior change. More specifically, chronological age might modify the functional dependencies in the mediation of the intention-behavior relation through planning. Strategy use that includes selection, optimization, and compensation (SOC; P. Baltes & M. Baltes, 1990) is investigated as an underlying mechanism for given age-differential mechanisms in behavior regulation.

The findings for these research questions are presented in *Chapter 2* to *Chapter 4*. Finally, *Chapter 5* provides a general discussion of the findings of the thesis and gives implications for interventions and future research.

References

Aldwin, C. M., & Levenson, M. R. (2001). Stress, Coping, and Health at Mid-Life: A Developmental Perspective. In M. E. Lachman (Ed.), *The Handbook of Midlife Development* (pp. 188-214). New York: Wiley.

Armitage, C. J., & Conner, M. (2000). Social cognition models and health behaviour. *Psychology and Health, 15*, 173-189.

Baltes, P. B. (2003). Extending longevity: Dignity gain - or dignity drain? *MaxPlanckResearch, 3*, 15-19.

Baltes, P. B., & Baltes, M. M. (1990). Psychological perspectives on successful aging: The model of selective optimization with compensation. In P. B. Baltes & M. M. Baltes (Eds.), *Successful aging: Perspectives from the behavioral sciences* (pp. 1-34). New York: Cambridge University Press.

Baltes, P. B., & Smith, J. (2003). New frontiers in the future of aging: From successful aging of the young old to the dilemmas of the fourth age. *Gerontology, 49*, 123-135.

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*, 1173–1182.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences* (3rd ed.). Mahwah, NJ: Erlbaum.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.

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

Hooker, K., & Kaus, C. R. (1994). Health-related possible selves in young and middle adulthood. *Psychology and Aging, 9*, 126-133.

Leventhal, H., Leventhal, E. A., & Schaefer, P. (1991). Vigilant coping and health behavior: A life span problem. In M. Ory & R. Abeles (Eds.), *Aging, Health, and Behavior* (pp. 109-140). Baltimore: Johns Hopkins.

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.

Lewin, K., Dembo, T., Festinger, L. A., & Sears, P. S. (1944). Level of aspiration. In J. McV. Hunt (Ed.), *Personality and the behavior disorders* (Vol. 1, pp. 333–378). New York: Ronald.

Link, B. G., & Shrout, P. E. (1992). Spurious associations in longitudinal research. *Research in Community and Mental Health, 7*, 301–321.

Lippke, S., & Ziegelmann (2008). Theory-Based Health Behavior Change: Developing, Testing, and Applying Theories for Evidence-Based Interventions. *Applied Psychology: An International Review, 57*(4), 689-716.

Locke, E. A., & Latham, G. P. (2002). Building a practically useful theory of goal setting and task motivation: A 35-year odyssey. *American Psychologist, 57*, 705-717.

Locke, E. A., & Latham, G. P. (2006). New directions in goal-setting theory. *Current Directions in Psychological Science, 15,* 265-268.

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

MacKinnon, D. (2008). *Statistical mediation analysis.* New York: Lawrence Erlbaum Associates.

MacKinnon, D. P., & Luecken, L. J. (2008). How and for whom? Mediation and moderation in health psychology. *Health Psychology. Suppl. Issue: Mediation and Moderation, 27*, 2, 99-100.

Maes, S., & Karoly, P. (2005). Self-regulation assessment and intervention in physical health and illness: A review. *Applied Psychology: An International Review, 54*(2), 267–299.

Metcalfe, J., & Mischel, W. (1999). A hot/cool-system analysis of delay of gratification: Dynamics of willpower. *Psychological Review, 106*, 3-19.

Orbell, S., Hodgkins, S., & Sheeran, P. (1997). Implementation intentions and the theory of planned behavior. *Personality and Social Psychology Bulletin, 23,* 945-954.

Renner, B., Spivak, Y., Kwon, S., & Schwarzer, R. (2007). Does age make a difference? Predicting physical activity of South Koreans. *Psychology and Aging, 22,* 482-493.

Rowe, J. W., & Kahn, R. L. (1987). Human aging: Usual and successful. *Science, 237*, 143-149.

Rowe, J. W., & Kahn, R. L. (1997). Successful aging. *Gerontologist, 37*, 433-440.

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 & Exercise Psychology, 27,* 135-151.

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: An International Review, 57*(1), 1-29.

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

Spencer, S. J., Zanna, M. P., & Fong, G. T. (2005). Establishing a causal chain: Why experiments are often more effective than mediational analyses in examining psychological processes. *Journal of Personality and Social Psychology, 89,* 845-851.

Sutton, S. (2002). Testing attitude–behaviour theories using non-experimental data: An examination of some hidden assumptions. *European Review of Social Psychology, 13*, 293–323.

Sutton, S. (2004). Determinants of health-related behaviours: Theoretical and methodological issues. In S. Sutton, A. Baum & M. Johnston (Eds*.), The Sage handbook of health psychology* (pp. 94-126). London: Sage.

Verplanken. B., & Faes, S. (1999). Good intentions, bad habits, and effects of forming implementation intentions on healthy eating. *European Journal of Social Psychology, 29,* 591-604.

Vita, A. J., Terry, R. B., Hubert, H. B., & Fries, J. F. (1998). Aging, health risks, and cumulative disability. *New England Journal of Medicine, 338*, 1035-1041.

Wang, B. W. E., Ramey, D. R., Schettler, J. D., Hubert, H. B., & Fries, J. F. (2002). Postponed Development of Disability in Elderly Runners: A 13-Year Longitudinal Study. *Archives of Internal Medicine, 162* (20), 2285 - 2294.

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.

Ziegelmann, J. P., & Lippke, S. (2007). Planning and strategy use in health behavior change: A life span view. *International Journal of Behavioral Medicine, 14,* 30-39.

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.

Chapter 2

Dynamics in Health Behavior Change: An Application of Latent True Change Modeling

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Abstract

This study demonstrates the application of latent true change (LTC) modeling to investigate mechanisms of behavior change in two health behaviors. Examining interindividual differences in within-person change allows modeling dynamic rather than static relations between social-cognitive determinants and behavior. Changes in intention, self-efficacy, and planning are examined as predictors of changes in two health behaviors (physical activity and fruit and vegetable intake). In a longitudinal study, *N*=1,949 individuals filled in questionnaires about intention, planning, self-efficacy, and behaviors at baseline and four weeks later. Interindividual differences in change were analyzed using LTC models. For both behaviors, similar prediction patterns were found. The present study demonstrates the usefulness of LTC modeling when analyzing change in several variables simultaneously.

Keywords: latent change analysis; longitudinal confirmatory factor analysis; latent difference models; behavior change

Dynamics in Health Behavior Change: An Application of Latent True Change Modeling

Latent true change (LTC) modeling is an approach for examining interindividual differences in intraindividual change and was introduced by Steyer, Eid, and Schwenkmezger (1997; see also McArdle & Hamagami, 1988, 2001; Steyer, Partchev, & Shanahan, 2000). The core idea of latent true change models is to specify a structural equation model in such a way that the true change scores between two occasions of measurement are the values of latent variables. Latent true change models allow analyzing the dynamics and synchronicity of change processes. Latent change variables can serve as explanatory and/or outcome variables. Using latent change variables as explanatory variables allows analyzing how change in one variable predicts observed or latent outcome variables. Using latent change variables as outcome variables allows predicting true change by potential observed or latent predictors. Additionally, latent change variables can serve to examine how change in one variable triggers change in other variables. An important advantage of using latent change variables rather than observed difference scores is that measurement error is taken into account.

This approach is especially useful when analyzing behavior change processes, because it involves dynamic and complex processes. In the past, most health behavior research focuses on modeling static relations between social-cognitive predictors and behavior rather than examining dynamic relations between predictors and behavior (e.g., Lippke, Nigg, & Maddock, 2007). This study aims at shedding light on the predictive value of changes in intention, self-efficacy, and planning for behavior change regarding two behaviors (physical activity and fruit and vegetable intake). The present study is one of the first to apply latent true change modeling for investigating complex associations among multiple latent difference scores.

Latent change variables

In contrast to observed change variables, latent change variables have the advantage that measurement error is taken into account. Observed change scores are often even more distorted by measurement error than single occasion scores given that both the pretest and posttest score are measured with measurement error. The error of both time points affects the observed change score. The latent change variables, on the other hand, depict inter-individual differences in intra-individual change corrected for measurement error (Steyer et al., 1997; 2000).

Steyer et al. (1997) argue that true intraindividual change models offer several advantages compared to the latent growth curve approach when modeling change. In traditional latent growth curve models, certain components (such as the linear and/or the quadratic component) of intraindividual change are correlated with covariates or regressed on potential predictors. These change components are modeled to fit all measurement occasions and do therefore not allow modeling intraindividual change between two specific measurement occasions. Furthermore, in latent growth curve models, one usually assumes a specific form of the latent growth curves (e.g., linear growth). In contrast, latent change models do not make any restrictive assumptions regarding the specific functional form of change. In such models, "pure" latent change variables (i.e., the true intraindividual change itself), and not a particular component of change, may be correlated with or regressed on other variables. Hence, Steyer and colleagues (1997) argue that true intraindividual change models offer a more direct approach to modeling change and a more fine-grained analysis of individual development.

Health behavior theories

Self-regulated health behavior change is a complex endeavor and consists of goal setting (i.e., intention formation) and goal pursuit (enacting intentions). However, most health behavior theories assume that behavioral intention is the most immediate and important predictor of behavior (e.g., Fishbein & Ajzen, 1975). This notion has been thwarted by a

substantial body of research suggesting that intentions alone do not suffice to change behavior (e.g., Sheeran, 2002). Lewin, Dembo, Festinger, and Sears (1944) distinguished two phases in goal-oriented action, namely a motivation phase of goal setting that is followed by a volition phase of goal pursuit. A model that construes health behavior change as a process of goal setting and goal pursuit rather than a single decision to change is the Health Action Process Approach (HAPA; Schwarzer, 2008). Goal setting (or intention formation) is seen as a necessary but not sufficient prerequisite for goal attainment. Individuals face various obstacles when pursuing a health goal such as distractions, forgetting, or conflicting bad habits. Volitional self-regulatory strategies and beliefs (such as planning and perceived self-efficacy) are assumed to facilitate the successful translation of intentions into action.

Planning health behavior change

Making a plan when, where, and how to act can facilitate goal achievement; people are much more likely to act upon their goals when generating such a plan (cf. Gollwitzer & Sheeran, 2006, for a review). Research on the role of planning in health behavior change began with Leventhal, Singer, and Jones (1965) who suggested that fear appeals may only be effective in producing health behavior change when specific parameters of the situation and an action sequence are provided. More recently, the concept of implementation intentions has been introduced (Gollwitzer, 1999). When forming an implementation intention, the when and where of a situation are linked to an action sequence (how to perform the behavior). Planning in advance how to overcome possible internal or external barriers has similar effects: Goal-directed action in critical situations is much more likely than without such plans (coping planning; Sniehotta, Scholz, & Schwarzer, 2006; Ziegelmann, Lippke, & Schwarzer, 2006). Holding such a mental representation in a critical situation is assumed to lead to an immediate behavioral response without conscious awareness. Increased information processing in terms of increased accessibility, recall, detection, and discrimination of critical cues have been

identified as underlying working mechanisms of implementation intentions (Webb & Sheeran, 2007, 2008).

To date, research has accumulated abundant evidence for the effectiveness of planning (for an overview, see Gollwitzer & Sheeran, 2006). In the HAPA model, planning is specified as a mediator of the relationship between intention and behavior, i.e., intention exerts their influence on behavior through planning (Schwarzer, 2008).

Perceived self-efficacy

Individuals with optimistic beliefs in their abilities to maintain a desired action (maintenance self-efficacy) and to recover from lapses (recovery self-efficacy) are more successful in adopting and maintaining a novel course of action (Luszczynska & Schwarzer, 2003; Luszczynska, Tryburcy, & Schwarzer, 2007; Scholz, Sniehotta, & Schwarzer, 2005; Wiedemann, Schüz, Sniehotta, Scholz, & Schwarzer, in press). Someone who lacks confidence in being able to maintain a certain behavior is less likely to engage in planning and to adopt a novel course of action (Lippke, Wiedemann, Ziegelmann, Reuter, & Schwarzer, in press). Such volitional, optimistic self-beliefs promote perseverance in the face of barriers (Bandura, 1997). Thus, volitional self-efficacy is assumed to be crucial for both, engagement in planning and change in behavior.

Examining health behavior change

Empirical research on health behavior change is often restricted to analyzing static relations rather than dynamic relations such as status-change or even change-change associations (e.g., change in one variable may trigger change in other variables). Furthermore, cross-sectional research designs and inappropriate methods of analysis have been used to draw inferences about processes that occur within individuals over time (Lippke & Ziegelmann, 2008; Sutton, 2002). Even in longitudinal studies, behavior change is often predicted using baseline levels of social-cognitive variables. On the basis of such results, it is concluded that changes in social-cognitive variables lead to changes in behavior. However, status-change

associations do not necessarily have to be equivalent to change-change associations. This assumption can only be tested with prospective research designs and models that depict differences in change across measurement occasions. Such models of change can be used to examine factors that predict growth and decline in particular health behaviors.

Only a few studies have modeled intraindividual processes with the aim of gaining more insight into how people can be supported to translate their intentions into action. Using latent growth curve models, Sniehotta, Nagy, Scholz, and Schwarzer (2006) found that level and change of action control, as a volitional self-regulatory process, were distinct predictors of changes in intentions and physical exercise. In another study, Scholz, Nagy, Göhner, Luszczynska, and Kliegel (in press) examined in two studies how changes in motivational and volitional predictors are associated with change in dietary (low-fat diet) and smoking behavior and their respective behavioral intentions. Change in self-efficacy turned out to be a crucial factor of change in intention in both studies and change in behavior in one study. Change in planning was only associated with change in dietary but not in smoking behavior. In addition, in both studies, change in action control was consistently associated with changes in behavior. These first results regarding change associations between social-cognitive predictors and behavior need to be replicated using different behaviors (e.g., increasing health behaviors instead of reducing risk behaviors) and contexts to reach reliable conclusions.

Research question and hypotheses

The present study aims to examine and predict change in physical activity and fruit and vegetable intake from change in intention, change in self-efficacy, and change in planning. It is expected that individual degrees and directions of changes in these social-cognitive variables are related to subsequent changes in behavior. Changes in self-efficacy and intention are expected to positively predict differential change in planning. Change in planning, in turn, is assumed to positively predict change in behavior. The effects of change in intention and change in self-efficacy on change in behavior are assumed to be mediated by change in

planning. Furthermore, the predictive power of baseline differences in self-efficacy and intention on changes in planning and changes in behavior as well as baseline differences in planning on changes in behavior will be tested (see Figure 2).

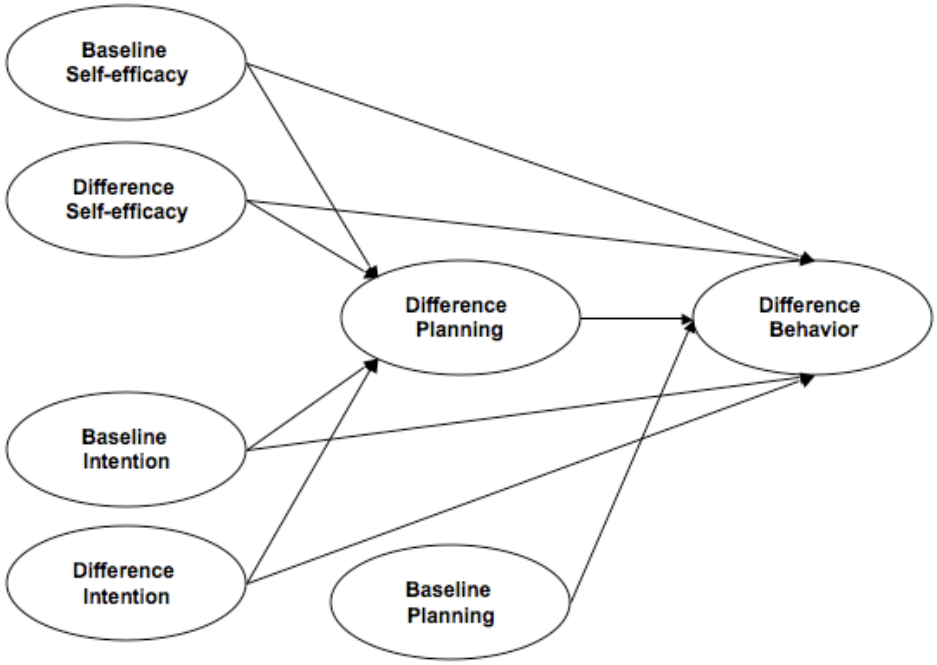


Figure 2. Conceptual model.

Method

Participants

Data were collected in an online study using the software dynQuest (Rademacher & Lippke, 2007). The study was advertised at different websites and newspapers. Two thousand seven hundred and ninety-eight individuals responded to the initial web page linked to a self-administered questionnaire; 1,948 individuals (69.6%) were considered as participants at Time 1 (T1) after they had completed the questionnaire and provided their e-mail addresses in order to receive an invitation for a follow-up assessment. The time lag between Time 1 and follow-up measurement was 4 weeks (Time 2, T2). Eight hundred and fifty-three participants

answered the follow-up questionnaire at Time 2. The longitudinal sample consisted of 77.5% women. Participants had a mean age of 37.4 years, *SD* = 12.62, range = 18-78 years. 53.5% of this sample reported being unmarried and 75.7% to have a senior high school degree.

No significant differences ($p < .05$) between the initial sample and those who completed both measurement points in social-cognitive variables (i.e., intention, self-efficacy, and planning) were found. Small, albeit statistically significant differences in baseline behavior indicate that those retained reported more physical activity (effect size $d = .17$) and fruit and vegetable intake ($d = .13$) than those lost to follow-up. Differences appeared in terms of sex (more men dropped out), education (persons without a high school degree were more likely to drop out), and age (older participants were more likely to drop out, $d = .10$). However, according to Cohen (1992) effect sizes of this magnitude indicate only small differences between the longitudinal sample and the initial one, thus indicating that the longitudinal sample is to a large degree representative of the sample at baseline.

Measures

Time 1 and Time 2 questionnaires were identical and scales were taken from Schwarzer (2008) and adapted for the current setting. If not indicated otherwise, response format for all scales was a four-point Likert scale ranging from 1 (*disagree*) to 4 (*agree*). Intention, self-efficacy, planning, and self-reported behavior were assessed regarding two behaviors: physical activity and fruit and vegetable intake. Item examples were translated from German.

The *self-efficacy* scale comprised two items for each behavior, such as “I am confident that I can maintain to eat five servings of fruit and vegetables a day even if it’s difficult” (maintenance self-efficacy for fruit and vegetable intake) or “I am confident that I can restart being physically active even if I was not for several days” (recovery self-efficacy for physical activity).

Planning was measured with two items per behavior, such as, "I have already precisely planned when, where, and how to eat five servings of fruit or vegetables throughout the day" (action planning for fruit and vegetable intake) or "I have already precisely planned how I can be physically active even in the face of difficulties and barriers" (coping planning for physical activity).

Behavioral intentions were measured by a single item for each behavior: "I intend to perform strenuous physical activity (i.e., with an increased heart rate and sweating) in my leisure-time" and "I intend to eat five servings of fruit and vegetables a day".

Fruit and vegetable intake was assessed by two items: "How often did you eat 5 servings of fruit and vegetables a day during the last four weeks?" The response format was a six-point Likert scale ranging from 1 (*never*) to 6 (*always*). The second item was answered in an open-ended format: "Regarding the last four weeks: How many portions of fruit and vegetables did you eat on an average day?" Participants received detailed information about portion sizes. Similar single-item measures of fruit and vegetable intake have been validated successfully against dietary biomarkers (Steptoe, Perkins-Porras, McKay, Rink, Hilton, & Cappuccio, 2003).

Physical activity was assessed with two items: "During the last four weeks, how often did you manage to be physically active for 3 days per week for at least 30 minutes in your leisure-time with an increased heart rate and sweating?" Responses were scored on a six-point Likert scale ranging from 1 (*never*) to 6 (*always*). The second item was worded "I have performed physical activity and sports for at least 30 minutes per week in my leisure time (e.g., gym, playing soccer) with an increased heart rate and sweating". Responses were scored on a four-point scale with 1 (*less than once*), 2 (*at least once*), 3 (*at least 3 times*), and 4 (*at least 5 times*) per week regarding the last four weeks. The external validity of a similar scale was demonstrated by Siconolfi, Lasater, Snow, and Carleton (1985).

Latent Change Analyses

The basic idea of latent change modeling (Steyer et al., 1997; 2000) is that a latent state factor can be decomposed into the initial state factor and a latent difference factor - representing latent change from Time 1 (T1) to Time 2 (T2).

For an illustration, Figure 3 shows for one construct (self-efficacy) measured at two time points how a basic longitudinal confirmatory factor analysis model (latent state model, Panel A) can be reformulated as a latent change model (Panel B). This reformulation makes use of the (trivial) decomposition of the *T2 state factor* into *T1 state factor* plus *latent change score T2-T1*:

$$\text{Self-efficacy}_2 = 1 * \text{Self-efficacy}_1 + 1 * (\text{Self-efficacy}_2 - \text{Self-efficacy}_1) \quad (1)$$

This equation is easily implemented in the model shown in Figure 3 B. Note that the residual term for the T2 state factor is set to zero given that the T2 state is perfectly determined by initial status and change. Further note that the parameters of the measurement model (the loadings and intercepts) are held equal over time (see discussion below).

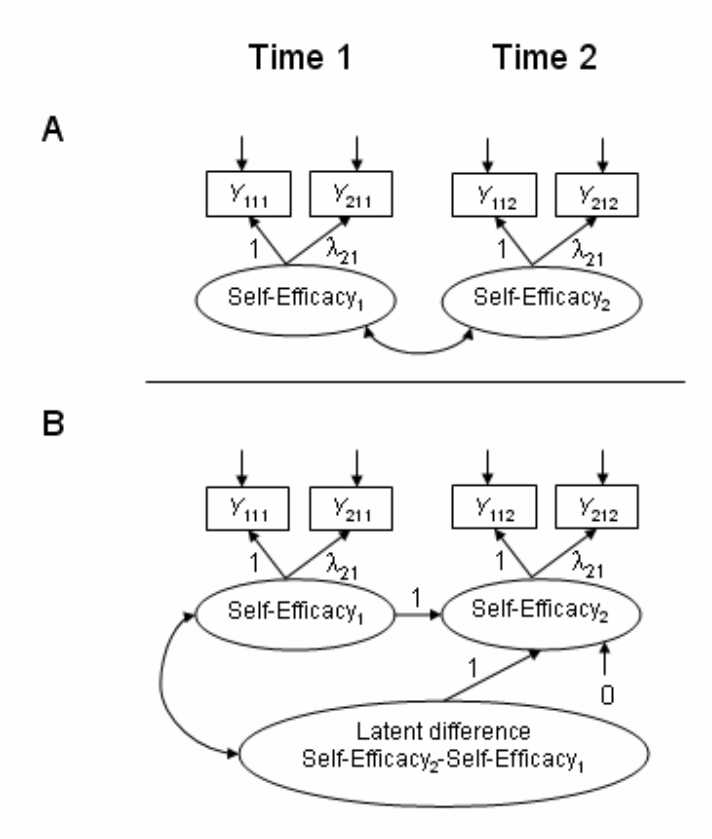


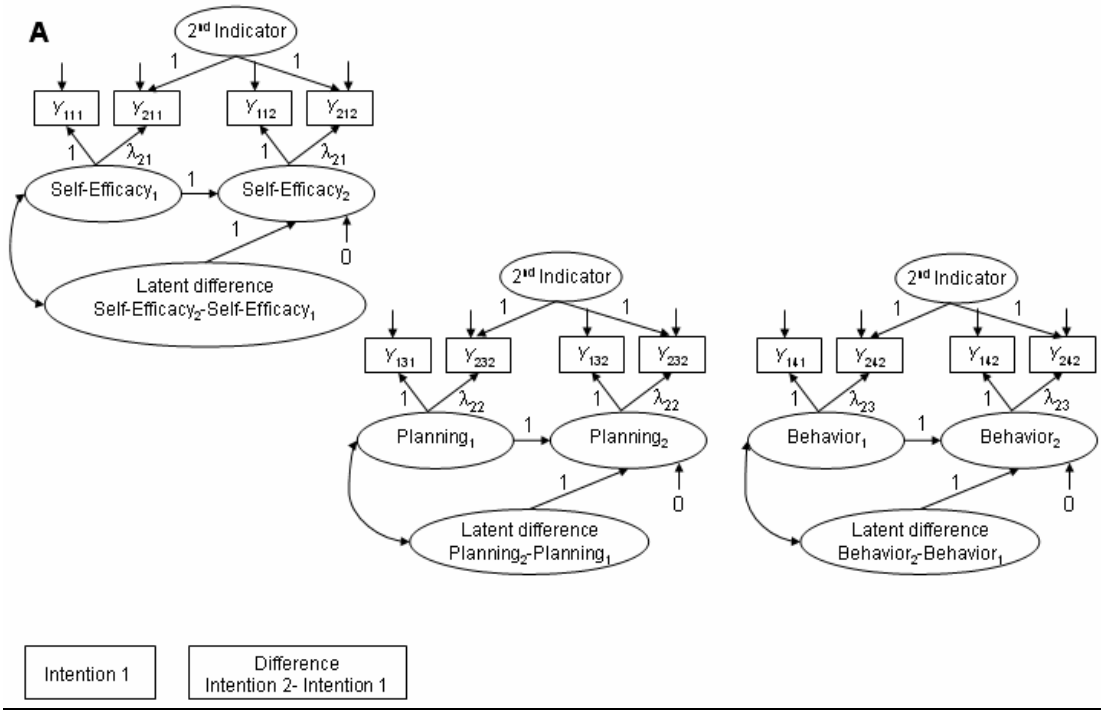
Figure 3. Longitudinal confirmatory factor analysis (latent state) model. Y_{ijk} denotes the *i*th observed variable measuring construct *j* on occasion *k*. A: Latent state model with correlated state factors. B: Reformulation of the latent state model as latent change model. The *T2 state factor* ist perfectly determined by the *T1 state factor* and *change* from T1 to T2 and thus has no residual term. The latent change model is just a reparametrization of the latents state model in Panel A. The factor loadings λ_{ij} have no occasion index *k* since invariance of factor loadings over time is assumed for all indicators. The models are identified by fixing the loading of the first indicator to one for each factor.

The latent change variables represent interindividual differences in intraindividual change and can be treated like any other factor in a structural equation model. They can, for example, be correlated with or regressed on other variables.

Figure 4 shows the complete latent change model estimated in the present study. For reasons of clarity, the measurement models with indicator-specific factors (Panel A) are shown separately from the structural model (Panel B). However, in our analyses the measurement models and the structural model were estimated simultaneously.

We specified change scores of self-efficacy and intention as well as baseline measures of self-efficacy and intention as predictors of the latent difference scores of planning as well as behavior. Moreover, latent change scores of planning and baseline planning were specified as predictors of behavior change. Intention was measured with a single item, thus, *state Intention*$_1$ and *difference Intention*$_2$*-Intention*$_1$ are observed variables. All Time 1 measures were allowed to correlate with each other as well as with all difference scores.

In our model specification, we assumed strong factorial invariance (i.e., equal factor loadings and intercepts for the same indicator) over time. Strong factorial invariance is required in order to allow for a meaningful interpretation of latent difference scores (cf. Steyer et al., 2000). For instance, if strong factorial invariance does not hold, an interpretation of latent mean differences would not be meaningful.



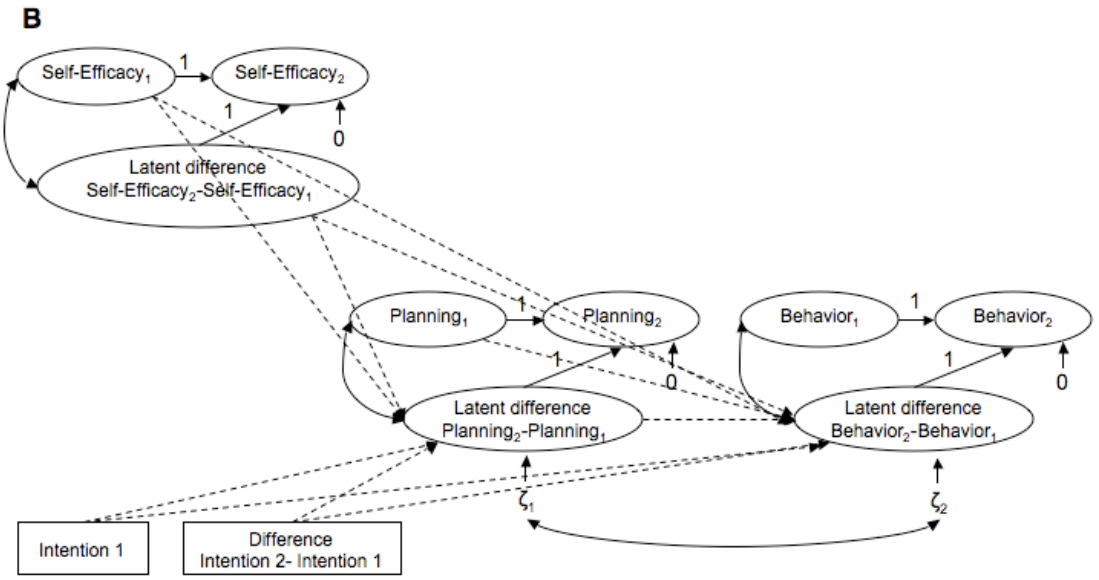


Figure 4. Latent change model. A: Measurement models with indicator-specific factors. The first indicators were selected as "reference indicators" for which no indicator-specific factors were specified. The models are identified by fixing the loading of the first indicator to one for each factor. *State Intention*$_1$ and *difference Intention*$_2$*-Intention*$_1$ are observed variables.
B: Structural model in which all variables can be correlated (except the *T2 state factors* which are completely determined by the *T1 state factors* and the *latent change factors*).
ζ_1–ζ_2 denote latent residual variables.

The problem auf auto-correlated error variables (for the same indicator over time) was accounted for by introducing indicator-specific (method) factors for the second indicator of each construct. Indicator-specific effects might be due to an unique item wording. Failure to account for systematic variable-specific variance can lead to model misspecification and biased parameter estimates (e.g., an overestimation of the stability of constructs). According to Eid, Schneider, and Schwenkmezger (1999), it is sufficient to use one indicator-specific factor less than the number of indicators per constructs. The loadings on the indicator-specific factors were also set equal over time by fixing them to 1 for both time points.

Mplus Version 3 (Muthén & Muthén, 2005) was used for model estimation. Full information maximum likelihood estimation (FIML, Arbuckle, 1996) was used to derive parameter estimates in the face of missing data; FIML makes use of all available data and is

preferred to listwise deletion or ad hoc strategies for handling missing data (Schafer & Graham, 2002).

Results

Goodness of fit. Model fit was assessed by examining χ^2, the comparative fit index (CFI), and the root-mean-square error of approximation (RMSEA). A satisfactory model fit is indicated by high CFI (> .95), and low RMSEA (< .05; Schermelleh-Engel, Moosbrugger, & Müller, 2003).

The latent change model for physical activity yielded a good fit: $\chi^2(38) = 71.6$; $p < .001$; CFI = .99; RMSEA = .021; 90% CI_{RMSEA} = .014, .029. The model fit for the latent change model for fruit and vegetable intake was also adequate: $\chi^2(38) = 128.4$; $p < .001$; CFI = .99; RMSEA = .035; 90% CI_{RMSEA} = .028, .042.

Table 1. Estimated Intercepts, Factor Loadings, and Variance Components in the Latent Change Model

Physical Activity	Intercept	State factor loading			Indicator-specific factor loading			Variance components		
		Estimate	*SE*	Standardized estimate	Estimate	*SE*	Standardized estimate	State	Indicator specific	Reliability
SE11	0.00*	1.00*	--	.80	--	--	--	.64	--	.64
SE21	-0.51[a]	1.04[g]	.06	.75	1.00*	--	.42	.56	.18	.73
SE12	0.00*	1.00*	--	.81	--	--	--	.66	--	.66
SE22	-0.51[a]	1.04[g]	.06	.78	1.00*	--	.44	.61	.19	.80
PL11	0.00*	1.00*	--	.85	--	--	--	.72	--	.72
PL21	0.20[b]	0.81[h]	.04	.73	1.00*	--	.37	.53	.14	.67
PL12	0.00*	1.00*	--	.89	--	--	--	.79	--	.79
PL22	0.20[b]	0.81[h]	.04	.77	1.00*	--	.39	.59	.15	.74
PA11	0.00*	1.00*	--	.94	--	--	--	.88	--	.88
BE21	0.67[c]	0.49[i]	.02	.77	1.00*	--	.33	.59	.11	.70
BE12	0.00*	1.00*	--	.90	--	--	--	.81	--	.81
BE22	0.67[c]	0.49[i]	.02	.76	1.00*	--	.32	.58	.10	.68

Note. SE = self-efficacy indicator; PL = planning indicator; BE = behavior indicator; the first number refers to the indicator, whereas the second number refers to the occasion of measurement. Fixed parameters are marked with an asterisk (*). Standard errors are not available for fixed parameters. Parameters set equal to each other (time invariant parameters) have the same superscript.

Fruit & Vegetable Intake	Intercept	State factor loading			Indicator-specific factor loading			Variance components		
		Estimate	*SE*	Standardized estimate	Estimate	*SE*	Standardized estimate	State	Indicator specific	Reliability
SE11	0.00*	1.00*	--	.91	--	--	--	.82	--	.82
SE21	-0.12 [d]	0.95 [j]	.02	.86	1.00*	--	.30	.74	.09	.83
SE12	0.00*	1.00*	--	.90	--	--	--	.81	--	.81
SE22	-0.12 [d]	0.95 [j]	.02	.87	1.00*	--	.30	.76	.09	.85
PL11	0.00*	1.00*	--	.95	--	--	--	.90	--	.90
PL21	0.20 [e]	0.94 [k]	.02	.87	1.00*	--	.24	.76	.06	.82
PL12	0.00*	1.00*	--	.90	--	--	--	.81	--	.81
PL22	0.20 [e]	0.94 [k]	.02	.84	1.00*	--	.23	.71	.05	.76
BE11	0.00*	1.00*	--	.90	--	--	--	.81	--	.81
BE21	0.18 [f]	0.74 [l]	.02	.83	1.00*	--	.37	.69	.14	.83
BE12	0.00*	1.00*	--	.84	--	--	--	.71	--	.71
BE22	0.18 [f]	0.74 [l]	.02	.78	1.00*	--	.34	.61	.12	.73

Note. SE = self-efficacy indicator; PL = planning indicator; BE = behavior indicator; the first number refers to the indicator, whereas the second number refers to the occasion of measurement. Fixed parameters are marked with an asterisk (*). Standard errors are not available for fixed parameters. Parameters set equal to each other (time invariant parameters) have the same superscript.

Measurement models. Table 1 shows the unstandardized intercepts, factor loadings, and variance components. The standardized state factor loadings (i.e., the correlations between each indicator and its latent state factor) are rather high, whereas the standardized loadings on the indicator-specific factors are rather small. This indicates that the indicators are rather homogeneous (i.e., there is not much indicator-specific variance).

The squared standardized loadings represent the percentage of variance accounted for by the state and indicator-specific factors, respectively. The sum of both types of squared loadings gives the total proportion of variance explained by systematic factors (the reliability coefficients). The reliability coefficients are high for all indicators. Only 5–19 % of the observed variable variance is due to reliable indicator-specific effects, i.e., the indicators measure to a large degree the same latent dimension.

Latent change model for physical activity: As shown in Figure 5, intraindividual change in planning was significantly predicted by change in self-efficacy and change in intention. Change in physical activity could be explained by change in self-efficacy and change in planning. In terms of indirect effects on change in physical activity, change in intention was mediated by change in planning (indirect effect: $\beta = .06$; with a bias-corrected bootstrapped 95%-confidence interval (CI) ranging from .02 to .13; cf. MacKinnon, Lockwood, & Williams, 2004). Change in planning also mediated between change in self-efficacy and change in physical activity ($\beta = .18$; 95% CI = .07, .44).

Baseline levels of intention and self-efficacy were neither predictive of change in planning nor physical activity. Also, baseline levels of planning did not predict changes in physical activity. Overall, 32% variance in change in planning and 13% of variance in change in behavior was explained by baseline differences and changes in intention, self-efficacy, and planning.

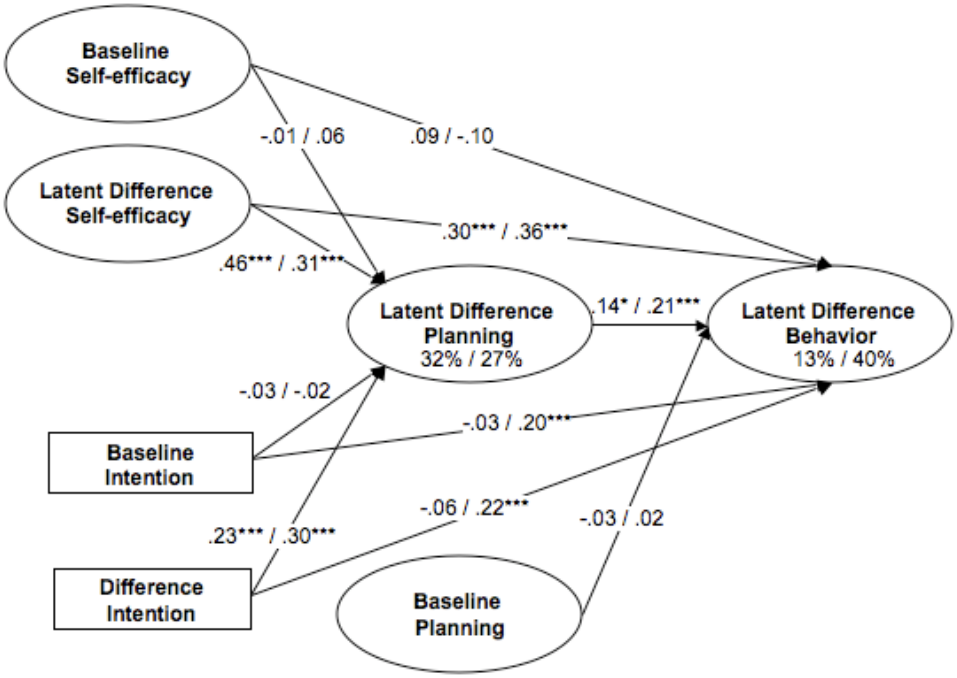


Figure 5. Structural model with standardized path coefficients for physical activity and fruit and vegetable intake. The first number relates to the model for physical activity. The second number indicates path coefficients for fruit and vegetable intake.
Note. * $p < .05$, *** $p < .001$.

Latent change model for fruit and vegetable intake: A similar prediction pattern emerged for fruit and vegetable intake. Change in planning was predicted by change in self-efficacy and change in intention. Change in planning, in turn, predicted change in behavior. Change in self-efficacy exerted a direct effect on change in behavior as well as an indirect effect via change in planning (indirect effect: β = .10; bias-corrected bootstrapped 95% CI = .04, .18). Change in intention directly predicted change in behavior and was mediated by change in planning (indirect effect: β = .07; bias-corrected bootstrapped 95% CI = .03, .13).

Baseline levels of intention predicted change in behavior, but not change in planning. Baseline levels of self-efficacy were neither predictive of change in behavior nor in change in planning. Likewise, baseline levels of planning were not predictive of changes in behavior. Overall, 27% variance in change in planning and 40% of variance in change in fruit and

vegetable intake was explained by baseline differences and changes in intention, self-efficacy, and planning.

Hence, in a four-week time interval, the present latent true change models show how baseline differences as well as interindividual differences in intraindividual change in intention, self-efficacy, and planning are related to interindividual differences in change in physical activity and change in fruit and vegetable intake, respectively.

Discussion

Our aim was to examine latent true change in self-regulation of health behavior change. The present application of LTC modeling demonstrates the usefulness of LTC models for analyzing change simultaneously in several constructs. A latent true change model was presented in which interindividual differences in true intraindividual change (i.e., change free of measurement-error) in behavior are predicted by baseline values as well as interindividual differences in change in social-cognitive predictors. Compared to previous research on health behavior change, an important contribution of this study is that we tested whether changes (rather than only baseline levels) in volitional factors are associated with change in behavior.

Volitional factors such as self-efficacy and planning explain how intentions are translated into actual behavior as holding an intention is not sufficient for successful goal pursuit (cf. Health Action Process Approach, HAPA; Schwarzer, 2008). To date, the impact of intentions, self-efficacy, and planning on health behavior has been documented in cross-sectional and longitudinal research (e.g., Lippke et al., 2007). However, only few studies have examined how changes in these variables are related to each other (e.g., Scholz et al., 2006; Sniehotta et al., 2006). Therefore, the present study is among the first to confirm that the relations among changes in social-cognitive predictors and behavior change (i.e., change-change associations) are similar to associations among initial levels of these predictors and behavior change (i.e., status-change associations). The replication of previous findings with a

dynamic approach offers additional support for the theoretical assumptions outlined in the HAPA model.

For both behaviors under study (physical activity and fruit and vegetable intake), changes in intention and self-efficacy are positively associated with change in planning. Change in planning, in turn, is predictive of change in behavior. Change in intention has an indirect effect on change in behavior through change in planning. This finding is in line with the assumption that planning is a mediator of the intention-behavior relation (Schwarzer, 2008). For fruit and vegetable intake, we found an additional direct effect of change in intention on change in behavior that remained significant and was not mediated by changes in planning.

Physical activity and fruit and vegetable intake are two distinct health behaviors that might depend to a different degree on self-regulatory factors. For instance, the dependence on action control for behavioral performance which refers to cognitive behavior regulation while acting (cf. Schüz, Sniehotta, & Schwarzer, 2007) might be higher for fruit and vegetable intake than for physical activity. The partial mediation effect of planning in the intention-behavior relation concerning fruit and vegetable intake adverts to putative additional mediators of the intention-behavior relation of which action control might be a potential candidate.

Changes in self-efficacy, the perceived capability to maintain one's behavior change and to recover from relapses, is an important predictor for change in planning and change in actual behavior itself. This result supports the contention that self-efficacious persons respond to barriers to action confidently with better strategies, more effort, and persistence when changing their health behavior. Thus, planning might be more likely to facilitate goal achievement in persons with high levels of self-efficacy. In previous studies on physical exercise and dietary behavior, it was found that high self-efficacious people are more likely to make a plan, i.e., perceived self-efficacy moderates the intention-planning link (Gutiérrez-Doña, Lippke, Renner, Kwon, & Schwarzer, in press, Study 2) and that high self-efficacy

promotes the translation of plans in behavior, i.e., self-efficacy moderates the planning-behavior link (Gutiérrez-Doña et al., in press, Study 1; Lippke et al., in press).

Overall, our findings supported the proposed relations among the volitional predictors of health behavior change. Almost identical change association patterns were replicated for two different behaviors. Based on the results of the present study, interventions should focus not only on increasing participants' intention to change a behavior but also on heightening their self-efficacy beliefs and planning activities for fostering change in physical activity and nutrition behavior.

There are limitations concerning the present study. In this study, behavioral intentions were measured by using a single item only which is in line with most of research in this area (Courneya, 1994). The possibility to integrate observed and latent factors in one model demonstrates the practicability of latent true change models. However, for studying the latent difference in intention, multiple indicators for intentions should be assessed in future studies.

The empirical relationships found here can only be interpreted cautiously as causes and effects. Based on our theoretical considerations, we assumed an influence of changes in volitional factors on behavior change. Nevertheless, a behavior such as regular physical activity or dietary behavior consists of complex action sequences. Experience with the actual behavior will influence behavioral intention, self-efficacy, and planning in turn (cf. Ziegelmann, Luszczynska, Lippke, & Schwarzer, 2007). It has to be considered that intention, perceived self-efficacy, planning, and behavior are likely to influence each other in a reciprocal manner. Thus, the presented analyses constitute only one possibility of modeling the relations between the variables in the study. Experimental designs are needed to draw causal inferences. Especially for mediation analyses experimental-causal-chain designs are a promising alternative to statistical mediation analysis in examining mediators of the intention-behavior relation (Reuter, Ziegelmann, Wiedemann, & Lippke, 2008). For investigating the effects of motivational and/or volitional interventions, future research could make use of latent

true change models. By examining latent change, researchers can avoid observed change scores that can be strongly affected by measurement error.

There are a few restrictions regarding the application of LTC modeling that have to be kept in mind. As demonstrated in the present study, LTC modeling does not allow analyzing latent change variables for constructs measured with single indicators. Thus, the measurement of several indicators per variable is required. Also, LTC models depict change as latent difference between two occasions of measurement. Therefore, assumptions about the functional (e.g., linear, quadratic) form of change cannot be tested. Such particular components of change can be examined when more than two time points are considered using the latent growth curve modeling approach (e.g., Bollen & Curran, 2006; Duncan, Duncan, & Strycker, 2006).

An assumption that has to be made in LTC models is that of strong measurement invariance over time. This constraint means that the state factor loadings and the intercepts of the indicators are assumed to be time-invariant. For non-time-invariant parameters, the meaning and interpretation of the latent difference variables would be ambiguous. However, the assumption of strong measurement invariance is a general requirement that has to be made in most longitudinal structural equation models. For example, first and second order growth models also require time-invariant parameters to allow for a meaningful interpretation of the growth parameters. In LTC models, the invariance of the loadings and intercepts is a testable assumption. If it is violated, the model fit will be bad. In the present study, the good overall model fit showed that the assumption of measurement invariance over time was tenable. In contrast, in first order growth curve models, this assumption is implicitly made and cannot be tested (in second-order growth models, it can be tested).

Conclusion

This study examined latent change in behavior and its social-cognitive determinants. It demonstrated that baseline levels and changes in intention, self-efficacy, and planning can

account for change in behavior. Drawing on latent true change models that unconfound true-score components and measurement-error components of intraindividual change (Steyer et al., 1997; 2000), we investigated change-change associations rather than using only initial levels of social-cognitive variables for predicting change in behavior. Our results support the findings of previous research on the status-status or status-change associations of intention, volitional strategies and beliefs, and behavior.

References

Arbuckle, J. L. (1996). Full information estimation in the presence of incomplete data. In G. A. Marcoulides & R. E. Schumacker (Eds.), *Advanced structural equation modeling* (pp. 243-277). Mahwah, NJ: Erlbaum.

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

Bollen, K. A. & Curran, P. J. (2006). *Latent curve models: A structural equation perspective.* New York: Wiley.

Bollen, K., & Long, J. (Eds.). (1993). *Testing structural equation models*. Thousand Oaks, CA: Sage.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*, 155-159.

Courneya, K.S. (1994). Predicting repeated behavior from intention: The issue of scale correspondence. *Journal of Applied Social Psychology, 24*, 580-594.

Duncan, T. E., Duncan, S. C., & Strycker, L. A. (2006). *An introduction to latent variable growth curve modeling: Concepts, issues, and applications* (2nd Ed.). Psychology Press.

Eid, M., Schneider, C., & Schwenkmezger, P. (1999). Do you feel better or worse? The validity of perceived deviations of mood states from mood traits. *European Journal of Personality, 13*, 283-306.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research.* Reading, MA: Addison-Wesley.

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

Gollwitzer, P.M., & Sheeran, P. (2006). Implementation intentions and goal achievement: A meta-analysis of effects and processes. *Advances in Experimental Social Psychology, 38,* 249-268.

Gutiérrez-Doña, B., Lippke, S., Renner, B., Kwon, S., & Schwarzer, R. (in press). How Self-Efficacy and Planning Predict Dietary Behaviors in Costa Rican and South Korean Women: A Moderated Mediation Analysis. *Health & Well-Being.*

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.

Lewin, K., Dembo, T., Festinger, L.A., & Sears, P.S. (1944). Level of aspiration. In J. McV. Hunt (Ed.), *Personality and the behavior disorders* (Vol. 1, pp. 333-378). New York: Ronald.

Lippke, S., Nigg, C. R., & Maddock, J. E. (2007). The Theory of Planned Behavior within the stages of the Transtheoretical Model - Latent structural modeling of stage-specific prediction patterns in physical activity. *Structural Equation Modeling: A Multidisciplinary Journal, 14*(4), 649-670.

Lippke, S., Wiedemann, A., Ziegelmann, J. P., Reuter, T., & Schwarzer, R. (in press). Translating intentions into behavior: When self-efficacy moderates the mediator role of plans. *American Journal of Health Promotion.*

Lippke, S., & Ziegelmann (2008). Theory-Based Health Behavior Change: Developing, Testing, and Applying Theories for Evidence-Based Interventions. *Applied Psychology: An International Review, 57*(4), 689-716.

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

Luszczynska, A., Tryburcy, M., & Schwarzer, R. (2007). Improving Fruit and Vegetable Consumption: A Self-Efficacy Intervention Compared to a Combined Self-Efficacy and Planning Intervention. *Health Education Research, 22*, 630-638.

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.

McArdle, J. J. (1988). Dynamic but structural equation modeling of repeated measures data. In R. B. Cattell & J. Nesselroade (Eds.), *Handbook of multivariate experimental psychology* (pp. 561-614). New York: Plenum Press.

McArdle, J. J., & Hamagami, F. (2001). Latent difference score structural models for linear dynamic analysis with incomplete longitudinal data. In L. M. Collins & A. G. Sayer (Eds.), *New methods for the analysis of change* (pp. 137–175). Washington, DC: American Psychological Association.

Muthén, L. K., & Muthén, B. O. (2005). *MPlus user's guide – 3rd edition*. Los Angeles, CA: Muthén & Muthén.

Rademacher, J. D. M., & Lippke, S. (2007). Dynamic online surveys and experiments with the free open source software dynQuest. *Behavior Research Methods, 39*, 415-426.

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*, 194-297.

Schafer, J. L., & Graham, J. W. (2002). Missing data: Our view of the state of the art. *Psychological Methods, 7,* 147-177.

Schermelleh-Engel, K., Moosbrugger, H., & Müller, H. (2003). Evaluating the fit of structural equation models: Test of significance and descriptive goodness-of-fit measures. *Methods of Psychological Research - Online, 8*, 23–74.

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., Sniehotta, F. F., & Schwarzer, R. (2005). Predicting physical exercise in cardiac rehabilitation: The role of phase-specific self-efficacy beliefs. *Journal of Sport & Exercise Psychology, 27,* 135-151.

Schüz, B., Sniehotta, F.F., & Schwarzer, R. (2007). Stage-specific effects of an action control intervention on dental flossing. *Health Education Research, 22*, 332–341.

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

Siconolfi, S. F., Lasater, T. M., Snow, R. C., & Carleton, R. A. (1985). Self-reported physical activity compared with maximal oxygen uptake. *American Journal of Epidemiology, 122,* 101-105.

Sniehotta, F. F., Nagy, G., Scholz, U., & Schwarzer, R. (2006). The role of action control in implementing intentions during the first weeks of behaviour change. *British Journal of Social Psychology, 45,* 87-106.

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.

Steptoe, A., Perkins-Porras, L., McKay, C., Rink, E., Hilton, S., & Cappuccio, F. P. (2003). Psychological factors associated with fruit and vegetable intake and with biomarkers in adults from a low-income neighborhood. *Health Psychology, 22,* 148-155.

Steyer, R., Eid, M., & Schwenkmezger, P. (1997). Modeling true intraindividual change: True change as a latent variable. *Methods of Psychological Research - Online, 2*, 21-33.

Steyer, R., Partchev, I., & Shanahan, M. (2000). Modeling true intra-individual change in structural equation models: The case of poverty and children's psychosocial adjustment. In T. D. Little, K. U. Schnabel & J. Baumert (Eds.), *Modeling longitudinal and multiple-group data: Practical issues, applied approaches, and specific examples* (pp. 109-126). Hillsdale, NJ: Erlbaum.

Sutton, S. (2002). Testing attitude–behaviour theories using non-experimental data:An examination of some hidden assumptions. *European Review of Social Psychology, 13*, 293–323.

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.

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.

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.

Chapter 3

Dietary Planning as a Mediator of the Intention-Behavior Relation: An Experimental-Causal-Chain Design

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AUTHOR NOTES

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Abstract

Objective: Health behavior change is seen as a self-regulatory process that consists of a motivation phase of goal setting and a volition phase of goal pursuit. Previous studies suggest that the intention-behavior association is mediated by planning. However, evidence is based on observational studies rather than on experimental designs. To validate the causal assumptions, an experimental-causal-chain design was employed. ***Method***: Study 1 (n = 145) examined whether changing intentions by a motivational intervention engenders changes in planning activities 1 month later. Study 2 (n = 115) examined, in a different sample, whether a volitional planning intervention engenders changes in behavior 1 month later. ***Results***: In both studies, repeated measures ANOVAs revealed a significant Time x Condition interaction. Changes in intention mediated the effects of the motivational intervention on planning activities (Study 1). Changes in planning mediated the effect of a volitional intervention on dietary behavior (Study 2). ***Conclusion***: Previous observational findings on planning as a mediator in the intention-behavior association were supported by the two experiments. The findings might help to identify points of intervention in the process underlying health behavior change.

Keywords*:* self-regulation; planning; intention; experimental-causal-chain design; randomized controlled trial

Planning as a Mediator of the Intention-Behavior Relation: An Experimental-Causal-Chain Design

Prominent theories of goal-directed action (e.g., Theory of Reasoned Action, Fishbein & Ajzen, 1975; Theory of Planned Behavior, Ajzen, 1991) assume that intention is the most proximal predictor of behavior. Therefore, research has concentrated on identifying factors that determine the formation of strong intentions. However, these studies have only been moderately successful in predicting goal attainment (Sheeran, 2002). Experimental tests of intention-behavior associations in which intention strength was manipulated revealed that a medium-to-large change in intention produced only a small-to-medium change in behavior (Webb & Sheeran, 2006). This so-called intention-behavior gap reveals that people do not fully act upon their intentions. Several factors may impede the adoption and maintenance of goal-directed behavior, such as distractions (Metcalfe & Mischel, 1999), forgetting (Orbell, Hodgkins, & Sheeran, 1997), or conflicting bad habits (Verplanken & Faes, 1999). Thus, models of behavior change should pay attention to the "black box" that follows intention formation, unravelling the mechanisms that operate between intention and actual behavior.

The contention that the process of goal-oriented action involves at least two different phases, namely a *motivation phase* of goal setting and a *volition phase* of goal striving, was introduced by Lewin, Dembo, Festinger, and Sears (1944). This implies that setting a goal (or forming an intention) is only one prerequisite for attaining a goal. In the volition phase, self-regulatory skills and strategies foster the successful translation of intentions into action (Gollwitzer, 1999).

The integration of such volitional factors might help to explicate the causal mechanism by which intentions influence behavior. By trying to explain the mechanism through which the causation occurs, we go beyond simple intention-behavior models. Proposing mediators of the intention-behavior relation is useful for both refining the theory and identifying potential points of intervention.

Planning as a Volitional Mediator of the Intention-Behavior Association

A large body of research regards planning as a powerful self-regulatory strategy for effective goal pursuit. Miller, Galanter, and Pribram's (1960) systematic study on planning was followed by clinical studies on weight loss (e.g., Bandura & Simon, 1977; Chapman & Jeffrey, 1978), academic study (e.g., Greiner & Karoly, 1976), and children's resistance to temptations (e.g., Mischel & Patterson, 1976). Research on the role of planning in health behavior change began with Leventhal, Singer, and Jones (1965), who suggested that fear appeals may only be effective in producing a health behavior when specific parameters of the situation (when, where) and an action sequence (how) are provided.

More recently, the concept of implementation intentions has been introduced (Gollwitzer, 1999). In the process of if-then planning (i.e., forming an implementation intention), an action sequence is linked to specific parameters of a situation in terms of when, where, and how to perform a behavior. Planning enhances information processing in terms of increased accessibility, recall, detection, and discrimination of critical cues. Once a specified situation is encountered, the intended behavior is elicited almost automatically (cf. Gollwitzer & Sheeran, 2006, for a review).

In Schwarzer's (1992, 2008) Health Action Process Approach (HAPA), planning is specified as a mediator of the intention-behavior relationship. This implies that individuals who form an intention will be more likely to engage in planning, and those who do plan will be more likely to engage in the desired behavior. There is ambiguous evidence for the mediating role of planning in the intention-behavior association. Whereas some studies find mediating effects (Norman & Conner, 2005, Study 2; Schwarzer et al., 2007), others do not (Norman & Conner, 2005, Study 1; White, Terry, & Hogg, 1994). However, all studies were observational and do not allow inferences for cause-and-effect relationships.

Theoretical and Statistical Mediation Analysis

Spencer, Zanna, and Fong (2005) criticize the default use of mediation analysis on the basis of regression models as proposed by Baron and Kenny (1986). Spencer et al. (2005) claim that theoretical mediation analysis is often assumed to be equivalent to statistical mediation analysis on the basis of observational data. In an early paper, Judd and Kenny (1981) caution the reader that a mediational analysis is nothing but a correlational analysis. Even if variables are ordered in time, there are other possible explanations of correlations of longitudinal data, such as spuriousness (Link & Shrout, 1992). Therefore, a series of experiments that demonstrates the proposed causal chain is superior to a statistical mediation analysis. In such ”experimental-causal-chain designs” (Spencer et al., 2005), both the independent variable and the mediating variable are manipulated, which allows causal inferences about the chain of events.

Research Aims

The present research attempts to overcome several limitations of previous studies by providing evidence for a causal chain process of behavior change. We propose that behavioral intentions (independent variable) lead to the intended behavior (dependent variable) through planning (mediating variable). Two studies were conducted to test this proposal. In Study 1, the intention is experimentally manipulated, and in Study 2 planning activities are experimentally manipulated (see Figure 6). By integrating mediating processes, the simple intention-behavior model is refined, and the intervening mechanisms may be identified.

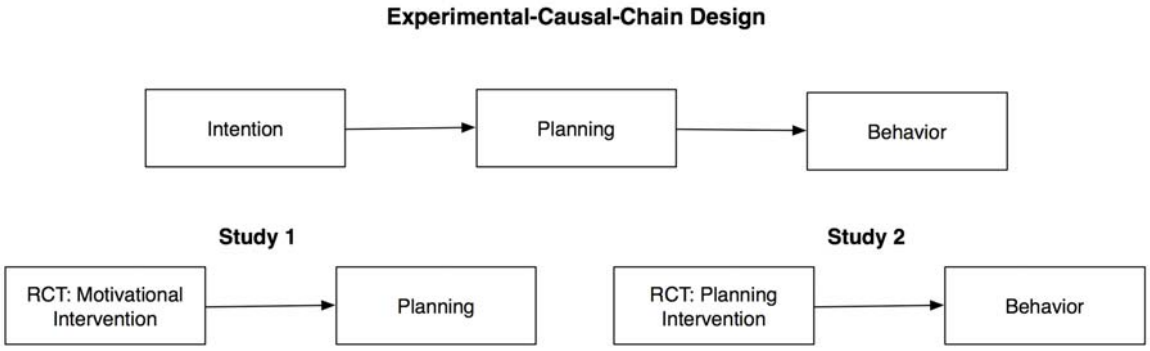

Figure 6. Mediation analysis employing an experimental-causal-chain design in which the proposed independent variable (intention) as well as the proposed mediator (planning) is manipulated (RCT = randomized controlled trial).

Study 1

Study 1 aims at testing the relation between the independent variable and the mediator. Therefore, the behavioral intention is manipulated experimentally, and self-reported planning is assessed 1 month later.

Method

Participants and Procedure. Participants were recruited from a large logistics service company. During a routine medical check-up, employees were invited by the physician to participate in a health-promotion program aimed at dietary changes. Persons who were diagnosed with one or more of the following conditions were excluded from the study: manifest diabetes mellitus, acute myocardial infarction within last year, contraindication for fruit and/or vegetable consumption. After giving informed consent, participants filled in a questionnaire. Participants (N = 304, mean age = 44 years, SD = 8.6 years, 20-64 years, 84% men) who reported that they consume less than five portions of fruit and vegetables per day and that they do not intend to change this intake were randomly assigned to a computer-based motivational intervention (n = 263) or to a control group (n = 41). Questionnaires sent at follow-up were returned by 145 (50.5%) participants. Of those, 122 were in the experimental

and 23 in the control group. In terms of self-reported intentions, planning, and dietary behavior, remaining participants at Time 2 did not differ significantly from those who discontinued participation.

Intervention. The intervention was designed to motivate the participants to consume five portions of fruit and vegetables a day. The theoretical framework underlying the motivational intervention was the HAPA (Schwarzer, 1992), which emphasizes self-efficacy beliefs, outcome expectancies, and risk perception to change behavioral intentions. The intervention comprised written verbal persuasion for enhancing participants' self-efficacy beliefs to adopt the new behavior, balancing positive and negative consequences (outcome expectancies) of eating fruit and vegetables, as well as risk communication. The control group received basic nutrition information on a computer screen. The intervention and control group treatment was performed using the software *dynQues*t (Rademacher & Lippke, 2007).

Measures. Intentions and planning concerning fruit and vegetable consumption were measured at baseline and four weeks later. Intentions were assessed with two items such as: "I intend to eat 5 servings of fruit and vegetables a day." Planning was measured with: "I have already precisely planned when, where, and how to eat 5 servings of fruit or vegetables throughout the day." Answers were scored on a four-point scale (*completely disagree, somewhat disagree, somewhat agree, completely agree*). All items were adapted from Schwarzer et al. (2007).

Analytical Procedure. Data were analyzed using a repeated-measures ANOVA to examine mean differences between the experimental and the control group. Hierarchical regression analyses were employed to test the mediating effects of intention changes in the relation between the experimental versus the control condition and subsequent planning activities. All analyses were conducted with SPSS 13.0.

Missing Values. Missing values (< 5%) were imputed cross-sectionally using the expectation maximization algorithm (Enders, 2001). For data missing at random, expectation maximization estimation has been recommended and has proven more robust than regression imputation (Gold & Bentler, 2000).

Results

The intervention and control groups did not differ in planning at preintervention, $F(1, 302) = 2.00$, *ns*. The first hypothesis concerned the effect of a motivational intervention on planning one month later. Means and standard deviations are shown in Table 2.

Table 2. Means and Standard Deviations for Variables in Study 1

	Motivational Intervention Group				Control Group			
	Time 1		Time 2		Time 1		Time 2	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Intention	1.73	0.83	2.27	0.91	1.88	1.02	2.39	1.03
Planning	1.41	0.67	1.89	0.86	1.83	0.86	1.83	0.83

Note. For Time 1, $N = 304$, for Time 2, $N = 145$.

A repeated-measures ANOVA revealed a significant main effect of time, $F(1, 141) = 5.05$, $p < .05$ ($eta_p^2 = .04$), as well as a significant Time x Group interaction, $F(1, 141) = 5.05$, $p < .05$ ($eta_p^2 = .04$, post hoc observed power test 0.61). The results are displayed in Figure 7.

To test whether the differential effects of motivational and control interventions on planning were mediated by change in intention, hierarchical regression models were performed. Time 2 planning was regressed onto baseline planning in the first step in order to predict change in planning.

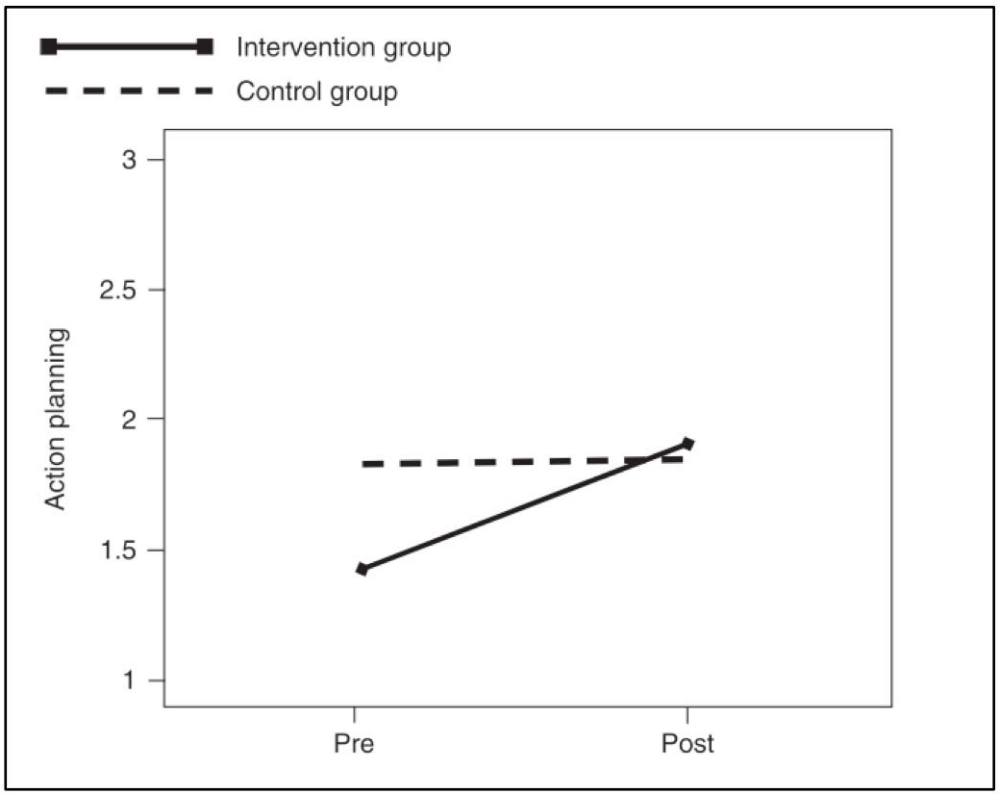

Figure 7. Changes in planning following an intervention to promote intention.

In a second step, the residualized change score of intention was entered as indicator of individual effects of the intervention. This residualized change score was obtained by regressing Time 2 intention onto Time 1 intention, $R^2 = .25$; $\beta = .50$; $p < .001$. A significant β was obtained in the intervention group, $\beta = .60$, $p < .001$, but not in the control group, $\beta = .38$, *ns*. The increase in variance explained was statistically significant in the intervention group only, $F(1, 115) = 34.46$, $p < .001$; $\Delta R^2 = .22$; control: $F(1, 19) = 1.07$, *ns*; $\Delta R^2 = .04$. Thus, intention changes predicted planning changes in the treatment group.

Discussion

Participants of the motivational treatment significantly increased their planning activities compared to participants of the control group. Moreover, these changes were mediated by changes in intention in the treatment group only. These results support the first hypothesis that motivation to change a behavior leads to increased planning activities.

Study 2

The second study aimed at testing the relation between the mediator and the dependent variable. Therefore, planning activities were experimentally manipulated, and behavior was assessed one month later.

Method

Participants and Procedure. Study 2 was conducted in a similar setting as Study 1, but with different participants. These participants did not yet consume five portions of fruit and vegetables, but they stated their intention to do so in the future (N = 246, mean age = 44 years, SD = 8.6 years, ranging from 20 to 62 years, 84% men). They were randomly assigned to a planning intervention (n = 214) or to a control group (n = 32). Time 2 questionnaires were returned by 115 persons (49.4%) one month after treatment. Of those, 96 were in the experimental and 19 in the control group. In terms of initial self-reported intentions, planning, and dietary behavior, the longitudinal sample did not differ significantly from dropouts.

Intervention. The proposed mediator (i.e., planning) was experimentally induced in a self-instructed, computer-based setting. Participants received the following instruction on the screen: ”Please write in the space below when, where, and how you will eat 5 portions of fruit and vegetables a day.” Trained interviewers answered questions or clarified misunderstandings in a nondirective manner. Self-reported planning, intention, and behavior were assessed four weeks later and compared to a control group without a planning intervention.

Measures. As in Study 1, self-reported planning concerning fruit and vegetable consumption and dietary behavior were measured at baseline and four weeks later. Fruit and vegetable intake at baseline and follow-up was assessed with an open-ended question format by asking “Regarding the last four weeks: How many portions of fruit and vegetables did you eat on an average day?” Participants received detailed information about portion sizes. Similar single-item measures of fruit and vegetable intake have been validated sucessfully against dietary biomarkers (Steptoe et al., 2003).

Analytical Procedure. Data were analyzed using a repeated-measures ANOVA to examine mean differences between the experimental and control groups. The mediating effects of changes in planning in the relation between the experimental versus the control condition and subsequent behavior were tested using hierarchical regression analyses. All analyses were conducted with SPSS 13.0.

Table 3. Means and Standard Deviations for Variables in Study 2

	Planning Intervention Group				Control Group			
	Time 1		Time 2		Time 1		Time 2	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Planning	2.44	1.05	3.12	0.96	2.05	1.13	2.00	0.67
Frequency of fruit and vegetable intake	3.35	1.86	3.91	1.95	3.32	1.90	2.92	1.74

Note. For Time 1, $N = 246$, for Time 2, $N = 115$.

Results

The intervention and control groups did not differ in frequency of fruit and vegetable intake at preintervention, $F(1, 240) = 2.15$, *ns*. The second hypothesis concerned the effect of a planning intervention on dietary behavior. Means and standard deviations are depicted in Table 3.

A repeated-measures ANOVA revealed a marginal significant Time x Group interaction, $F(1, 112) = 3.18$, $p = .08$ ($eta_p^2 = .04$, post hoc observed power test 0.42). The results are displayed in Figure 8.

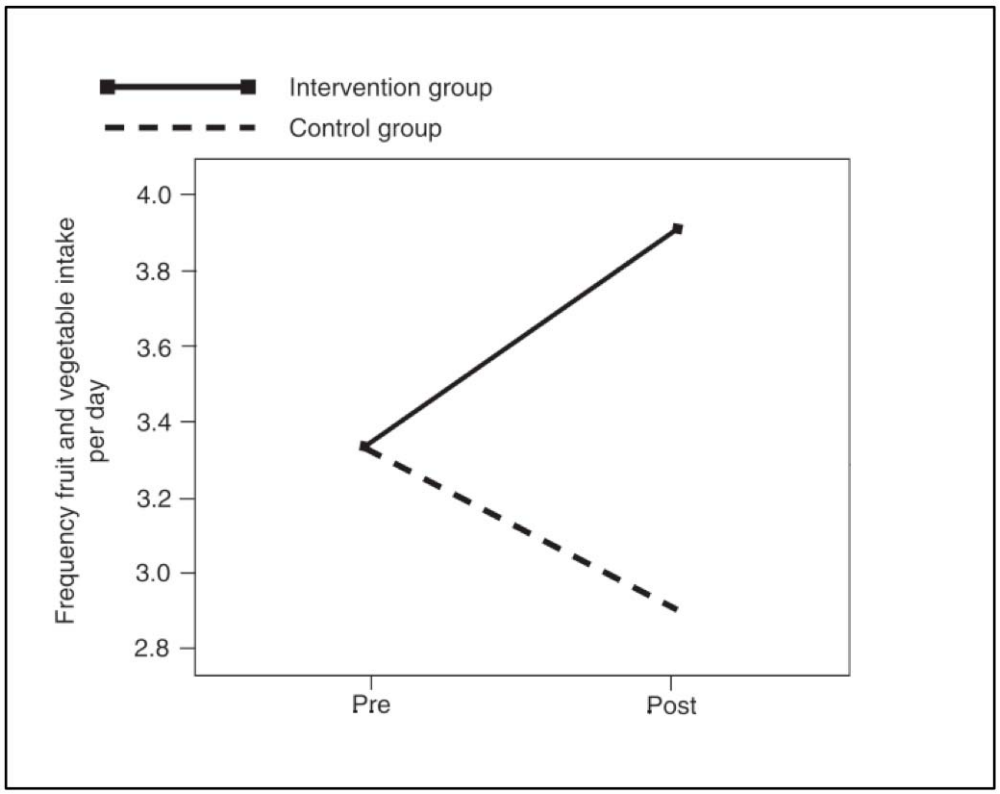

Figure 8. Changes in frequency of fruit and vegetable intake following a planning intervention.

Hierarchical regression tested whether the differential effects of planning and control interventions on behavior were mediated by change in planning. Time 2 fruit and vegetable intake was regressed onto baseline behavior in the first step in order to predict behavior change. In a second step, the residualized change score of planning was entered as a predictor of behavior change. This residualized change score was obtained by regressing Time 2 planning onto Time 1 planning, $R^2 = .09$; $\beta = .30$; $p < .001$. A highly significant β was obtained in the intervention group, $\beta = .47$, $p < .001$, but not in the control group, $\beta = .16$, *ns*. The increase in variance explained was significant in the intervention group only, $F(1, 91) = 28.50$, $p < .001$; $\Delta R^2 = .21$; control: $F(1, 17) = 0.43$, *ns*; $\Delta R^2 = .02$. Hence, change in behavior can be predicted by changes in planning in the intervention group only.

Discussion

Participants of the planning treatment showed increases in behavior as opposed to participants in the control condition. Moreover, only in the treatment group were these changes mediated by changes in self-reported planning. These results support the second hypothesis that changes in planning enhance goal attainment. This study supports previous research on the beneficial effects of if-then planning on goal attainment (Gollwitzer & Sheeran, 2006).

General Discussion

Using an experimental-causal-chain design (Spencer et al., 2005) with two experimental studies (Study 1, Study 2), the present research investigated whether planning mediates the intention-behavior relation. Results of Study 1 demonstrated that changing intentions by a motivational intervention in formerly unmotivated persons led to an increase in self-reported planning. These changes in planning were predicted by intention changes in the treatment group only. Results of Study 2 demonstrated that individuals who received a planning intervention improved their behavior. Behavior change was predicted by changes in self-reported planning in the treatment group only. To summarize, an experimental causal chain from intention to behavior via planning was established. Thus, in line with Michie and Abraham (2004), it was not only demonstrated that the interventions did work and how well they worked, but also how they worked.

The present results on the basis of experimental designs corroborate the findings of observational studies (cf. Schwarzer et al., 2007). Many experimental studies use implementation intention (i.e., planning) interventions, but in those studies it is typically tested whether the effect of the intervention on behavior is mediated by increases in self-reported planning (e.g., Luszczynska, Sobczyk, & Abraham, 2007) or by the amount of plans generated in the planning intervention (e.g., Ziegelmann, Lippke, & Schwarzer, 2006). The studies presented here, however, provide experimental evidence for the mediation hypothesis, thereby supporting the view that intentions have an impact on behavior through planning.

The theoretical implications of these results are twofold: First, they refine the simple intention-behavior association by identifying both intentions and planning as variables that operate in a sequential manner. In addition, they cast a temporal perspective on behavior change, which commences with a motivational phase (setting a goal) and proceeds to a volitional phase (goal pursuit), ultimately leading to a specific outcome (cf. Gollwitzer, Heckhausen, & Steller, 1990; Lewin et al., 1944).

The findings might help to identify intervention points in the process underlying health behavior change. By providing evidence for a sequence of events, or specific phases, of goal-directed behavior, the concept of tailoring interventions to stages of change is supported (cf. Lippke, Ziegelmann, & Schwarzer, 2004; Schüz, Sniehotta & Schwarzer, 2007). Such a stage-matched approach allows designing parsimonious interventions (Weinstein, Rothman, & Sutton, 1998).

The limitations of the two experimental studies are discussed below. In both studies, the attrition rate was about 50%. However, at baseline, no significant differences in study variables or sociodemographic variables between participants and dropouts were found. This indicates that the longitudinal sample was representative of the initial sample.

Findings based on self-reported planning might be biased due to common error variance with self-reported behavior. However, we tried to minimize the common error variance by employing a different response format (i.e., open end) for the measure of behavior. Concerning self-reported fruit and vegetable consumption, evidence exists for the criterion validity in relation to dietary biomarkers (Steptoe et al., 2003). Regarding the measurement of planning as an outcome variable, it might prove advisable for future studies to collect the participants' planning sheets and to examine the quality or quantity of their plans. A rating scheme for the different components of planning was proposed by Ziegelmann et al. (2006).

In Study 2, we assessed the effects of a planning intervention on the initiation of goal-directed behavior four weeks later. The study was designed to capture the mechanisms of behavior change for this particular time frame. However, the question of long-term behavioral effects should also be studied in future experiments. In an observational study, Ziegelmann, Luszczynska, Lippke, and Schwarzer (2007) found that implementation intentions can predict physical activity over and above goal intentions for an extensive period of time (up to 12 months).

Directions for Future Research

In future research addressing volitional processes of behavior change, it would be fruitful to collect further experimental evidence for other proposed, volitional mediators of the intention-behavior relation, such as action control (e.g., Sniehotta, Scholz, & Schwarzer, 2005; Schüz et al., 2007) or volitional self-efficacy beliefs (e.g., Renner, Spivak, Kwon, & Schwarzer, 2007).

Furthermore, there is evidence that the proposed mediator model works better in some populations or contexts than in others. Previous research on planning has provided evidence for different mediation effects between age groups. Goal-related factors, such as intentions and planning, are more predictive of physical activity in middle-aged and older adults than in younger adults (Renner et al., 2007). Moreover, this mediator effect has been found to increase with the strength of intention (Wiedemann, Schüz, Sniehotta, Scholz, & Schwarzer, in press).

Conclusions

Effective goal pursuit requires self-regulation strategies, such as planning the intended behavior. Previous observational studies have demonstrated that planning mediates the intention-behavior relation (e.g., Schwarzer et al., 2007). In a further step, the two studies outlined here provide evidence for the advantages of using an experimental-causal-chain approach (Spencer et al., 2005) in order to illuminate the mediating role of planning. Hence, planning appears to be an important volitional factor for successful goal pursuit. For health-

promotion interventions, it might be useful to identify a person's current phase in the behavior change process and to tailor the intervention accordingly.

References

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

Bandura, A., & Simon, K. M. (1977). The role of proximal intentions in self-regulation of refractory behavior. *Cognitive Therapy and Research, 1*, 177-193.

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*, 1173–1182.

Chapman, S. L., & Jeffrey, D. B. (1978). Situational management, standard setting, and self-reward in a behavior modification weight loss program. *Journal of Consulting and Clinical Psychology, 46*, 1588-1589.

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

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.

Greiner, J. M., & Karoly, P. (1976). Effects of self-control training on study activity and academic performance: An analysis of self-monitoring, self-reward, and systematic planning components. *Journal of Counseling Psychology, 23,* 405-502.

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

Gollwitzer, P. M., & Sheeran, P. (2006). Implementation intentions and goal achievement: A meta-analysis of effects and processes. *Advances in Experimental Social Psychology, 38*, 249–268.

Judd, C. M., & Kenny, D. A. (1981). *Estimating the effects of social interventions*. New York: Cambridge University Press.

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.

Lewin, K., Dembo, T., Festinger, L. A., & Sears, P. S. (1944). Level of aspiration. In J. McV. Hunt (Ed.), *Personality and the behavior disorders* (Vol. 1, pp. 333–378). New York: Ronald.

Link, B. G., & Shrout, P. E. (1992). Spurious associations in longitudinal research. *Research in Community and Mental Health, 7,* 301–321.

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., Sobczyk, A., & Abraham, C. (2007). Planning to lose weight: Randomized controlled trial of an implementation intention prompt to enhance weight reduction among overweight and obese women. *Health Psychology, 2*6, 507-512.

Metcalfe, J., & Mischel, W. (1999). A hot/cool-system analysis of delay of gratification: Dynamics of willpower. *Psychological Review, 106*, 3-19.

Miller, G., Galanter, E., & Pribram, K. (1960). *Plans and the structure of behavior*. New York: Holt, Rinehart & Winston.

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

Mischel, W., & Patterson, C. J. (1976). Substantive and structural elements of effective plans for self-control. *Journal of Personality and Social Psychology, 34*, 942-950.

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.

Orbell, S., Hodgkins, S., & Sheeran, P. (1997). Implementation intentions and the theory of planned behavior. *Personality and Social Psychology Bulletin, 23*, 945-954.

Rademacher, J. D. M., & Lippke, S. (2007). Dynamic online surveys and experiments with the free open source software dynQuest. *Behavior Research Methods, 39*, 415-426.

Renner, B., Spivak, Y., Kwon, S., & Schwarzer, R. (2007). Does age make a difference? Predicting physical activity of South Koreans. *Psychology and Aging, 22*, 482-493.

Schüz, B., Sniehotta, F. F., & Schwarzer, R. (2007). Stage-specific effects of an action control intervention on dental flossing. *Health Education Research, 22*, 332-341.

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: An International Review, 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.

Sheeran, P. (2002). Intention-behavior relations: A conceptual and empirical review. *European Review of Social Psychology, 12*, 1–36.

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.

Spencer, S. J., Zanna, M. P., & Fong, G. T. (2005). Establishing a causal chain: Why experiments are often more effective than mediational analyses in examining psychological processes. *Journal of Personality and Social Psychology, 89*, 845-851.

Steptoe, A., Perkins-Porras L., McKay, C., Rink, E., Hilton, S., & Cappuccio, F. P. (2003). Psychological factors associated with fruit and vegetable intake and with biomarkers in adults from a low-income neighborhood. *Health Psychology, 22,* 148-155.

Verplanken. B., & Faes, S. (1999). Good intentions, bad habits, and effects of forming implementation intentions on healthy eating. *European Journal of Social Psychology, 29*, 591-604.

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

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

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

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.

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.

Chapter 4

Planning Bridges the Intention-Behavior Gap: Age Makes a Difference and Strategy Use Explains Why

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Abstract

Objective: This study examines age-differential association patterns between intentions, planning, and physical activity in young and middle-aged individuals. The effectiveness of planning to bridge the intention-behavior gap is assumed to increase with advancing age. We explore the use of behavior change strategies that include selection, optimization, and compensation (SOC) as underlying mechanism for age differences. ***Methods***: In *N*=265 employees of a national railway company (aged 19 to 64 years), intentions, planning, SOC strategy use, and physical activity were assessed at baseline (Time 1) and again one month later (Time 2). Hypotheses were tested in two different path models. ***Results***: Age moderates the extent to which planning mediates the intention-behavior relation due to an increasing strength of the planning-behavior link. As a possible psychological mechanism for these age differences, we identified SOC strategy use as a mediator of the age by planning interaction effect on physical activity. ***Conclusion***: These findings suggest differential mechanisms in behavior regulation in young and middle-aged individuals.

Keywords: self-regulation; planning; selection, optimization, and compensation (SOC); moderation; mediation; health behavior change

Planning Bridges the Intention-Behavior Gap: Age Makes a Difference and Strategy Use Explains Why

Leading a healthy lifestyle may reduce the probability of pathological aging and is therefore seen as a general principle for successful development (P. Baltes & M. Baltes, 1990). Especially early in life, the accumulation of health resources (e.g., by means of health behaviors) is seen as an important foundation for subsequent life span development and old age (Baltes & Smith, 2003). Promoting healthy lifestyle changes may hence serve to maintain employability and productivity in the face of an aging workforce. The present study aims to explore the processes that maintain health behaviors in young and middle adulthood among a working population. The study focuses on performing regular physical activity that is associated with health benefits, irrespective of age (McAuley & Rudolf, 1995). Regular physical activity can also help to prevent work-related musculusceletal disorders in individuals with low work-related physical activity, fixed body positions, or repetitive movements (van Eijsden-Besseling, Staal, van Attekum, de Bie, & van den Heuvel, 2008). However, little research has identified the determinants that maintain physical activity in middle adulthood as compared to young adulthood.

Determinants of health behavior change across the life span

Current health behavior theories assume that health behavior change is a self-regulatory process that consists of a *motivation phase* of goal setting and a *volition phase* of goal pursuit (e.g., Abraham, Sheeran, & Johnston, 1998; Heckhausen & Gollwitzer, 1987; Schwarzer, Luszczynska, Ziegelmann, Scholz, & Lippke, 2008). Volitional factors can help to bridge the so called "intention-behavior gap" (Sheeran, 2002), i.e., the phenomenon that people do not fully act upon their intentions. Thus, a major challenge for models of behavior change is unravelling the mechanisms that operate between intention and actual behavior. We developed a volitional model, shown in Figure 9, for predicting physical activity. The model

characterizes the linkages among behavioral intention, planning, and physical activity. Further, we explored the extent to which age modifies these linkages.

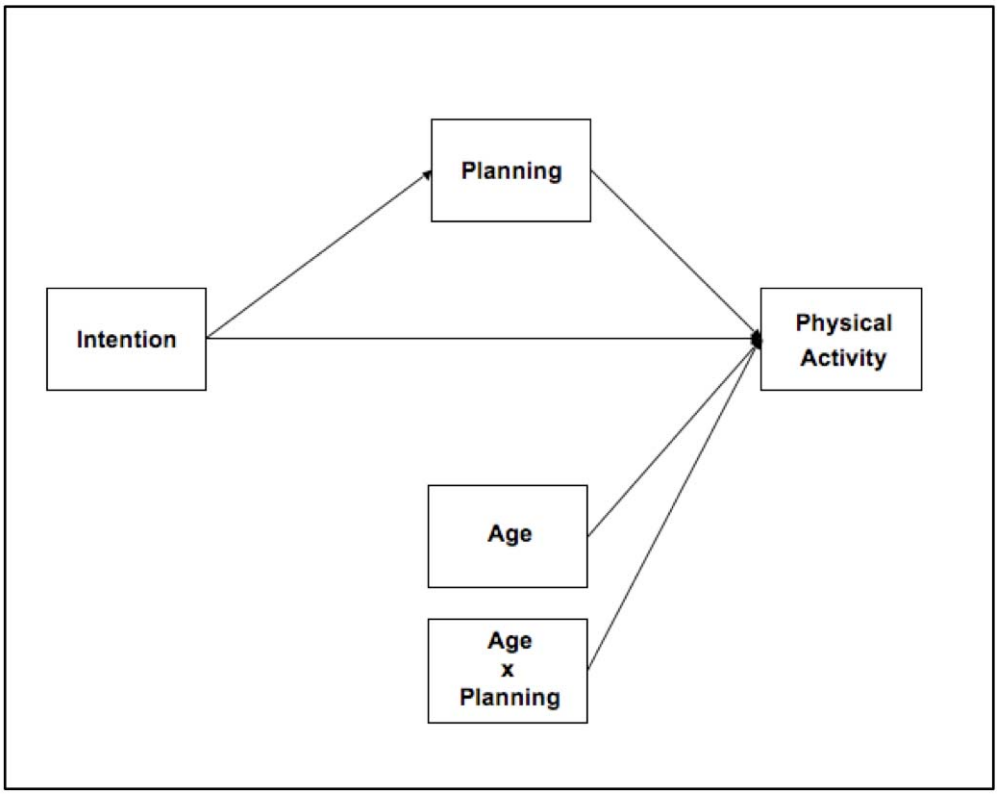

Figure 9. Hypothesized model 1: Planning as mediator between behavioral intention and physical activity as a function of age.

As it can be seen, planning plays a major role in the volition phase and is assumed to facilitate goal pursuit by linking behavioral responses to specific situations. Planning can be subdivided in two facets: action planning and coping planning. In the process of action planning (i.e., implementation intention, Gollwitzer & Oettingen, 1998) an action sequence is linked to specific parameters of a situation in terms of 'when', 'where', and 'how' to perform a behavior (e.g., Armitage, 2007; Leventhal, Singer, & Jones, 1965; Sniehotta, Scholz, & Schwarzer, 2005). This process can also be considered as a mental simulation of behavior in crucial key situations (Pham & Taylor, 1999). Holding such a mental representation in a critical situation is assumed to lead to an immediate and efficient behavioral response without conscious awareness. Increased information processing (e.g., accessibility and strength of cue-

response links) has been identified as an underlying working mechanism of implementation intentions (Webb & Sheeran, 2007). Self-generated implementation intentions predict physical activity over and above goal intentions for an extensive period of time (up to 12 months; Ziegelmann, Luszczynska, Lippke, & Schwarzer, 2007).

Coping planning, on the other hand, refers to the anticipation of barriers (e.g., distractions, temptations, or conflicting habits) and the generation of behavioral (or cognitive) responses to overcome them (e.g., Sniehotta et al., 2005). Whereas an action plan specifies the details of action implementation (the when, where, and how), a coping plan specifies how to cope with anticipated barriers. Both facets of planning jointly work together in concert. Thus, these two facets of planning can either be considered separately or combined in a second order factor. Intervention studies show that individuals who engage in a combination of action planning and coping planning display greater changes in behavior than individuals who focus on action plans alone (Sniehotta, Scholz, & Schwarzer, 2006; Ziegelmann, Lippke, & Schwarzer, 2006).

The mediation of the intention-behavior relation through planning

Planning is hypothesized to mediate the intention-behavior relation (e.g., Schwarzer et al., 2008). Planning is the critical psychological process through which behavioral intentions are translated into behavior. Individuals with higher intentions are more likely to plan when, where, and how to act; their plans help them translate their intentions in behavior. This mediating effect of planning between intention and behavior has been demonstrated in studies in which planning was experimentally induced (e.g., Reuter, Ziegelmann, Wiedemann, & Lippke, 2008) as well as observational studies in which planning was measured psychometrically (e.g., Norman & Conner, 2005).

Does age make a difference?

The processes that underlie the maintenance of health behavior may vary with age. For both theory development and the design of age-sensitive interventions, it is important to

consider age-associated changes in self-regulation of health behaviors. The present study further explores the factors that underlie the maintenance of physical activity across age. In Figure 9, intention to engage in physical activity predicts both subsequent planning and physical activity, whereas planning predicts physical activity. The model thus allows estimation of both the direct effect of intention on physical activity and the indirect effect of intention on physical activity through planning. We predict that the strength of the association between planning and physical activity will increase with age; this is represented by the interaction between age and planning in Figure 9. Put another way, we propose that age modifies, i.e., moderates the planning-activity link. For correct estimation of the path from the interaction to physical activity, we included a path from age to physical activity (Aiken & West, 1991).

Possible explanation for age-differential effects

As age cannot be referred to as a "causal" variable (Schaie, 1988), possible underlying mechanisms of the age-differential effect need to be examined. The model of selection, optimization, and compensation (SOC; P. Baltes & M. Baltes, 1990) provides a theoretical framework for the development of self-regulation (i.e., goal selection and goal pursuit) across the lifespan. The SOC model forms the basis of our expectation that the strength of association between planning and physical activity will increase in age. The SOC model yields four adaptive strategies for self-regulation: (1) *Elective selection* (i.e., developing and committing to a hierarchy of personal goals), (2) *Optimization* (i.e., engaging in goal-directed actions and means), (3) *Loss-based selection* (i.e., changing the goal or the goal system in response to loss in goal-relevant means), and (4) *Compensation* (i.e., acquiring and using alternative means in response to loss in goal-relevant means). In an action-theoretical framework, SOC is seen as a dynamic system that operates as an integrated ensemble of the processes of selection, optimization, and compensation (Freund & Baltes, 2000). While planning can be seen as aiming at achieving a specific goal (Das, Kar, & Parrila, 1996), we conceptualize SOC

strategy use to guide behavior at the operational level (cf. Ziegelmann & Lippke, 2007). Thus, self-reported planning exhibits to what extent an individual plans to perform a behavior in a given context (e.g., "I have already precisely planned, how I can be physically active even in the face of difficulties and barriers"). Self-reported SOC strategy use, on the other hand, gives insights how people actually go about to do this (e.g., "When it is getting more difficult to lead a healthy lifestyle, I increase my efforts even more").

Taking a life span view, Freund and Baltes (2002) argue that individuals acquire and refine their knowledge and use of SOC-related behaviors with increasing age. For instance, compared to young adults, middle-aged individuals have made more experience with barriers to behavior and experience losses in their respective life courses. Thus, coping planning as a way of overcoming barriers to action might be more effective in translating intentions into behavior in middle-aged adults who make use of compensation strategies (Freund & Baltes, 2002). For instance, when a temporary foot pain does not allow going running, swimming as a compensatory alternative of physical activity can help to maintain one's exercise level. If compensatory means are no longer available to achieve a given exercise goal, new standards can be adopted that can be achieved with the available resources (loss-based selection).

Thus, the closer orchestration of planning and SOC strategies should foster the planning-behavior link in middle-aged as compared to younger adults, because these middle-aged adults have more experience in terms of goal achievement. The second focus of the present study therefore is to examine whether an increase in the association of planning and physical activity as age increases (i.e., the age by planning interaction in Figure 9) can be explained by an increase in use of SOC strategies (see Figure 10). Put another way, we can ask whether the effect of the positive interaction between age and planning on physical activity is attributable to (i.e., mediated by) increased use of SOC strategies. For instance, we assume that a middle-aged individual is more likely than a younger individual to use SOC strategy use to translate plans into action. The role of SOC strategy use in linking the age-planning interaction

to physical activity is shown in Figure 10. The interaction predicts SOC strategy use which in turn predicts physical activity. Paths from planning and age to SOC were included as required for accurate estimation of the path from the interaction to SOC (Aiken & West, 1991).

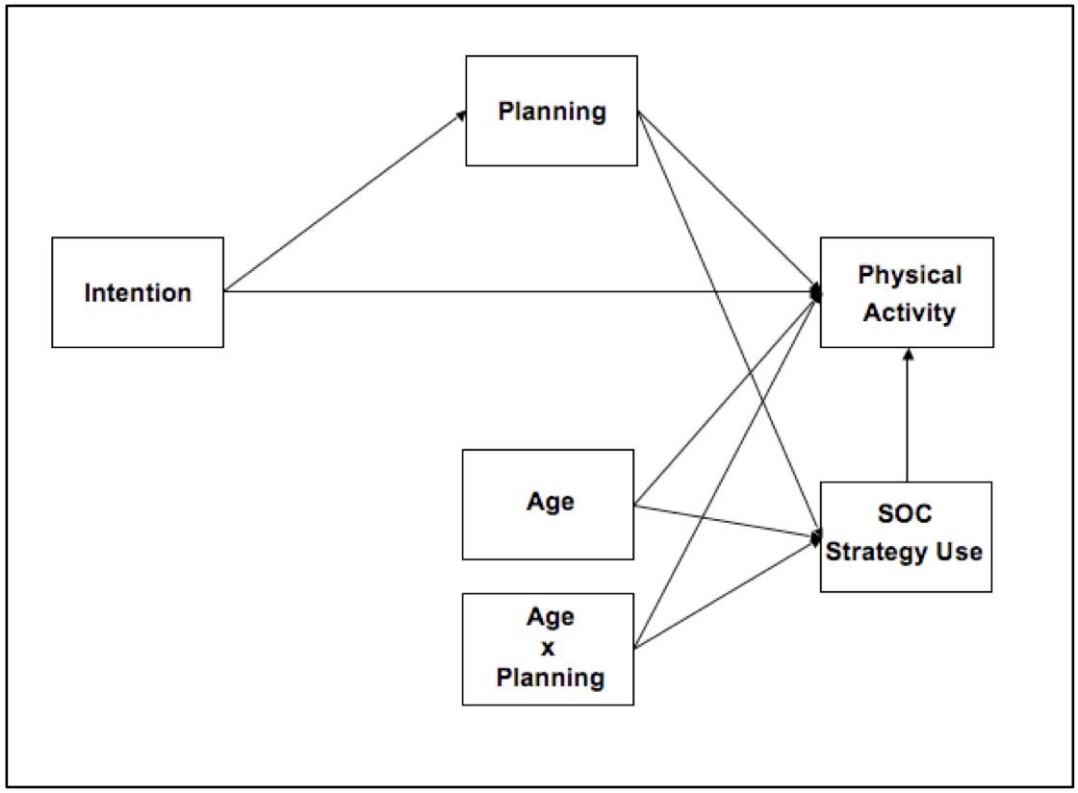

Figure 10. Hypothesized model 2: SOC strategy use as mediator of the planning by age interaction effect on physical activity.

An examination of the hypothesized processes of physical activity maintenance requires a population that maintains its physical activity over a wide age range. Only then it is possible to examine the processes that underlie physical activity maintenance across age. A population in which physical activity declines significantly with age does not permit such an examination. We identified an extensive population of young to middle aged adults who report maintained physical activity levels. This population is employees of the Deutsche Bahn, the national railway company of Germany, rated 163 of the international Fortune 500 Companies in 2008 (CNNMoney.com, 2008).

Research questions

The aim of present study is two-fold. First, we aim to identify age-specific patterns in the processes by which individuals sustain health behavior, specifically regular physical activity. In particular, we examine the extent to which planning mediates the relationship of intention to exercise and actual physical activity. We hypothesize that the extent to which planning mediates the intention-behavior relationship increases with age, due to growing strength of relationship of planning to physical activity with increasing age. Second, we aim to examine possible psychological mechanisms that underlie age differences in the planning-activity link. We test whether increasing strength of relationship of planning to physical activity as age increases can be explained through an increase in use of SOC strategies that result in increased physical activity.

From a statistical perspective, the first aim involves the examination of moderated mediation (Preacher, Rucker, & Hayes, 2007). Age is hypothesized to moderate (or modify) the mediational path from intention to planning to physical activity by increasing the strength of the link from planning to activity, as manifested in the age x planning interaction. The second aim involves the examination of mediated moderation (Morgan-Lopez & MacKinnon, 2006), which characterizes the factor that links the age x planning interaction to physical activity. This factor is hypothesized to be SOC strategy use.

Method

Participants and procedure

Participants were recruited from Germany's national railway company during a routine medical check-up. Employees in security-relevant domains such as engine drivers or track workers receive the same standard of preventive health care and are encouraged to engage in activities that maintain health. After giving informed consent, N = 537 participants (83.6 %

men) were assessed at baseline (Time 1). Of those, n = 265 (49.4 %) returned Time 2 questionnaires (one month after first assessment). Mean age was 44.9 (SD = 7.69), ranging from 19 to 64 years.

Measures.

All items were taken from Ziegelmann and Lippke (2007) and adapted for the current setting if not stated differently. *Behavioral intention* was assessed at Time 1 and Time 2: "I intend to perform strenuous physical activity (i.e., with an increased heart rate and sweating) in my leisure-time" (Lippke, Ziegelmann, Schwarzer, & Velicer, in press). *Planning* was measured at Time 1 and Time 2: "I have already precisely planned, when, where, and how to be physically active" (action planning) and "I have already precisely planned, how I can be physically active even in the face of difficulties and barriers" (coping planning; r = .73). The scale *SOC strategy use* was adapted by Ziegelmann and Lippke (2007) from the original generic questionnaire of selection, optimization, and compensation strategies (Freund & Baltes, 2002) to assess self-reported strategy use in the domain of physical activity. For the present study, this domain-specific scale was adapted for leading a healthy lifestyle (Cronbach's α = .85). The stem "Concerning my healthy lifestyle…," was followed by 2 items "…I have defined my goals exactly and stick to them" (elective selection) and "… I do everything possible to make my plans to lead a healthy lifestyle come true" (optimization). The second pair of items consisted of the stem "When it is getting more difficult to lead a healthy lifestyle…" which was followed by "…I only strive for my most important health goal" (loss-based selection) and "… I increase my efforts even more" (compensation). All items were answered on four-point scales ranging from *completely disagree* (1) *to completely agree* (4). *Physical activity* was assessed at Time 1 and Time 2: "I have performed physical activity and sports for at least 30 minutes per week in my leisure time (e.g., gym, playing soccer) with an increased heart rate and sweating". Responses were scored on a four-point scale with *less than once* (1), *at least once, at least 3 times, at least 5 times* (4) per week

regarding the last four weeks. The external validity of a similar scale was demonstrated by Siconolfi, Lasater, Snow, and Carleton (1985). Means, standard deviations, and intercorrelations of all variables are displayed in Table 4.

Table 4. Intercorrelations and descriptive statistics for behavioral intention, planning, SOC strategy use, physical activity, and age.

	2.	3.	4.	5.	6.	7.	Range	*M*	*SD*
1. Intention Time 1	.61**	.44**	.29**	.45**	.43**	-.03	1-4	2.55	1.13
2. Planning Time 1		.50**	.31**	.47**	.42**	.00	1-4	2.49	1.06
3. Planning Time 2			.50**	.36**	.47**	-.07	1-4	2.49	0.91
4. SOC strategy use Time 2				.26**	.43**	.00	1-4	2.63	0.64
5. Physical activity Time 1					.38**	.03	1-4	1.90	0.89
6. Physical activity Time 2						.01	1-4	2.21	0.90
7. Age in years							19-64	44.9	7.69

Note. ** $p < .01$.

Results

Analyses

In a first step, attrition between Time 1 and Time 2 data collection was examined in tests of difference between those retained versus lost to follow-up. In a second step, the two main hypotheses were examined in separate path models.

Mplus Version 3 (Muthén & Muthén, 2005) was used for model estimation. Full information maximum likelihood estimation (FIML, Arbuckle, 1996) was employed to derive parameter estimates in the face of missing data; FIML makes use of all available data in model

estimation. Given that models involve interactions, predictors were centered into deviation form to render first order effects interpretable (Aiken & West, 1991).

The first model (Figure 9) included the age x planning interaction, following the hypothesis that age would moderate the link from intention to physical activity by modifying the path from planning to physical activity (*moderated mediation*). Following the estimation of Model 1, the age x planning interaction was further probed through simple slope analysis (Aiken & West, 1991) to characterize the relation of planning to physical activity as a function of age. The non-parametric bootstrapping approach of Preacher et al. (2007) was employed to estimate the specific age range through which planning mediated the relationship of intention to physical activity. Put another way, this analysis identified the range of ages in which the indirect effect of intention on physical activity through planning was significant. The second model (Figure 10) tested whether SOC strategy use mediated the relationship of the age by planning interaction to physical activity (*mediated moderation*).

Attrition analysis

The retention rate of participants from Time 1 to Time 2 of 49% is comparable to studies in similar contexts (e.g., Renner, Spivak, Kwon, & Schwarzer, 2007). We examined differences between those retained versus lost to follow-up on all baseline measures including demographics, physical activity level, intention to engage in physical activity, planning for physical activity, and SOC strategy use. No significant differences were found in terms of age, sex, physical activity, behavioral intention, and planning. For SOC strategy use a small, albeit statistically significant difference was found $t(488) = -2.06$, $p < .05$, effect size $d = .19$), indicating that those retained reported more SOC strategy use than those lost to follow-up ($M = 2.74$, $SD = 0.66$ vs. $M = 2.61$, $SD = 0.72$).

Age by planning interaction: moderated mediation model

Model 1 estimates are given in Figure 11. The overall model yielded a reasonable fit, $\chi^2(2) = 8.99$; $p < .05$; CFI = .96; RMSEA = .08; 90% CI = .03, .14. As shown in Figure 11,

planning at T1 and physical activity at T1 are included to control for previous levels on these constructs. Intention at Time 1 significantly predicted planning at Time 2. In turn, planning at Time 2 was significantly associated with physical activity Time 2. Bootstrapping yielded a mean indirect effect of intentions on physical activity through planning of ß = .04 (*SE* = .02) with a 95%-confidence interval ranging from -.01 to .10. While age did not significantly predict physical activity, the significant positive age by planning interaction predicting physical activity confirmed the first hypothesis that the relationship of planning to physical activity would increase with age.

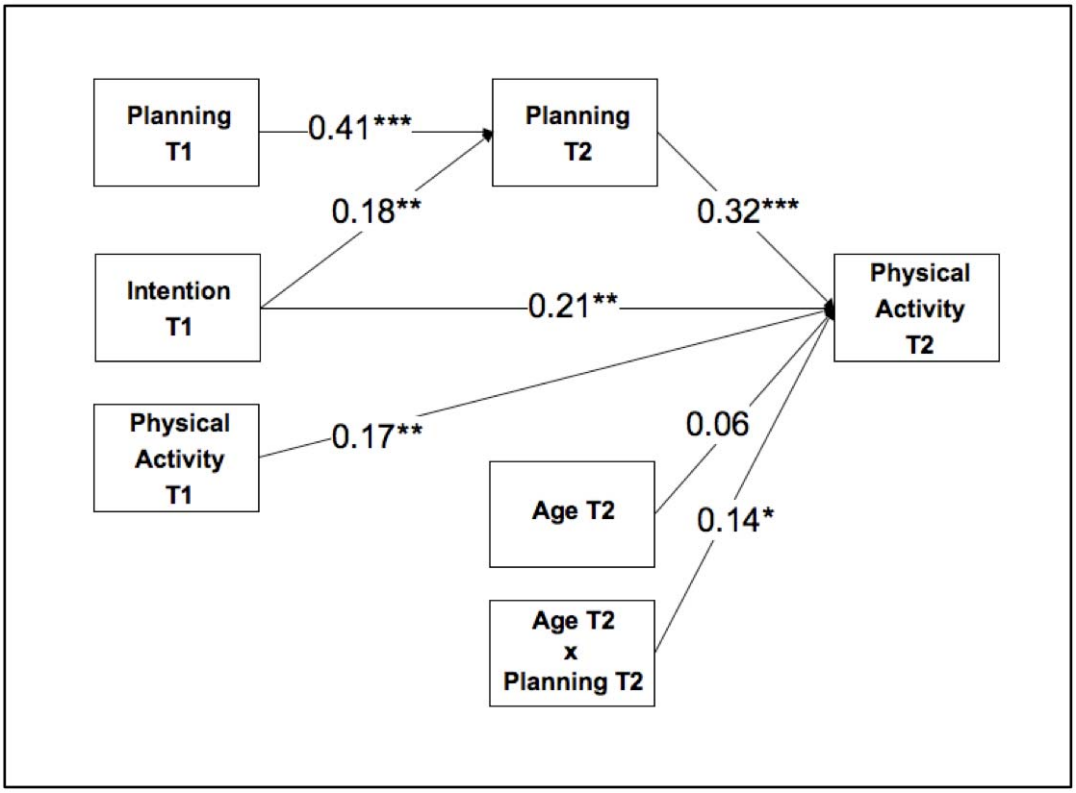

Figure 11. Planning as mediator between behavioral intention and physical activity as a function of age (Note. *$p < .05$, **$p < .01$, ***$p < .001$; standardized path coefficients are reported).

Probing the age by planning interaction. Following Aiken and West (1991) we characterized the age by planning interaction by estimating the regression of physical activity on planning as a function of age. We examined the simple regression of physical activity on

planning at five ages: 29, 37, 45, 53, and 60; these ages represent approximate values of the Mean (M) age - 2SD, M – 1 SD, M, M + 1 SD, and M + 2 SD, respectively, and tested the significance of the simple slope of physical activity on planning at each age. The estimated simple slope for age = 29 (.06, p = .38) was not statistically significant. At age = 37, 45, 53, and 60 (.14, .23, .31, and .39) the estimated simple slopes became increasingly positive and statistically significant (all ps < .001), as shown in Figure 12. The cross-over nature of the interaction is critical; at low levels of planning, physical activity appeared to decrease with increasing age, while at high levels of planning, the reverse was true. This cross-over interaction accounts for the lack of overall correlation between age and physical activity, but the significant impact of age on the planning to behavior link. In a next step, the conditional indirect effect of intention on physical activity through planning was estimated for the entire age range of the sample using a non-parametric bootstrapping approach[1] (Preacher et al., 2007). The indirect effect of intention on physical activity through planning was significant (p < .05) from age 34 to age 64 (the age of the oldest participant). Otherwise stated, planning was found to mediate the intention-behavior relation for this age range.

[1] Non-parametric bootstrapping was used for estimating the sampling distribution of the indirect effect as a function of age. The percentile-based confidence intervals were further improved through bias-correction and acceleration (Preacher et al., 2007). The results verified the results of the normal-theory approach for assessing the indirect effect moderated by age.

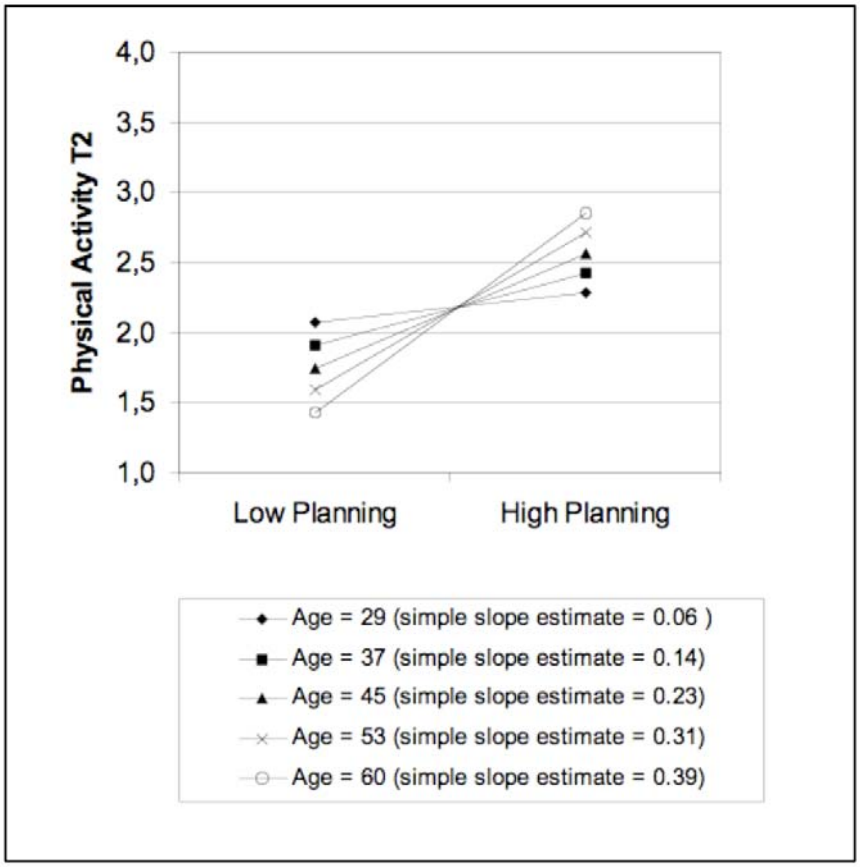

Figure 12. Estimated direct effect of planning on physical activity at different Age values.

SOC strategy use as a mediator of the age differential effect on physical activity

To examine potential underlying mechanisms of the age-differential mediation patterns, in Model 2, SOC strategy use was integrated as a mediator of the relationship of the age by planning interaction to physical activity (see Figure 13). Overall model fit was good, $\chi^2(3) = 4.83$; $p = .18$; CFI = .99; RMSEA = .03; 90% CI = .00, .09. Planning at Time 2 significantly predicted SOC strategy use at Time 2, with planning at Time 1 controlled. The age by planning interaction was significantly associated with SOC strategy use. In turn, SOC strategy use predicted physical activity. The indirect effect from the age by planning interaction to physical activity via SOC strategy use was estimated using the bootstrapping procedure and resulted in an indirect effect of ß = .05 (*SE* = .02) with a 95%-confidence interval from .01 to .08. Thus, the age by planning interaction effect on physical activity was partially mediated by SOC strategy use.

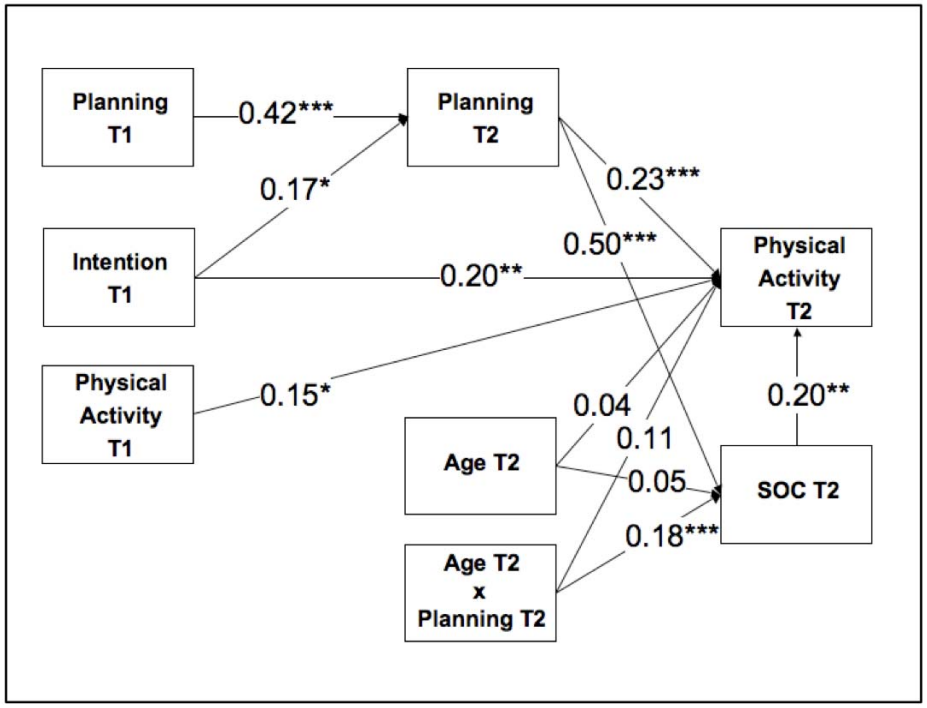

Figure 13. SOC strategy use as mediator of the planning by age interaction effect on physical activity (Note. *$p < .05$, **$p < .01$, ***$p < .001$; standardized path coefficients are reported).

Discussion

The primary goal of this study was to examine the age-differential association patterns between intentions, planning, and physical activity in young and middle-aged adults. Previous studies have found that planning is beneficial for the translation of intentions into behavior in all adult age groups (Scholz, Sniehotta, Burkert, & Schwarzer, 2007; Ziegelmann et al., 2006). However, both studies were conducted in rehabilitation settings. The present study found in a healthy working population that the degree to which planning mediates the intention-behavior relation increases with age. Planning as a way to translate intentions into physical activity seems to be more beneficial for middle-aged than for younger adults. Thus, age can be considered a moderator in the self-regulatory framework rather than a direct determinant of health behavior (cf. Leventhal, Leventhal, & Schaefer, 1991).

Strategy use that includes selection, optimization, and compensation (SOC) was hypothesized and tested as an intervening explanatory variable for the age by planning

interaction for the following reasons: knowledge and use of SOC-related strategies is refined with increasing age (Freund & Baltes, 2002) and the enactment of plans requires the use of such strategies (Smith, Dixon & Baltes, 1989; Ziegelmann et al., 2006). The inclusion of SOC strategy use revealed that the interaction effect of age and planning on behavior is partially mediated by the use strategies of selection, optimization, and compensation. This result can be interpreted as indicating that middle-aged adults compared to young adults are more successful in translating their plans into behavior due to SOC strategy use. For instance, older adults enact their plans and thus achieve their health goals despite barriers by increasing their effort or selecting their most important health goal. The present study is one of the first to examine explanatory variables for the moderating effects of age in behavioral self-regulation.

A different pathway by which planning might affect the intention-behavior relationship as a function of age is the subjective relevance of the behavioral domain. With increasing age, the personal relevance of health increases (Hooker & Kaus, 1994), which might explain why in older individuals health-related plans are translated into behavior more effectively than in younger participants. Additionally, a shift in goal orientation from growth in young adults to maintenance and loss prevention in middle-aged and older adults (Ebner, Freund, & Baltes, 2006) might serve as an explanatory variable for age differences in goal striving. Further research is needed to explain age-differential self-regulation of health behaviors. Additionally, further subgroups of people and contexts may be identified to explain how intentions are differentially translated into behavior through planning. For instance, the mediating effect of planning between intentions and behavior has been found to increase with the strength of intention (Wiedemann, Schüz, Sniehotta, Scholz, & Schwarzer, in press). Moreover, moderators can influence the mediation process in different ways, e.g., by (1) moderating the intention-planning association, (2) the planning-behavior association, (3) or both. In the present study, we examined how age moderates the planning-behavior association. Further research needs to identify other critical variables that modify the link from planning to

behavior and thus to extend our understanding of the mechanisms of health behavior change in different contexts and for different behaviors.

There are limitations to the present study. The longitudinal, but non-experimental design of the study does not allow strong inferences for cause-and-effect relationships. The underlying mediation model of the study was based on theoretical consideration and time lag. However, even though observational studies do not allow strong causal inferences, they can provide insights for experimental studies in which the putative causal processes are manipulated (see MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). An experimental-causal-chain design may be employed to test mediation hypotheses experimentally (e.g., Reuter et al., 2008). Further studies are needed, in which planning and SOC strategies are experimentally induced in different age groups to understand age differences and putative explanatory variables.

Finally, regarding the reported age-related findings, one has to bear in mind that cross-sectional age data are unable to unconfound chronological age, cohort, and selective mortality.

Conclusions

The pursuit of health-related goals requires self-regulation strategies such as planning the intended behavior. While previous research has demonstrated that planning mediates the intention-behavior relation (e.g., Norman & Conner, 2005; Schwarzer et al., 2008), the present study provides to our knowledge first evidence for an increased association of planning and goal attainment with increasing age. As a first attempt to explore age-differential mediation patterns when intentions are translated into behavior through planning, the present study compared young and middle-aged adults. Furthermore, SOC strategy use was examined as an explanatory variable for age differences. These findings might be helpful for stimulating further research on volitional processes of health behavior change and, in particular, conditional mediation effects of the intention-behavior association. Furthermore, the present

findings may be useful for designing effective age-group specific interventions such as increasing strategy knowledge and training of successful planning in younger age groups.

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.

Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions.* Thousand Oaks: Sage.

Arbuckle, J. L. (1996). Full information estimation in the presence of incomplete data. In G. A. Marcoulides & R. E. Schumacker (Eds.), *Advanced structural equation modeling* (pp. 243-277). Mahwah, NJ: Erlbaum.

Armitage, C. J. (2007). Effects of an implementation intention-based intervention on fruit consumption. *Psychology & Health, 22*, 917-928.

Baltes, P. B., & Baltes, M. M. (1990). Psychological perspectives on successful aging: The model of selective optimization with compensation. In P. B. Baltes & M. M. Baltes (Eds.), *Successful aging: Perspectives from the behavioral sciences* (pp. 1-34). New York: Cambridge University Press.

Baltes, P. B., & Smith, J. (2003). New Frontiers in the Future of Aging: From Successful Aging of the Young Old to the Dilemmas of the Fourth Age. *Gerontology, 49*, 123-135.

CNNMoney.com (2008, July 21 – last update). *Global 500: our ranking of the world's largest corporations* [Online]. Available: http://money.cnn.com/magazines/fortune/global500/2008/full_list/101_200.html [August 30, 2008].

Das, J. P., Kar, B. C., & Parrila, R. K. (1996). *Cognitive planning: The psychological basis of intelligent behavior*. New Delhi, India: Sage.

Ebner, N. C., Freund, A. M., & Baltes, P. B. (2006). Developmental changes in personal goal orientation from young to late adulthood: From striving for gains to maintenance and prevention of losses. *Psychology and Aging, 21*, 664–678.

Freund, A. M., & Baltes, P. B. (2000). The orchestration of selection, optimization, and compensation: An action-theoretical conceptualization of a theory of developmental

regulation. In W. J. Perrig & A. Grob (Eds.), *Control of human behavior, mental processes and consciousness* (pp. 35–58). Mahwah, NJ: Erlbaum.

Freund, A. M., & Baltes, P. B. (2002). Life-management strategies of selection, optimization and compensation: Measurement by self-report and construct validity. *Journal of Personality and Social Psychology, 82*, 642-662.

Gollwitzer, P. M. & Oettingen, G. (1998). The emergence and implementation of health goals. *Psychology & Health, 13,* 687-715.

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

Hooker, K., & Kaus, C. R. (1994). Health-related possible selves in young and middle adulthood. *Psychology and Aging, 9*, 126-133.

Leventhal, H., Leventhal, E. A., & Schaefer, P. (1991). Vigilant coping and health behavior: A life span problem. In M. Ory & R. Abeles (Eds.), *Aging, Health, and Behavior* (pp. 109-140). Baltimore: Johns Hopkins.

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., 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.*

MacKinnon, D. P., Lockwood, C. M., Hoffman, J. M., West, S. G., & Sheets, V. (2002*). A comparison of methods to test mediation and other intervening variable effects. Psychological Methods, 7*, 83–104.

McAuley, E., & Rudolf, D. (1995). Physical activity, aging, and psychological well-being. *Journal of Aging and Physical Activity, 3*, 67–96.

Morgan-Lopez, A. A., & MacKinnon, D. P. (2006). Demonstration and evaluation of a method for assessing mediated moderation. *Behavior Research Methods, 38*(1), 77-87.

Muthén, L. K., & Muthén, B. O. (2005). *MPlus user's guide – 3rd edition*. Los Angeles, CA: Muthén & Muthén.

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.

Pham, L. B., & Taylor, S. E. (1999). From thought to action: Effects of process- versus outcome-based mental simulations on performance. *Personality and Social Psychology Bulletin, 25*(2), 250-260.

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

Renner, B., Spivak, Y., Kwon, S., & Schwarzer, R. (2007). Does age make a *difference? Predicting physical activity of South Koreans. Psychology* and Aging, 22, 482-493.

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*, 194-297.

Schaie, K. W. (1988). Ageism in psychological research. *American Psychologist, 43*, 179-183.

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., Luszczynska, A., Ziegelmann, J. P., Scholz, U., & Lippke, S. (2008). Social-cognitive predictors of physical exercise adherence: Three longitudinal studies in rehabilitation. *Health Psychology, 27,* 854-863.

Sheeran, P. (2002). Intention-behavior relations: A conceptual and empirical review. *European Review of Social Psychology, 12*, 1–36.

Siconolfi, S. F., Lasater, T. M., Snow, R. C., & Carleton, R. A. (1985). Self-reported physical activity compared with maximal oxygen uptake. *American Journal of Epidemiology, 122*, 101-105.

Smith, J., Dixon, R. A., & Baltes, P. B. (1989). Expertise in life-planning: A new research approach to investigating aspects of wisdom. In M. L. Commons, J. D. Sinnott, F. A. Richards, & C. Armon (Eds.), *Beyond formal operations II* (Vol. 1, pp. 307-331). New York: Praeger.

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

van Eijsden-Besseling, M. D., Staal, J. B., van Attekum, A., de Bie, R. A., van den Heuvel, W. J. (2008). No difference between postural exercises and strength and fitness exercises for early, non-specific, work-related upper limb disorders in visual display unit workers: a randomised trial. *Australian Journal of Physiotherapy, 54*, 95-101.

Webb, T. L., & Sheeran, P. (2007). How do implementation intentions promote goal attainment? A test of component processes. *Journal of Experimental Social Psychology, 43*(2), 295-302.

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. (2007). Planning and strategy use in health behavior change: A life span view. *International Journal of Behavioral Medicine, 14*, 30-39.

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.

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.

Chapter 5

General Discussion

Summary

Health behavior change is not a simple function of how much one intends to change a behavior. The studies in this thesis demonstrated that self-regulatory skills and beliefs are needed for successful goal pursuit. The Health Action Process Approach (HAPA; Schwarzer, 1992, 2008) provided the guiding theoretical framework of this thesis. While most theories of health behavior are limited to the processes of goal setting, the Health Action Process Approach distinguishes between a *motivation phase* of goal setting and a *volition phase* of goal pursuit. The motivation phase culminates in the formation of an intention; in the volition phase intentions are translated into behavior. As most health behaviors are challenged with volitional problems, a theory distinctly addressing such factors should allow for more thorough insights in the processes of health behavior change.

Research on volitional goal striving is still underrepresented as compared to the long tradition in research on motivational factors of health behavior change. The aim of this thesis was to unravel the mechanisms that determine goal striving in the volitional phase of the process of health behavior change. The studies presented in this thesis focused on elaborating the simplistic intention-behavior relation and shedding light on postintentional, volitional factors including planning, strategy use, and perceived self-efficacy that promote the translation of intentions into behavior. A process approach was taken by modeling the dynamic interplay of these volitional factors. Furthermore, a developmental approach was pursued by integrating the action-theoretical life management strategies of selection, optimization, and compensation (SOC; Freund & Baltes, 2002) in the self-regulatory framework of volitional goal pursuit (cf. Ziegelmann, Lippke, & Schwarzer, 2006).

Three main research questions were addressed: (1) Adopting a dynamic perspective, whether previous findings concerning the predictive power of volitional factors for health behavior change could be replicated by applying latent true change modeling, and thus, provide first answers on a long-standing question in health behavior change research on inter-

individual differences in intraindividual change and their determinants. (2) Whether there is experimental evidence for the causal assumption that planning mediates the intention-behavior relation employing an experimental-causal-chain design. (3) Taking a developmental perspective, whether age modifies the functional dependencies in the mediation of the intention-behavior relation through planning and whether given age differences can be explained by strategy use.

This thesis also aims to further advance theory, method, and intervention development in the research field of health behavior change by applying recent state-of-the-art methodologies for analyzing longitudinal data that allow examining questions about dynamic relationships in the self-regulation framework of health behavior change and by employing an innovative experimental design for testing mediation hypotheses. The main findings of this dissertation are summarized in Table 5.

Table 5. Summary of the main findings in this thesis.

Aims and Research Questions	Findings	Conclusions
Chapter 2. To model dynamic relations between social-cognitive determinants and behavior. Interindividual differences in within-person change in intention, self-efficacy, and planning are examined as predictors of changes in two health behaviors (physical activity and fruit and vegetable intake). Interindividual differences in change were analyzed using latent true change (LTC) models.	For both behaviors similar prediction patterns were found: Changes in intention and self-efficacy predicted change in planning. Changes in planning and self-efficacy predicted change in behavior, whereas the effect of change in self-efficacy on change in behavior was partially mediated by change in planning. A complete mediation was found for the effect of change in intention on change in behavior through change in planning for physical activity and a partial mediation for fruit and vegetable intake.	The present study is among the first to study interindividual differences in within-person change in the health behavior change process. Results confirm that the relations among changes in social-cognitivie predictors and behavior change (i.e., change-change associations) are similar to associations among initial levels of these predictors and behavior change (i.e., status-change associations). Furthermore, the present study demonstrates the usefulness of LTC modeling when analyzing change in several variables simultaneously.
Chapter 3. An experimental-causal-chain design was employed to validate the causal assumption that planning mediates the intention-behavior relation. In such a design, both, the independent variable (intention) and the mediator (planning) are manipulated.	Study 1 found that changing dietary intentions using a motivational intervention engenders changes in planning activities 1 month later. Study 2 found, in a different sample, that a volitional planning intervention brings forth changes in dietary behavior 1 month later.	Previous observational findings on planning as a mediator in the intention–behavior association were supported by the two experiments. The findings might help to identify points of intervention in the process underlying health behavior change.
Chapter 4. To examine age-differential association patterns between intentions, planning, and physical activity in young and middle-aged individuals. Furthermore, to explore the use of strategies that include selection, optimization, and compensation (SOC) as underlying mechanism for age differences.	Age moderates the extent to which planning mediates the intention-behavior relation due to an increasing strength of the planning-behavior link. As a possible psychological mechanism for these age differences, we identified SOC strategy use as a mediator of the age by planning interaction effect on physical activity.	These findings might be helpful for stimulating further research on volitional processes of health behavior change and, in particular, conditional mediation effects of the intention-behavior association.

Chapter 2 takes an effort to conceptualize health self-regulation matters in more dynamical, change-oriented terms rather than the static terms that have tended to dominate past research on health behavior change. In static models, between-person differences in social-cognitive variables at baseline are used to predict between-person differences in behavior at subsequent measurement occasions. However, such models are not necessarily depicting the processes that occur within individuals. Therefore, latent true change (LTC) modeling (Steyer, Eid, & Schwenkmezger, 1997; Steyer, Partchev, & Shanahan, 2000) was used to model change across two measurement occasions and to examine interindividual differences in intraindividual change. The present study tested whether changes (rather than only baseline levels) in intention, self-efficacy, and planning are associated with change in behavior. The findings concerning the change associations corroborate previous studies examining static relations between these variables. This study is one of the first that takes a much-needed dynamic perspective emerging in health behavior research.

In *Chapter 3*, a central proposition of the Health Action Process Approach was tested: When it comes to translate intentions into behavior, planning is specified as an intervening mechanism, i.e., intentions exert their influence on behavior through planning. In previous research, this mediation hypothesis has been tested in observational studies using statistical mediation analysis. However, non-experimental studies do not allow cause-and-effects inferences. Employing an experimental-causal-chain design (cf. Spencer, Zanna, & Fong, 2005), a causal chain from intentions to planning and planning to behavior was demonstrated. In such a design, both the independent variable (intention) and the mediator (planning) are experimentally manipulated. Two independent randomized controlled trials were conducted: intention was manipulated in unmotivated participants (non-intenders; Study 1) and planning to consume five portions of fruit and vegetables per day was prompted in motivated participants (intenders; Study 2). The first study showed that participants who received a motivational intervention significantly increased their planning activities as compared to the

control group. In the second study, participants who received a planning intervention significantly increased their behavioral levels compared to a control group. These findings speak in favor of planning as a putative mediator of the intention-behavior relation. From a theoretical perspective, the empirical validation of the causal direction of such mediating processes helps elucidating the intervening processes by which intentions are translated into behavior.

Chapter 4 examined whether the functional dependencies between intention, planning, and behavior in terms of mediation are equivalent for different age groups. For physical activity, it was found that the association between planning and behavior becomes stronger with age within a healthy working population ranging from 19 to 64 years. Therefore, it can be concluded that middle-aged adults benefit more from planning when it comes to translate intentions into behavior. The use of strategies of selection, optimization, and compensation was identified as a mediator for the finding that age moderates the relationship between planning and behavior. This might be one of the underlying mechanisms of age differences in self-regulation. These findings advert to age-differential mechanisms in behavior regulation and highlight the need for research on its underlying causes.

In the following general discussion, the findings of this thesis will be integrated and specific aspects of the discussions of the different chapters will be elaborated and integrated. The discussion includes a critical reflection on strengths and weaknesses of the studies conducted in this thesis, as well as more general considerations on methodological aspects in studying health behavior self-regulation. Furthermore, implications for further research from the background of this thesis will be developed.

Dynamic perspective: Interindividual differences in intraindividual change

Most research on health behavior has focused on modeling static relations between social-cognitive predictors and behavior rather than examining dynamic (i.e., change) relations between these variables. Longitudinal panel data is often analyzed by regressing (behavioral) outcomes on baseline levels of (social-cognitive) predictors. Such an approach implicitly postulates that cognitions, e.g., the levels of intentions or attitudes, remain constant. The focus on static prediction cannot account for changes during the course of time and ignores notions of change and dynamism.

Applying a dynamic perspective in longitudinal research permits to investigate whether values of social-cognitive predictors and levels of behavior rise and fall together over time within individuals. Modeling interindividual differences in within-person change allows approaching questions such as "Is an increase in planning activities associated with an increase in behavior across occasions within an individual?" Models of change such as latent true change models (Steyer et al., 1997; 2000) can be used to examine the synchronicity of within-person change in social-cognitive predictors and behavior. The study in *Chapter 2* examined a pattern of change that was defined across social-cognitive variables and behavior within persons over time. The predictive value of interindividual differences in intraindividual changes in intentions, self-efficacy, and planning for changes in behavior was tested for two health behaviors: physical activity and fruit and vegetable intake. The results regarding the associations among the change variables were in line with the theoretical assumptions of the HAPA model and corroborated the findings from previous studies (e.g., Schwarzer et al., 2007) that examined baseline levels of these social-cognitive predictors and behavior change. The results did not only underscore the importance of planning but also the role of self-efficacy as a postintentional factor in the volition phase, which supports previous research findings on the between-person level (e.g., Lippke, Wiedemann, Ziegelmann, Reuter, & Schwarzer, in press).

Investigating change associations between volitional factors and behavior permits to draw inferences about processes that occur within individuals over time. In contrast to previous research that focused on static modeling, latent true change models provide insights on promoting and impeding factors that may contribute to differential within-person change. On the basis of the results, it can be concluded that changes in the social-cognitive variables under study are associated with changes in behavior on the within-person level.

Findings on within-person associations of self-efficacy and behavioral performance are still sparse and inconclusive. Vancouver and colleagues (Vancouver, Thompson, & Williams, 2001) found that the direction of the relation of self-efficacy and performance is on the opposite on the within- and between-person level. The findings of Scholz, Sniehotta, Schüz, and Oeberst (2007) are in the same line; self-efficacy to execute an action plan predicted successful mastery of this plan on the between-person level but not on the within-person level. More research is needed in order to better understand the processes of self-regulated health behavior change at the within-person level.

Not only initial status (i.e., baseline levels) and rate of change but also occasion-specific fluctuations of social-cognitive predictors of health-behavior change and their multivariate associations may be examined (e.g., Scholz, Nagy, Schüz, & Ziegelmann, 2008). Most longitudinal studies on health behavior change follow the underlying assumption that short-term variability in social-cognition and behavior is small relative to the respective long-term changes. Consequently, research designs that measure antecedents, correlates, and consequences of health behavior in widely spaced intervals are applied.

A dynamic approach to the phenomenon health behavior change assumes that intraindividual variability as an additional source of information might turn out to be of relevance for describing, explaining, predicting, and modifying health behaviors. Intraindividual variability has been shown in many studies to be predictive for a wide range of diversified phenomena. This suggests that short-term variability embraces valuable

information, which goes beyond mean level information (Ghisletta, Nesselroade, Featherman, & Rowe, 2002). Between-person differences in the magnitude of week-to-week within-person fluctuations in perceived control emerged to be predictive of mortality irrespective of the mean level of perceived control over time (Eizenman, Nesselroade, Featherman, & Rowe, 1997). Drawing on repeated assessments of individuals, Scholz et al. (2008) found that the degree of fluctuation in intentions, self-efficacy, planning, and action control turned out to be consistently associated with changes in self-regulated running over time and with successfully running marathon- or half-marathon distance.

Future research should explore the usefulness of examining within-person variability in social-cognitive variables when predicting health behavior change, e.g., to what extent intraindividual variability in behavioral intentions serves as a correlate of adoption and maintenance of health behaviors. Depending on how we look at the phenomenon of intraindividual variability – day-to-day, week-to-week, or month-to-month fluctuations – the chosen time frame determines the magnitude of intraindividual variability. Future theoretical considerations might be able to determine the time frame that captures fluctuations social-cognitive variables that predict behavioral outcomes.

Mediation of the intention-behavior relation

The Health Action Process Approach (Schwarzer, 2008) refines the intention-behavior association by specifying planning as a mediating mechanism. This implies that individuals who form an intention will be more likely to engage in planning, and those who do plan will be more likely to engage in the desired behavior.

From a theoretical perspective, a detailed plan (or implementation intention) is subordinate to a behavioral intention. A behavioral intention takes the form “I intend to perform x!”, whereas planning links certain situations (in terms of when and where) to the intended behavior (Gollwitzer, 1999). Such plans adopt the form of a mental simulation of

behavior in crucial key situations (Pham & Taylor, 1999), and they are assumed to lead to an immediate and efficient behavioral response without conscious awareness. Increased information processing (e.g., accessibility and strength of cue-response links) has been identified as an underlying working mechanism of implementation intentions (Webb & Sheeran, 2007, 2008).

Observed regression approach for estimating mediation

Chapter 2 and *Chapter 4* presented two methods for testing mediation effects based on the observed regression approach. Longitudinal mediation models were employed, which respects one important condition of causality, namely temporal precedence. Both studies found (partial) mediation effects of planning in the intention-behavior relation. However, the results have to be interpreted cautiously with regard to causal inferences, as the restriction to only two measurement waves in both studies limited the possibilities to vary the ordering of the data in time.

In *Chapter 4* two path models were specified in which the independent variable (intention) at Time 1 (T1) preceded the mediator (planning) measured at Time 2 (T2). Yet, the mediator as well as the outcome (behavior) was measured concurrently at T2. Relating the mediator to the outcome at the same measurement occasion allows testing contemporaneous mediation effects but not longitudinal mediation effects (in statistical terms; cf. MacKinnon, 2008). In *Chapter 2* a latent true change (LTC) model was applied in which change in the independent variable is related to change in the mediator, which is, in turn, related to change in the outcome, whereas all change variables relate to change between T1 and T2. Without temporal precedence there might be equivalent models that explain the data just as well. Further studies should include more measurement waves and make use of the full potential of longitudinal mediation analysis.

Extending a LTC model to four and more measurement occasions would be useful for examining whether change in intention (T1-T2) predicts change in planning (T2-T3), which in

turn predicts change in behavior (T3-T4). Research designs have to be based on plausible time frames for causal effects of, for instance, intentions on planning. If time windows between measurement occasions are too narrow or too wide, causal effect might have not yet occurred or already faded out.

In terms of cause-and-effects relationships it has to be considered, however, that associations of variables measured over time cannot be taken to imply causal sequences. Alternative explanations of over-time correlations abound, among them spuriousness (Link & Shrout, 1992; MacKinnon, 2008; MacKinnon & Luecken, 2008).

Experimental-causal-chain design for studying mediation

Whereas the mediating effect of planning has been found in many observational studies (e.g., Schwarzer et al., 2007) including the studies presented in *Chapter 2* and *Chapter 4*, the findings of the study in *Chapter 3* provided first experimental evidence for the proposed causal chain process.

Drawing on an experimental-causal-chain design (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002; Spencer et al., 2005), (i) intention was manipulated in a motivational intervention and the mediator (planning) was measured as an outcome in Study 1, and (ii) the mediator was manipulated in a planning intervention and behavior was measured as an outcome in Study 2. In an experimental design, randomization and temporal precedence help to rule out alternative causal explanations (West & Aiken, 1997).

There are number of ways in which an experimental-causal-chain design complements typical statistical mediation analyses. For theory development, it can provide experimental evidence for putative mediators of the intention-behavior relation. Second, it can help to examine temporal aspects of the change process and provide evidence for specific phases of health behavior change. Compared to past approaches, such a research design scrutinizes different outcomes for different phases of the health behavior change process, i.e., a variety of social-cognitive outcomes along the proposed causal chain instead of only measuring

behavioral outcomes. Furthermore, these intermediate outcome variables can serve as predictor variables for a subsequent phase in the health behavior change process. An experimental-causal-chain design enables us to examine and model the sequence of events in the health behavior change process.

For designing interventions, the findings might help to identify intervention points in the process underlying health behavior change. By providing evidence for a temporal path of goal-directed behavior, the concept of matching interventions to stages of change reveals its relevance (cf. Lippke, Ziegelmann, & Schwarzer, 2004; Schüz, Sniehotta & Schwarzer, 2007). The notion of action phases or stages of change in the process of health behavior change implies that individuals proceed through qualitatively distinct stages when changing their behaviors. Individuals within a particular stage share certain motivational and behavioral characteristics. Hence, interventions can be applied in a certain sequence addressing qualitatively different patterns of factors that produce specific transition between phases. Furthermore, the concept of tailoring allows designing parsimonious interventions (Weinstein, Rothman, & Sutton, 1998).

The finding in *Chapter 3* that a planning intervention promotes fruit and vegetable intake in motivated participants (Study 2) is in line with findings of previous studies (e.g., Luszczynska, Tryburcy, & Schwarzer, 2007). Thus, there is a large body of evidence for the latter link in the causal chain: The beneficial effect of detailed plans (i.e., implementation intentions) on behavioral performance has been shown in numerous studies for different behaviors (see Gollwitzer & Sheeran, 2006, for a meta-analysis).

There is only little research on the intention-planning link, i.e., on the assumption that forming an intention results in planning. In an observational study, Gollwitzer and Brandstätter (1997) found that two thirds of the participants who were asked to list two projects, they intended to achieve during the upcoming vacation, had already specified the when and where to get started (for easy as well as for difficult to implement projects). Of those, two thirds

reported project completion (for the difficult to implement) whereas only one fourth of those who had not planned the when and where reported successful project completion. Study 1 in *Chapter 3* is, to our knowledge, the first study that provides experimental evidence for the former link in the causal chain: A motivational intervention targeting intentions to consume five portions of fruit and vegetables leads to an increase in planning activities. This finding has to be replicated in further experimental studies and with different behaviors.

The results of Study 1 and Study 2 combined speak in favor of a causal chain from intentions to planning and planning to behavior. Thus, an experimental-causal-chain design helps to examine the causal structure of the HAPA and to draw inferences on volitional factors that help to bridge the intention-behavior gap.

A prerequisite for applying such a design for an experimental test of a mediation hypothesis is the equivalence of the mediator as it is measured and as it is manipulated. In both studies, planning referred to a mental representation of the target behavior in specific situations in terms of when, where, and how. We assume that planning as it is measured psychometrically (i.e., asking participants if they already have precisely planned when, where, and how to act) and planning as it is manipulated (asking participants to specify when, where, and how to act) represent the same construct. However, research is needed in which this assumption is tested.

Further developments of experimental-causal-chain designs

The experimental-causal-chain design presented in *Chapter 3* aimed to test mediation in two independent randomized controlled trials by demonstrating (1) a relation between the independent variable and the mediator and (2) a relation between the mediator and the dependent variable. The limitation of this initial foray into the experimental-causal-chain design is that the two experiments involved distinct individuals. The research showed the efficacy of intervention at each phase of the causal chain but did not link the two phases within a common set of individuals.

Further development could concern the demonstration of a causal chain at the within-person level by conducting two successive experiments on the same set of individuals. This variation of an experimental-causal-chain design allows examining intraindividual mediation processes and allows even stronger inferences for a causal chain than the experimental-causal-chain design presented in *Chapter 3*.

In terms of the mediation of the intention-behavior relation through planning, this analysis would consider whether formerly unmotivated participants (non-intenders, i.e., individuals who have not concluded they will undertake a health behavior) who receive a motivational treatment would increase their intentions (i.e., become intenders by making the decision to undertake a health behavior) and start to plan the desired behavior. The subsequent volitional planning intervention should serve as a booster session on self-induced planning and lead to an increase in behavior. If such a pattern emerges it would provide evidence for the mediating effect, i.e., a causal chain from intentions to behavior via planning. Furthermore, the planning treatment should match the intenders more than participants who remained non-intenders. In other words, those individuals who have been treated successfully in the first treatment would be the ideal candidates for the subsequent treatment, whereas this causal chain would not apply to those who failed to become intenders by the motivational treatment.

Planning in the context of self-regulatory mechanisms

Although planning is an important factor in the volition phase, other mechanisms are necessary as well to guarantee goal attainment. Furthermore, the partial mediation effect of planning in the intention-behavior relation found in *Chapter 2* and *Chapter 4* adverts to potential additional mediators of the intention-behavior relation. According to Ford and Nichols (1991), three mechanisms for goal pursuit can be distinguished: (a) feedback mechanisms, (b) feedforward mechanisms, and (c) control processes. *Feedback mechanisms* enable monitoring and evaluation of progress towards a goal on the basis of behavioral results. Outcome anticipations as *feedforward mechanisms* are steered by expectancies regarding the

context and personal capabilities. Self-efficacy beliefs in one's capabilities to perform a desired action relates to such outcome anticipations. *Control processes* such as planning and action control ensure continuation of progress in the face of concurrent goals and obstacles. While planning refers to an anticipatory control process (*ex-situ*), action control refers to cognitive behavior regulation while acting (*in situ*; cf. Sniehotta, Scholz, & Schwarzer, 2005). Action control consists of self-regulatory acts including self-monitoring, awareness of standards, and self-regulatory efforts and is predictive of behavior over and above intentions, self-efficacy, and planning (Sniehotta et al., 2005).

Moderation of the mediated intention-behavior relation

While mediator models explain how or why an effect occurs (Baron & Kenny, 1986), the investigation of putative moderators of the mediation effect goes one step further. Moderation analysis investigates whether the mediation effect remains constant across different populations (cf. Preacher, Rucker, & Hayes, 2007). Including a moderator in the intention-planning-behavior relation allows estimating different relationships for different levels of the moderating variable. *Chapter 4* found that age modifies (i.e., moderates) the effect of intention on behavior trough planning due to an increasing strength of the planning-behavior link. Theoretical and practical implications of this result are discussed in the next sections. From a methodological point of view such a moderated mediation analysis allows investigating whether the size of the indirect effect of an independent variable on a dependent variable through a mediator differs depending on the levels of other variables (i.e., moderators).

Moderators can influence this mediation process in different ways, e.g., by moderating (1) the intention-planning association, (2) the planning-behavior association, (3) or both. Further research needs to identify other critical variables that modify the link from intention to planning as well as from planning to behavior and thus to extend our understanding of the mechanisms of health behavior change in different contexts and for different behaviors.

A developmental perspective on health behavior change

Adopting a developmental perspective on health behavior change (e.g., H. Leventhal, E. A. Leventhal, & Schaefer, 1991; Scholz, Sniehotta, Burkert, & Schwarzer, 2007; Ziegelmann et al., 2006) may lead to valuable insights into how the processes of goal selection and goal pursuit differ across the lifespan. Developmental processes are directly associated with gains and losses and therefore with resources (e.g., knowledge about planning; Smith, Dixon & Baltes, 1989) and barriers (e.g., memory decline affects negatively remembering medical information; Brown & Park, 2003) to health behavior change. Research on the self-regulation of health behavior change may benefit from studying the adaptive management of gains and losses across the lifespan. In other words, directing attention "toward development as a dynamic force that shapes health behaviors" (Peterson, 1996, p. 155) may contribute to the understanding of health behavior change.

Chapter 4 examined the roles played by planning and intentions in behavior and explores the possibility that these relationships may be moderated by age. Specifically, planning is tested as a mediator for translating intentions into behavior in young and middle-aged adults (19 to 64 years) regarding leisure-time physical activity of a working population. Path analysis revealed that the degree to which planning mediates the intention-behavior relation increases with increasing age, as indicated by the age by planning effect on physical activity. This result points out that the effectiveness of planning to bridge the intention-behavior gap seems to be higher for middle-aged adults as compared to young adults.

This result is in line with the finding of Renner, Spivak, Kwon, and Schwarzer (2007) who demonstrated the age-differential predictive power of intentional and volitional factors (i.e., planning and coping self-efficacy) in explaining variance in physical activity. The authors found that these factors accounted for 20% of variance in physical activity among middle-aged and older adults (36-90 years), but only for 6% among younger adults (16-35 years).

However, when examining age-differential mechanisms in behavior regulation, it is necessary to discuss what might underlie those age differences as age cannot be referred to as a "causal" variable (Schaie, 1988). A novel contribution of the study in *Chapter 3* is the identification of an explanatory variable for the differential effect of age on the role of planning in the intention-behavior link. Model 2 in *Chapter 3* showed that the use of strategies that include selection, optimization, and compensation (SOC, P. Baltes & M. Baltes, 1990) provided a possible explanation for the increasing association between planning and physical activity with age. While planning can be seen as anticipating how to achieve a goal (Das, Kar, & Parrila, 1996), the use of SOC strategies is regarded as guiding behavior at the operational level (i.e., present-oriented and non-anticipatory; cf. Ziegelmann & Lippke, 2007). Consequently, the result of planning is the generation of a strategy (Diefendorff & Lord, 2003), which requires the application of knowledge (Scholnick & Friedman, 1993). For instance, according to Baltes (1997) committing oneself to a personal goal or changing the goal in response to loss in goal-relevant means represents a strategy of elective or loss-based selection, respectively. Focusing one's attention or modeling successful others corresponds to an optimization strategy. When losses in goal-relevant means (e.g., limiting constraints in time and energy) are experienced, strategies of compensation promote goal attainment by using alternative means (e.g., increasing effort).

Further research is needed why the effectiveness of health-related skills and strategies does not lead to comparable effects in all age groups. A concept that is closely related to the SOC model is the model of assimilative and accommodative coping proposed by Brandstädter and colleagues (Brandtstädter & Renner, 1990). The model portrays two forms of coping in the face of discrepancies between actual and desired states. *Tenacious goal pursuit* refers to assimilating circumstances to personal goals (e.g. persisting in the face of barriers such as training for a marathon despite joint problems). *Flexible goal adjustment*, on the other hand, refers to accommodating personal goals to circumstances (e.g., adapting one's level of

aspiration such as deciding to run the half-marathon). These two modes of coping might also serve as explanatory variables for age-differential mechanisms in goal striving when imminent or actual losses in resources (e.g., physical functioning) are to be avoided or compensated.

A cognitive developmental perspective might be another promising line of research. For instance, planning might also support behavior enactment as a mnemonic technique to overcome age-related problems. Remembering to perform an intended behavior is an instance of prospective memory (Einstein & McDaniel, 1990). However, prospective memory consists of effortful cognitive processes such as encoding, retrieval, inhibition, and manipulation of information, which have been shown to be subject to age-related decline (Brown & Park, 2003). A meta-analysis of studies on prospective memory performance indicated that younger participants (mean age at least 15 years younger) outperformed older participants (mean age of 55 years and older) in both time-based (*r*s = -.39) and event-based (*r*s = -.34) prospective memory laboratory tasks (Henry, MacLeod, Phillips, & Crawford, 2004).

Gollwitzer (1999) argues that engaging in planning enhances information processing in terms of increased accessibility, recall, detection, and discrimination of critical cues. Once a specified situation – in terms of when and where – is encountered the intended behavior is elicited almost automatically. Thus, planning might work as an internal memory strategy and help to overcome these age-related inhibitions in prospective memory performance. Future studies should investigate further explanatory variables for the differential effectiveness of planning across age.

Practical implications

The main implication of the studies in this thesis regards the role of planning as a key self-regulatory mechanism for successful goal pursuit in health behavior change. In two prospective observational and one experimental study, it was demonstrated that planning is relevant for regular physical activity and fruit and vegetable intake. Together with a large body of research for various health behaviors such as dental flossing (Schüz et al., 2007) or self-

examination behaviors (Prestwich et al., 2005), these results advise to incorporate planning interventions in health promotion programs targeting health behaviors.

Especially in the face of demographic changes, effective approaches for enhancing health behaviors are needed. Healthy lifestyle changes may reduce the probability of pathological aging and are therefore seen as a general principle for successful development (P. Baltes & M. Baltes, 1990). The study in *Chapter 4* examined a working population of Germany's national railway company. The Deutsche Bahn AG occupies approximately 200,000 employees; of those approximately 30 percent are 50 years and older. This proportion is expected to double to an estimated 60 percent by 2015. The odds of diminishing health, and physical functioning increase with growing age.

Comprehensive health-promotion programs that aim at preventive nutrition, physical exercise, smoking cessation, preventing use of alcohol and drugs may maintain employability and productivity in an aging workforce. Action planning and coping planning enriched by strategy training is an effective and easy-to-implement method for changing health behaviors that are as complex as physical activity or nutrition. For optimal effectiveness, such strategies at the individual level should be complemented with strategies at the organizational level including healthy nutrition choices in cafeterias and access to fitness centers.

Conclusion

The present thesis aimed to add to our understanding of the complex interplay among volitional factors of health behavior change. By applying recent methodological advances of analyzing longitudinal data that allow examining questions about dynamic relationships in the self-regulation framework of health behavior change as well as employing an experimental-causal-chain design for testing mediation hypotheses, this thesis aimed to further advance theory and intervention development in the research field of health behavior change.

In future research, it might be valuable to employ experimental-causal-chain designs in which two successive experiments on the same set of individuals are conducted and outcome measures are obtained repeatedly. Such a series of experiments can be analyzed at the within-individual level as well as at the between-individual (or group) level and allows even stronger inferences for a causal chain in the health behavior change process.

The examination of self-regulation processes from a lifespan perspective and learning from those who successfully self-regulate their health behaviors may deepen our understanding of the mechanisms of health behavior change. The successful orchestration of planning and the use of strategies that include selection, optimization, and compensation may be a promising field of investigation. Further research is needed as an empirical basis for developing intervention techniques that promote knowledge and use of adaptive strategies that may in turn enhance the effectiveness of planning as a powerful tool for health behavior change.

References

Baltes, P. B. (1997). On the Incomplete Architecture of Human Ontogeny: Selection, Optimization, and Compensation as Foundation of Developmental Theory. *American Psychologist, 52*, 366-380.

Baltes, P. B., & Baltes, M. M. (1990). Psychological perspectives on successful aging: The model of selective optimization with compensation. In P. B. Baltes & M. M. Baltes (Eds.), *Successful aging: Perspectives from the behavioral sciences* (pp. 1-34). New York: Cambridge University Press.

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*, 1173–1182.

Brandtstädter, J., & Renner, G. (1990). Tenacious goal pursuit and flexible goal adjustment: Explication and age-related analysis of assimilative and accommodative strategies of coping. *Psychology and Aging, 5,* 58-67.

Brown, S. C., & Park, D. C. (2003). Theoretical models of cognitive aging and implications for translational research in medicine. *The Gerontologist, 43,* Special Issue I, 57-67.

Das, J. P., Kar, B. C., & Parrila, R. K. (1996). *Cognitive planning: The psychological basis of intelligent behavior.* New Delhi, India: Sage.

Diefendorff, J. M., & Lord, R. G. (2003). The volitional and strategic effects of planning on task performance and goal commitment. *Human Performance, 16*, 365-387.

Einstein, G. O., & McDaniel, M. A. (1990). Normal aging and prospective memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 16*, 717-726.

Eizenman, D. R, Nesselroade, J. R., Featherman, D. L., Rowe, J. W. (1997). Intra-individual variability in perceived control in an elderly sample: The MacArthur Successful Aging Studies. *Psychology and Aging, 12*, 489–502.

Ford, M. E., & Nichols, C. W. (1991). Using goal assessments to identify motivational patterns and facilitate behavioral regulation and achievement. In M. L. Maehr & P. R. Pintrich (Eds.), *Advances in motivation and achievement* (pp. 51–84). Greenwich, CT: JAI.

Ghisletta, P., Nesselroade, J. R., Featherman, D. L., & Rowe, J. W. (2002). The structure, validity, and predictive power of weekly intraindividual variability in health and activity measures. *Swiss Journal of Psychology, 61,* 73-83.

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

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

Gollwitzer, P. M., & Sheeran, P. (2006). Implementation intentions and goal achievement: A meta-analysis of effects and processes. *Advances in Experimental Social Psychology, 38*, 249–268.

Henry, J. D., MacLeod, M. , Phillips, L. H., & Crawford, J. R. (2004). A meta-analytic review of prospective memory and aging. *Psychology and Aging, 19*, 27-39.

Kreuter, M. W., Strecher, V. J., & Glassman, B. (1999). One size does not fit all: The case for tailoring print materials. *Annals of Behavioral Medicine, 21*, 276–283.

Leventhal, H., Leventhal, E. A., & Schaefer, P. (1991). Vigilant coping and health behavior: A life span problem. In M. Ory & R. Abeles (Eds.), *Aging, Health, and Behavior* (pp. 109-140). Baltimore: Johns Hopkins.

Link, B. G., & Shrout, P. E. (1992). Spurious associations in longitudinal research. *Research in Community and Mental Health, 7*, 301–321.

Lippke, S., Wiedemann, A., Ziegelmann, J. P., Reuter, T., & Schwarzer, R. (in press). Translating intentions into behavior: When self-efficacy moderates the mediator role of plans. *American Journal of Health Promotion.*

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., Tryburcy, M., & Schwarzer, R. (2007). Improving fruit and vegetable consumption: a self-efficacy intervention compared with a combined self-efficacy and planning intervention. *Health Education Research, 22*, 630-638.

MacKinnon, D. P. (2008). *Statistical mediation analysis*. New York: Lawrence Erlbaum Associates.

MacKinnon, D. P., Lockwood, C. M., Hoffman, J. M., West, S. G., & Sheets, V. (2002). A comparison of methods to test mediation and other intervening variable effects. *Psychological Methods, 7*, 83–104.

Peterson, L. (1996). Establishing the study of development as a dynamic force in health psychology. *Health Psychology, 15*, 155-157.

Pham, L. B., & Taylor, S. E. (1999). From thought to action: Effects of process- versus outcome-based mental simulations on performance. *Personality and Social Psychology Bulletin, 25*(2), 250-260.

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

Renner, B., Spivak, Y., Kwon, S., & Schwarzer, R. (2007). Does age make a difference? Predicting physical activity of South Koreans. *Psychology and Aging, 22,* 482-493.

Schaie, K. W. (1988). Ageism in psychological research. *American Psychologist, 43*, 179-183.

Scholnick, E. K. & Friedman, S. L. (1993). Planning in context: Developmental and situational considerations. *International Journal of Behavioral Development, 16,* 145-167.

Scholz, U., Nagy, G., Schüz, B., & Ziegelmann, J. P. (2008). The role of motivational and volitional factors for self-regulated running training: Associations on the between- and within-person level. *British Journal of Social Psychology, 47,* 421-439.

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., Schüz, B., & Oeberst, A. (2007). Dynamics in Self-Regulation: Plan-Execution Self-Efficacy and Mastery of Action Plans. *Journal of Applied Social Psychology, 37*, 2706-2725.

Schüz, B., Sniehotta, F. F., & Schwarzer, R. (2007). Stage-specific effects of an action control intervention on dental flossing. *Health Education Research, 22*, 332-341.

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: An International Review, 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.

Smith, J., Dixon, R. A., & Baltes, P. B. (1989). Expertise in life-planning: A new research approach to investigating aspects of wisdom. In M. L. Commons, J. D. Sinnott, F. A. Richards, & C. Armon (Eds.), *Beyond formal operations II* (Vol. 1, pp. 307-331). New York: Praeger.

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.

Spencer, S. J., Zanna, M. P., & Fong, G. T. (2005). Establishing a causal chain: Why experiments are often more effective than mediational analyses in examining psychological processes. *Journal of Personality and Social Psychology, 89*, 845-851.

Steyer, R., Eid, M., & Schwenkmezger, P. (1997). Modeling true intraindividual change: True change as a latent variable. *Methods of Psychological Research - Online, 2*, 21-33.

Steyer, R., Partchev, I., & Shanahan, M. (2000). Modeling true intra-individual change in structural equation models: The case of poverty and children's psychosocial adjustment. In T. D. Little, K. U. Schnabel & J. Baumert (Eds.), *Modeling longitudinal and multiple-group data: Practical issues, applied approaches, and specific examples* (pp. 109-126). Hillsdale, NJ: Erlbaum.

Vancouver, J. B., Thompson, C. M., & Williams, A. A. (2001). The changing signs in the relationships among self-efficacy, personal goals, and performance. *Journal of Applied Psychology, 86*, 605-620.

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

West, S. G., & Aiken, L. S. (1997). Toward understanding individual effects in multicomponent prevention programs: Design and analysis strategies. In K. J. Bryant, M. Windle, & S. G. West, (Eds.). *The science of prevention: Methodological advances from alcohol and substance abuse research* (pp. 167–209). Washington, DC: American Psychological Association.

Ziegelmann, J. P., & Lippke, S. (2007). Planning and strategy use in health behavior change: A life span view. *International Journal of Behavioral Medicine, 14*, 30-39.

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

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

List of Publications

Journal articles

2009

Lippke, S., Wiedemann, A. U., Ziegelmann, J. P., Reuter, T., & Schwarzer, R. (2009). Self-efficacy moderates the mediation of intentions into behavior via plans. *American Journal of Health Behavior, 33*(5), 521-529.

2008

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.

in press

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., Schüz, B., & Aiken, L. S. (in press). Planning Bridges the Intention-Behavior Gap: Age Makes a Difference and Strategy Use Explains Why. *Psychology & Health.*

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*.

submitted

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

2007

Wiedemann, A. U., & Reuter, T. (2007). Voller Energie durch's Leben. Mit körperlicher Aktivität und gesunder Ernährung. *Fundiert. Das Wissenschaftsmagazin der Freien Universität Berlin, 1*, 18-23.

Book Chapters

Reuter, T., & Schwarzer, R. (in press). Verhalten und Gesundheit [Behavior and health]. In J. Bengel & M. Jerusalem (Eds.), *Handbuch der Psychologie (Band: Gesundheitspsychologie und Medizinische Psychologie)*. Göttingen, Germany: Hogrefe.

Reuter, T., & Schwarzer, R. (in press). Manage Stress at Work Through Preventive and Proactive Coping. In E. A. Locke (Ed.), *Blackwell Handbook of Principles of Organizational Behavior* (2nd ed.). Oxford, UK: Blackwell.

Published abstracts (first authorships only)

2008

Reuter, T., Ziegelmann, J. P., Wiedemann, A. U., & Schüz, B. (2008). *Intraindividual Change following Health Self-Regulation Interventions for Young, Middle-Aged, and Older Adults*. Paper to be presented at the 61st Annual Scientific Meeting of the Gerontological Society of America, National Harbor, USA.

Reuter, T., Ziegelmann, J. P., Wiedemann, A. U., Gravert, C., & Schwarzer, R. (2008). *Planning as a Mediator of the Intention-Behaviour Relation: An Experimental-Causal-Chain Design.* Paper presented at the Annual Meeting of the British Psychological Society Division of Health Psychology & European Health Psychology Society, Bath, United Kingdom.

Reuter, T., Ziegelmann, J. P., Wiedemann, A. U., Lippke, S., & Schüz, B. (2008). *Health-Related Goal Pursuit in Young and Middle Adulthood*. Paper presented at the XXIX International Congress of Psychology, Berlin, Germany.

2007

Reuter, T., Ziegelmann, J. P., Wiedemann, A. U., Lippke, S., & Schüz, B. (2007). *The role of strategic planning in health self-regulation: Differences among younger and older adults*. Paper presented at the 60th Annual Scientific Meeting of the Gerontological Society of America, San Francisco, CA, USA.

Reuter, T., Ziegelmann, J. P., Wiedemann, A. U., Lippke, S., Schüz, B., & Schwarzer, R. (2007). *Strategic planning in the adoption and maintenance of physical activity*. Paper presented at the Annual Conference of the European Health Psychology Society, Maastricht, The Netherlands.

Reuter, T., Ziegelmann, J. P., Wiedemann, A. U., Lippke, S., & Schüz, B. (2007). *Health self-regulation in young and middle-aged adults: Strategic planning for the adoption and maintenance of physical activity*. Paper presented at the 13th European Conference on Developmental Psychology, Jena, Germany.

Reuter, T., Ziegelmann, J. P., Wiedemann, A. U., Lippke, S., Schüz, B., & Schwarzer, R. (2007). *Strategische Planung als Mediator und Moderator der Intentions-Verhaltens-Beziehung* [Strategic planning as a mediator and moderator of the intention-behavior relation]. Paper presented at the 8th Conference of the Division of Health Psychology of the German Psychological Society, Schwäbisch Gmünd, Germany.

2006

Reuter, T., & Gravert, C. (2006). Die Wirkungen von Arbeitsbelastungen und Selbstwirksamkeitserwartungen auf die Gesundheit von Beschäftigten [Effects of work stressors and self-efficacy beliefs on employees' health]. In F. Lösel & D. Bender (Hrsg.). *45. Kongress der Deutschen Gesellschaft für Psychologie* (S. 84). Lengerich: Pabst Science Publishers.

Reuter, T., Ducki, A., & Gravert, C. (2006). *Effects of task-related work characteristics on employees' health.* Paper presented at the Annual Conference of the European Health Psychology Society, Warsaw, Poland.

Erklärung zur Dissertation

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

Berlin, 20. Oktober 2008 Tabea Reuter