

The Interplay of Social-Cognitive Constructs in Health
Behavior Change: Studies on Nutrition, Hand Washing,
Oral Hygiene, Sun Protection, Face Mask Use, and
Physical Activity

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Abstract

Adopting or sustaining appropriate levels of health behavior can offer numerous physical and mental health benefits. Unfortunately, most people are unable to initiate or maintain their health behavior. The present thesis aimed to explain and improve behavior change in the context of six kinds of health behavior (face mask wearing, fruit and vegetable consumption, physical activity, hand hygiene behavior, sun screen use, and dental flossing) among Chinese samples, using the Health Action Process Approach (HAPA) as a theoretical backdrop.

To examine psychosocial predictors of face mask wearing, fruit and vegetable consumption, and physical activity, three longitudinal studies were conducted based on the HAPA among Chinese young adults. The first longitudinal study represented in *Chapter 2* is the first to identify both motivational and volitional predictors of face mask wearing to avoid exposure to polluted air with a structural equation model. Results from this study showed that self-efficacy and risk perception jointly predicted intention and planning and action control as two parallel mediators predicted face mask wearing. The second longitudinal study described in *Chapter 3* aimed to explore the roles of action control and action planning between intention and fruit and vegetable intake. The results revealed action control and action planning to sequentially mediate between intention and subsequent fruit and vegetable consumption, controlling for baseline behavior, which suggested that planning may be more proximal to behavior than action control. The specific aim of the third longitudinal study described in *Chapter 4* was to examine the roles of motivation, planning, and self-efficacy as well as mechanisms that operate in the change of physical activity levels. The study found that only when people are motivated to become more active, a mediation from self-efficacy via planning to physical activity seems to work. All the findings from the three longitudinal studies supported the HAPA as a useful framework to explain diverse health behaviors, with a

focus on planning and action control, which might be influential in the adoption and maintenance of health behavior.

To improve hand hygiene behavior, sun screen use, and dental flossing by a theory-guided self-regulatory intervention, three randomized controlled trials were conducted. The first experimental study (*Chapter 5*) aimed to examine the effectiveness of a planning technique in the new context of hand hygiene among adolescents. Results from the study replicated the previous studies in other domains which confirmed the usefulness of a planning intervention in the context of hand hygiene. It also found that changes in planning operated as a mediator between experimental conditions and changes in behavior. The second experimental study (*Chapter 6*) aimed to compare the effect of a self-regulatory intervention with focusing on planning sun screen use with a standard educational condition. The results also replicated planning as a mediator between conditions and later sun screen use while controlling for baseline behavior. It also found that people who were less motivated benefited more from the intervention. A theory-guided intervention on oral self-care was evaluated in *Chapter 7* by a third intervention study. The results also replicated planning as a mediator between conditions and later dental flossing, with self-efficacy and action control serving as two moderators. All the results from the three intervention studies supported planning and action control strategies constitute a superior approach than motivational messages to improve different kinds of health behaviors.

Overall, the present dissertation contributes to the development of theory to predict health behavior as well as accumulation of evidenced interventions based on self-regulatory skills selected from HAPA in the domain of six kinds of health behaviors.

Abstract (Deutsch)

Die Initiierung und Aufrechterhaltung von Gesundheitsverhalten trägt in vielfacher Hinsicht zu körperlicher und psychischer Gesundheit bei. Dennoch gelingt es den meisten Menschen nicht, ein Gesundheitsverhalten aufzunehmen oder aufrechtzuerhalten. Das Ziel der vorliegenden Dissertation ist die Erklärung und Förderung von Verhaltensänderungen im Kontext von sechs Gesundheitsverhaltensweisen (Tragen eines Mundschutzes, Obst- / Gemüsekonsum, körperliche Aktivität, Handhygiene, Sonnenschutzverhalten, Benutzung von Zahnseide) in chinesischen Stichproben. Der Health Action Process Approach (HAPA) dient dabei als theoretisches Rahmenmodell.

Drei HAPA basierte Längsschnittstudien mit chinesischen Jugendlichen wurden durchgeführt, um psychosoziale Prädiktoren des Tragens eines Mundschutzes, von Obst- / Gemüsekonsum sowie körperlicher Aktivität zu untersuchen. Die erste Längsschnittstudie, welche in Kapitel 2 vorgestellt wird, ist die erste überhaupt, die ein Strukturgleichungsmodell anwendet, um motivationale und volitionale Prädiktoren des Tragens eines Mundschutzes als präventive Maßnahme im Hinblick auf Luftverschmutzungen zu bestimmen. Die Ergebnisse zeigen, dass Selbstwirksamkeit und Risikowahrnehmung als gemeinsame Prädiktoren der Intention fungieren, Planung und Handlungskontrolle als zwei parallele Mediatoren das Tragen des Mundschutzes vorhersagen. Die zweite Längsschnittstudie wird in Kapitel 3 präsentiert und geht der Frage nach, welche Rollen Handlungskontrolle und Planung im Zusammenhang von Intention und Obst- / Gemüsekonsum spielen. Die Ergebnisse zeigen Handlungskontrolle und Planung als sequenzielle Mediatoren zwischen der Intention und dem Obst- /Gemüsekonsum bei Kontrolle des Baseline-Verhaltens. Demzufolge scheint Planung dem Verhalten proximaler zu sein als Handlungskontrolle. Das Ziel der dritten Längsschnittstudie, beschrieben in Kapitel 4, war, die Wirkweisen von Motivation, Planung, Selbstwirksamkeit und weiteren Mechanismen zu untersuchen, welche die Verhaltensänderung von körperlicher Aktivität beeinflussen. Es wurde gezeigt, dass nur bei

Menschen, die motiviert sind, ihre körperliche Aktivität zu steigern, Planung den Zusammenhang zwischen Selbstwirksamkeit und körperlicher Aktivität mediierte. Alle drei Längsschnittstudien bestätigen das HAPA-Modell als hilfreiches Rahmenkonzept für die Erklärung von unterschiedlichen Gesundheitsverhalten mit dem Fokus auf Planung und Handlungskontrolle, die maßgebend für die Initiierung und Aufrechterhaltung von Gesundheitsverhalten zu sein scheinen.

Zur Förderung von Gesundheitsverhalten im Kontext von Handhygiene, Sonnenschutz und Benutzung von Zahnseide wurden mittels theoriebasierter Selbstregulationsinterventionen drei randomisierte kontrollierte Studien durchgeführt. Die erste experimentelle Studie (Kapitel 5) untersuchte die Effektivität einer Planungsstrategie im Kontext von Handhygiene bei Jugendlichen. Die Ergebnisse der Studie bestätigen vorherige Forschungsergebnisse anderer Bereiche über die Wirksamkeit einer Planungsintervention für Handhygiene. Änderungen in der Planung wirkten als Mediator zwischen den experimentellen Bedingungen und der Verhaltensänderung. Die zweite experimentelle Studie (Kapitel 6) zielte darauf ab, den Effekt einer Selbstregulationsintervention mit Fokus auf die Planung von Sonnenschutzverhalten mit einer Standard Informations-Bedingung zu vergleichen. Die Ergebnisse bestätigen ebenfalls frühere Studien, da Planung auch hier als Mediator zwischen den experimentellen Bedingungen und Sonnenschutzverhalten fungierte, bei gleichzeitiger Kontrolle des Baseline-Verhaltens. Es zeigte sich auch, dass Menschen, die weniger motiviert waren, mehr von der Intervention profitieren. In Kapitel 7 wird eine Studie vorgestellt, die eine theoriebasierte Intervention für Mundhygiene untersuchte. Die Befunde bestätigen Planung als Mediator zwischen den experimentellen Bedingungen und der Benutzung von Zahnseide, während Selbstwirksamkeit und Handlungskontrolle als Moderatoren wirkten. Die Befunde der drei Interventionsstudien bestätigen die herausragende Stellung von Strategien der Planung und Handlungskontrolle für die Änderung von unterschiedlichen Gesundheitsverhalten im Vergleich zu einfachen motivationalen Botschaften.

Zusammenfassend leistet die vorliegende Dissertation einen Beitrag zur Entwicklung von Theorien zur Vorhersage von Gesundheitsverhalten und den Ausbau evidenzbasierter Interventionen im Kontext von sechs unterschiedlichen Gesundheitsverhalten, die auf selbstregulativen Fähigkeiten entsprechend des HAPA-Modells beruhen.

1

Introduction

Introduction

In the general view, health behavior refers to the actions that reduce the probability of a wide range of diseases and improve an individual's health. Although the domain of health behavior is vague, a working definition has been proposed by Gochman based on his previous work (Gochman, 1981, 1982, 1988). He assumes health behavior as personal attributes, personality characteristics, and behavior patterns which are related to health maintenance, health restoration, and health improvement. The behavioral element of Gochman's definition is consistent with the definition given by Conner and Norman (2005) who defined health behavior as any activity undertaken for the purpose of preventing or detecting disease or for improving health and well-being. In line with this concept, it includes two types of health behavior: health enhancing behavior and health compromising behavior. Health compromising behavior can have harmful effects on health or otherwise predispose individuals to disease, whereas health enhancing behavior can convey health benefits or otherwise protect individuals from disease.

Health behavior has attracted great interest in academia including health psychology. There are two key reasons for such interest. The first reason is that health behavior could significantly influence mortality and morbidity. For example, less physical activity and low fruit and vegetable consumption are accountable to the top 10 risk factors contributing to mortality and morbidity worldwide (WHO, 2002). Second, health behavior can be modified by evidence-based interventions designed by researchers (Conner & Norman, 2005). To improve health behavior, health psychologists have explored psychosocial factors contributing to behavior and construed theories to uncover mechanisms underlying behavior changes. Interventions based on health behavior theories have been found effective in several contexts, such as health dietary behavior, regularly exercise, and oral health care.

In the present thesis, we focus on six kinds of health enhancing behavior: *face mask wearing, fruit and vegetable consumption, physical activity, hand hygiene, sun screen use,*

and dental flossing. This chapter (*Chapter 1*) will begin with a brief review of social cognitive models related to health behavior, followed by their common limitations on the gap between intention and behavior. Next, a theoretical backdrop for this thesis will be provided, followed by evidences to support the theory in three kinds of health behavior (*face mask wearing, fruit and vegetable consumption, and physical activity*). Then, the self-regulatory constructs selected from theory, which have been implemented in interventions, will be examined in the other three kinds of health behavior (*hand hygiene, sun screen use, and dental flossing*). Finally, the research questions that are addressed in the empirical chapters of this thesis (*Chapters 2-7*) are outlined.

Social-cognitive theories to predict health behavior

During the past several decades, a number of researchers have developed social cognition models to predict health behavior. One of the earliest pioneers is Rosenstock who construed the health belief model (HBM; Rosenstock, 1974). The HBM posited six independent predictors of behavior, which are perceived susceptibility, perceived severity, perceived benefits, perceived barriers, health motivation, and cues to action. According to the theory, people could more likely carry out health behavior if they perceived threat of disease (i.e., high susceptibility and severity) and if they perceived more benefits and less barriers to implement such behavior. Similarly, if individuals were motivated to keep health, they would more likely to take action. Finally, people who realized symptoms of illness could more likely perform corresponding health behavior. Although the HBM opened the window to explain behavior by psychosocial variables, it ignored one important predictor of individuals' behavior, which is the belief in one's own competence to successfully implement action.

The social cognitive theory (SCT; Bandura, 1986) assumed self-efficacy and outcome expectancies as core determinants of behavior. Self-efficacy refers to confidence in one's ability to carry out a particular behavior. Outcome expectancy is defined as individuals'

estimate that a specific action will lead to positive or negative consequences. According to SCT, people who perceived control over outcome, expected few external barriers, and believed in his or her ability to accomplish a particular task would be more successful on initiation and persistence of behavior.

The theory of reasoned action (TRA; Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975) and its updated version the theory of planned behavior (TPB; Fishbein & Ajzen, 2010) postulated intention as the proximal determinant of behavior. The intention refers to self-instructions to attain certain outcomes or perform a particular behavior, which is formatted as “I intend to reach the aimed health behavior!” (Gollwitzer, 1999). Within the TPB framework, attitudes, subjective norm and perceived behavioral control (PCB) jointly predict intention formation, while intention and PCB can directly predict behavior. According to TPB, the stronger the intention to perform a specific behavior, the more likely people would initiate the behavior. Although intention is the strongest predictor of behavior, there is sparse evidence that promoting intentions could improve actual actions.

Until now, all the above models mentioned are continuum models which proposed behavior may change linearly with time in a quantitative way. In fact, behavior change could also be described in terms of qualitative stages. The Rubicon Model, also known as the model of action phases (Heckhausen, 1980), explicitly posited a motivational-volitional dual process for behavior change. This model distinguished four stages which are intention formation, post-decision, action, and evaluation. All these stages are with clear boundaries and have distinctive thought contents and cognitive functioning (Heckhausen & Gollwitzer, 1987). Although the Rubicon Model has been verified, there are few interventions based on the theory.

Motivation for health behavior change and the intention-behavior gap

Social cognitive models, such as HBM, TRA, TPB, and SCT, assumed motivation as the central and proximal determinant of behavior, implicitly supposing high correspondence between intention and behavior (Armitage & Conner, 2000). There are great overlaps to predict intention among the motivational models, which incorporate constructs like attitudes, expectancies, norms, self-efficacy, skills and abilities. Although the construct of intention is central in explaining health behavior change, its predictive value is limited (Sheeran 2002). McEachan *et al.* (2011) reviewed 237 prospective studies and found a small-to-medium mean correlation of $r = .43$ between intention and health behavior, accounting for about 16% of the criterion variance. Another review found that 47% people who often do not behave according to their intentions are named as “inclined abstainers” (Sheeran, 2002). There is one study showed that the weak intention-behavior relation is largely due to the inclined abstainers (Orbell & Sheeran, 1998). Previous findings indicate that there is a substantial unexplained “gap” between people’s intentions and their subsequent behaviors.

Health behavior theory to bridge intention-behavior gap: the HAPA model

To bridge this so-called intention-behavior gap, new theories should incorporate possible self-regulatory constructs to increase the likelihood of goal attainment. The Health Action Process Approach (HAPA; Schwarzer, 2008) is a theory that includes both continuum layer and a stage layer, which manage to tackle the intention-behavior gap problem. The HAPA can not only describe, explain, and predict behavior change (function of the continuum layer), but is also useful for the development of interventions (function of the stage layer). According to HAPA, there are two distinction sequential phases: preintentional motivation processes that lead to forming a behavioral intention (motivational phase); then, postintentional volition processes that lead to initiating and maintaining the actual health behavior (volitional phase). Within the two phases, different patterns of social-cognitive

predictors of health behavior may emerge (see Figure 1). The HAPA has been explicitly developed to aim on health behavior change (Schwarzer & Luszczynska, 2015).

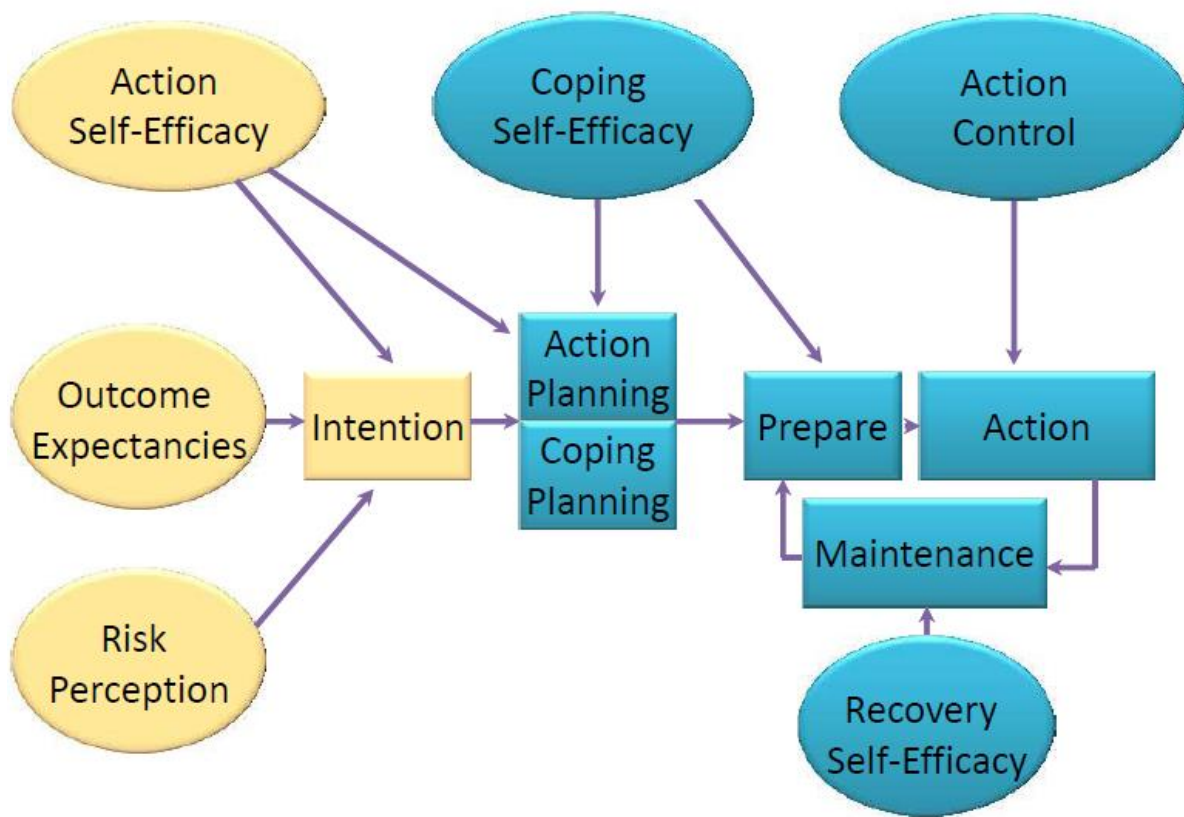


Figure 1. Health Action Process Approach

In the motivation phase, a person develops intentions to initiate a particular behavior, which is similar as motivational models mentioned above. Within the first phase, *risk perception* (e.g., “I am at risk for developing specific kinds of diseases”), and *positive outcome expectancies* (e.g., “If I achieved the aimed health behavior, I will reduce my risk for specific kinds of diseases”) are predictors of intention. Risk perception operates in concert with positive outcome expectancies, which contribute to forming an intention. After developing a motivation towards adopting a particular health behavior, people have transformed their ‘good intentions’ into detailed instructions on how to perform the desired action. Moreover, once an action has been initiated, it needs to be maintained. This is not achieved through a single act of will, but involves self-regulatory skills and strategies. Thus, *planning* and *action control* come to play in the volitional phase, both of which are specified

as mediators between intention and subsequent behavior. Planning can be further divided into action planning and coping planning in accordance to targets (Sniehotta, 2009). Action plans may follow the SMART principles which means that they should be specific (a narrow behavior), measurable, assignable (who will perform), realistic, and time-related (when to perform the action; Doran, 1981). *Action planning* clearly specifies where, where, and how to initiate one actual behaviour. *Coping planning* refers to the anticipation of barriers and the generation of alternative behaviors to overcome them (Sniehotta, Scholz, & Schwarzer, 2006). People imagine scenarios that hinder them in performing their intended behavior, and they develop one or more plans to cope with such a challenging situation. While planning is a prospective strategy, that is, behavioral plans are made before the situation is encountered, *action control* is a concurrent self-regulatory strategy, where the ongoing behavior is continuously evaluated with regard to a behavioral standard. Action control comprises three facets: *self-monitoring* (e.g., “I consistently monitored when, where, and how long I implement aimed behavior”), *awareness of standards* (e.g., “I have always been aware of my intention to do the aimed behavior”), and *self-regulatory effort* (e.g., “I took care to do aimed behavior as much as I intended to”) (Carver & Scheier, 2002; Sniehotta, Scholz, & Schwarzer, 2005).

Perceived self-efficacy works throughout the entire process. However, there are different formats of self-efficacy from phase to phase. This is because people will meet different challenges as they progress from one phase to the next. Goal setting, goal striving and goal maintenance pose tasks that are different and it is required to distinguish specific self-efficacies. Therefore, two specific self-efficacies corresponding to two phases are proposed: motivational self-efficacy and volitional self-efficacy. *Motivational self-efficacy*, also known as *task self-efficacy* or *action self-efficacy*, refers to believe oneself to initiate a new action (e.g., “I am certain that I can begin doing one specific behavior, even if I have to mobilize myself.”). *Volitional self-efficacy* refers to volitional phase and can be further

subdivided into *maintenance self-efficacy* (e.g., “I am capable of continuing doing specific behavior, even if it takes some time before I integrate it into my lifestyle.”) and *recovery self-efficacy* (e.g., “I am confident that I can resume to do a behavior, even if I haven’t done it for a long time.”).

The main aims of this thesis are to examine the social-cognitive factors based on the HAPA that predict three kinds of health behavior (*face mask wearing, fruit and vegetable consumption, and physical activity*) and improve the other three kinds of health behavior (*hand hygiene, sun screen use, and dental flossing*) by a selected self-regulatory skills intervention among Chinese samples.

Application of HAPA constructs to predict health behavior

The HAPA allows for the prediction of health behavior with its framework. A great number of predictive studies have been conducted to examine its suitability for diverse health behaviors. Most of these studies have supported the assumptions of the model, such as studies on dental flossing, seat belt use, dietary behavior, and physical activity (Schwarzer *et al.*, 2007), fruit and vegetable intake (Zhou *et al.*, 2013), breast self-examination (Luszczynska & Schwarzer, 2003), sunscreen use (Craciun, Schüz, Lippke, & Schwarzer, 2012), condom use (Teng & Mak, 2011), food hygiene behavior (Chow & Mullan, 2010), vaccination (Ernsting *et al.*, 2013), and quitting smoking (Scholz *et al.*, 2009). Although the aforementioned results are encouraging, the roles of post-intentional predictors of behavior are still vague and needed to be clarified by further study. In corresponding to this shortcoming, three longitudinal studies are conducted. In the following part, importance of three kinds of health behavior (*face mask wearing, fruit and vegetable consumption, and physical activity*) and social-cognitive factors to predict such behavior in longitudinal studies have been briefly reviewed.

Face mask wearing

There are more than 100 haze days every year in Beijing, which makes it one of the most air-polluted mega cities in the world (Chen, Wang, Ma & Zhang, 2013; Langrish *et al.*, 2009). Research has shown that long time exposure to such polluted air can increase morbidity and mortality from respiratory and cardiovascular diseases and cancer (Brunekreef & Holgate, 2002). It is unusual to cancel outside activities to reduce exposure to air pollution for most residents in Beijing. Therefore, the use of filtering facepiece respirators (also called disposable respirators, dust masks, breathing masks, face masks) is the most effective and common choice to avoid exposure in smog days (Langrish *et al.*, 2009; Singh *et al.*, 2010). However, adherence to respiratory protective devices is below recommended levels, and therefore, it is needed to explore the psychological mechanisms of such behavior.

Wearing face masks to avoid toxic chemicals have been studied in occupational settings, where workers are asked to use of dust masks. In a study, health beliefs and social influence were hypothesized as predictors of respirator use in painters (White, Baker, Larson & Wolford, 1988). Authors did not find much evidence between psychological constructs and past use but in terms of future use, they found that lack of adherence was associated with beliefs such as outcome expectancies concerning discomfort, inconvenience, smoking, social factors, and availability of masks. They concluded that changing workers' beliefs may have only limited success. Considering the dearth of literature on exploring psychosocial predictors of use of face piecefilter respirator to avoid to polluted air, a longitudinal study based on the HAPA theory is conducted in Beijing and its results are represented in the *Chapter 2*.

Fruit and vegetable consumption

Fruit and vegetables are important components to a healthy diet. Nutritionally balanced diets rich in fruit and vegetables are associated with a reduced risk of chronic diseases including cardiovascular diseases and certain cancers (Boeing *et al.*, 2012). Low fruit and vegetable consumption lead to approximately 1.7 million (2.8%) of deaths worldwide (Guilbert, 2003). Therefore, the World Health Organization (WHO) recommended that adults

should consume more than five daily portions of fruit and vegetables per day. Despite substantial benefits of consuming enough fruit and vegetables, an international survey study found that people in most of countries do not achieve such recommendation (Hall, Moore, Harper, & Lynch, 2009). To a large extent, fruit and vegetable intake is due to psychosocial reasons which could be attributed to motivational or volitional factors. Therefore, it is pivotal to explore such relevant psychosocial predictors underpinning fruit and vegetable consumption.

Most previous studies that have explored psychosocial predictors of dietary behavior have focused on motivational factors such as beliefs about capabilities and consequences, social influence, knowledge, habits, and goals (Guillaumie, Godin, & Vézina-Im, 2010). It is still less clear how the mechanism of volitional variables underlying fruit and vegetable intake work, such as the role of action planning and action control (Adriaanse, Gollwitzer, De Ridder, De Wit, & Kroese, 2011). Thus, in the *Chapter 3*, a longitudinal study is designed to explore the role of action control and action planning in fruit and vegetable intake based on the HAPA.

Physical activity

The health benefits of regular moderate to vigorously intensive physical activity include considerably reduced risks of most major chronic disease such as cardiovascular system disease, several cancers, and musculoskeletal tissues, as well as the prevention and rehabilitation of mental disorders such as anxiety and depression (Asmundson *et al.*, 2013; Mammen & Faulkner, 2013; Warburton, Nicol, & Bredin, 2006). The Centers for Disease Control and Prevention recommended at least 30 min of moderate-intensity physical activity daily. Unfortunately, very few people meet such guidelines.

Several studies have addressed various social-cognitive determinants of physical activity based on SCT (Bandura, 1997), such as perceived self-efficacy, social support, perceived barriers, outcome expectancies, and self-regulatory behaviors (Anderson, Wojcik, Winett, & Williams, 2006; Ayotte, Margrett, & Hicks-Patrick, 2010; Mailey, & McAuley,

2014; Rovniak, Anderson, Winnett, & Stephens, 2002). However, planning, as an essential element of self-regulatory skills, has not been examined together with self-efficacy in the context of physical activity. Meanwhile, the role of motivation in such a relationship is also less known. Thus, a longitudinal study is described in *Chapter 4* to uncover the interacting role of self-efficacy, planning, and motivation for physical activity.

Application of selected self-regulatory constructs to promote health behavior

Self-regulation is defined as reflective processes by which individuals could pursue and attain their goals (Mann, De Ridder, & Fujita, 2013). Self-regulation is not an easy way, as exemplified by the failure of accomplishing the New Year's resolutions. Most frequency topics of people's New Year' resolutions are related to initiate or maintain health behavior. Gollwitzer and Sheeran (2006) have outlined four ways in which self-regulation can fail. For instance, they pointed out that people may fail to get started their goals, or get derailed from goals' direction. Moreover, it seems that people's cognitive capacity is a limited resource. Once people's cognitive resource has been exhausted, their strength of self-regulation will be greatly influenced. Social psychologists have proposed the terminology "*ego depletion*" to support such idea (Baumeister, Bratslavsk, Muraven, & Tice, 1998). In order to translate goal intentions into goal attainment, motivation alone will not be sufficient to change people's behavior, thus they must be equipped with the self-regulatory skills to meet these obstacles. As suggested by the HAPA, two strategies for effective self-regulation of goal striving, planning, and action control, have been selected as instruments to improve health behavior in this thesis.

Planning, also known as *implementation intention* (Gollwitzer, 1999), refers to the formation of specific contingency plans linking opportunities for action with concrete goal-directed behaviors. Planning is an efficacious self-regulatory strategy, which has been demonstrated as a useful skill to bridge the intention-behavior gap not only in predictive

studies, but also in interventions targeting health behavior change (Head & Noar, 2014).

Randomized controlled trials have documented evidence in support of such planning interventions in the domain of physical activity (Gellert, Ziegelmann, Lippke, & Schwarzer, 2012, Luszczynska, 2006; Prestwich *et al.*, 2012), healthy eating (Adriaanse, de Ridder, & de Wit, 2009; Armitage, 2007; Sullivan & Rothman, 2008), smoking (Armitage & Arden, 2008), alcohol drinking (Hagger *et al.*, 2012), breast self-examination (Orbell, Hodgkins, & Sheeran, 1997), and sun screen use (Cracium, Schüz, Lippke, & Schwarzer, 2012a). Meta-analyses have also summarized the effects of planning on diverse health behaviors (Amireault, Godin, & Vézina-Im, 2013; Carraro, & Gaudreau, 2013; Gollwitzer, & Sheeran, 2006; Kwasnicka, Presseau, White, & Sniehotta, 2013).

Learning from cybernetic control theory, Carver and Scheier (2002) proposed the control-process theory. The theory holds that people set a goal and then strive to achieve it. During this process, individuals should keep the goal in their minds and monitor the extent to which a discrepancy remains between the goal and their present state and take steps to reduce the discrepancy. Based on the control-process theory, Sniehotta *et al.*, (2005) have operationalized action control in three elements which are self-monitoring, awareness of behaviour standards, and self-regulatory efforts. This concept of action control has been embedded into the HAPA theory. Action control, in particular self-monitoring, is also an essential behavior change technique that can be applied to a variety of health behaviours (Michie *et al.*, 2013). When people keep records of their behaviors in form of a diary or checkmarks on their calendar, they become aware of gains and deficits which lead them to take further action.

Although planning and action control have been demonstrated as effective self-regulatory skills to promote health behaviour, few studies have explored multi-plan effects or the joint effects of planning and action control on behavior. In the following part, interventions focused on self-regulatory skills in three kinds of health behaviors (*hand*

hygiene, sunscreen use, and dental flossing) have been reviewed and the limitations of previous studies have been pointed out.

Hand hygiene behavior

Most communicational diseases can be attributed to dirty hands or washing hands improperly and infrequently. Washing hands properly with soap or disinfection products could reduce the spread of foodborne illnesses in the foodservice industry, as well as illness-related absenteeism among either children in elementary schools or younger adults in universities (Correa *et al.*, 2012; Lau *et al.*, 2012; Mart ínez *et al.*, 2014; Nandrup-Bus, 2009; Pellegrino *et al.*, 2015). The right ways to wash hands recommended by WHO include: (1) clean hands regularly; (2) wash hands with water and soap, and dry hands thoroughly; (3) use other alternative hand hygiene products if there are no water and soap; (4) wash hands long enough to sing “Happy Birthday” twice (WHO, 2015). Although washing basins and soap have been provided in Chinese high schools, washing hands properly is still not performed regularly by adolescents.

Several interventions have been designed to decrease disease risk via improving hand hygiene in school settings (Aunger *et al.*, 2010). Educational information on hand hygiene related to health and disease is the main principle used in previous interventions, which typically includes knowledge transfer about infections transmitted by hands and how to prevent them by washing hands properly (Cairncross, Shordt, Zacharia & Govindan, 2005; Cole *et al.*, 2012; Correa *et al.*, 2012; Mart ínez *et al.*, 2014). Psychological interventions via role models (Davis *et al.*, 2013), social norms (Mackert, Liang & Champlin, 2013), rewards (Bowen *et al.*, 2007), and disgust emotion (Porzig-Drummond, Stevenson, Case & Oaten, 2009) were also investigated. However, primary outcomes of such studies are often the infection rates or school absenteeism, but little is known about the active ingredients of such interventions. Until now, there is only one study examined the effects of a planning intervention on hand hygiene behavior among a small number of nurses in hospital (Erasmus

et al., 2010). In the *Chapter 5*, promoting hand hygiene behavior via a planning intervention is examined among high school students with a large sample size.

Sun screen use

The incidence of skin cancer is continuing to increase around the world (Bray *et al.*, 2013; Lomas *et al.*, 2012). There are several means to escape from skin cancer including seeking shade, wearing protective clothing, and applying sunscreen. As a simple way, sunscreen use has been proven to be an efficient prevention method suggested by dermatologists (Gonzalez *et al.*, 2008). The World Health Organization (WHO) recommend using sunscreen with a SPF (sun protection factor) of 15 and above (WHO, 2010) under the sun. However, a population-based study showed that younger adults reported the least sunscreen use (Lazovich *et al.*, 2011). In light of this, many researchers have started to look for effective interventions to motivate young adults to use sun screen.

There have been several successful campaigns to improve sunscreen use like the “Slip! Slop! Slap!” (Rassaby, Larcombe, Hill, & Wake, 1983), the SunSmart campaign (Borland, Hill, & Noy, 1990; Hill, Marks, White & Borland, 1993), and the Skin Safe Program (Girgis, Sanson-Fisher, Tripodi, & Golding, 1993). However, these are multi-component interventions that do not inform on the active ingredients. Therefore, it is necessary to develop interventions that can examine the effectiveness of specific elements, such as motivational and volitional variables. Earlier studies aimed to improve sunscreen use have focused on motivational variables, although volitional interventions have been shown more effective in health behavior change (Mahler *et al.*, 2003; Pagoto *et al.*, 2010). Only one randomized controlled trial was conducted with young women to improve sunscreen use via volitional intervention focused on planning technique. The study found coping planning as an active ingredient in the volitional group, but not in the motivational or control group (Craciun *et al.*, 2011).

Considering paucity of evidenced studies to explore the role of planning in sunscreen use, it appears useful to explore the effectiveness of a volitional plus a motivational component for

improving sunscreen use, such as planning plus relevant information on combined risks and benefits. A self-regulatory intervention study incorporating planning is thus implemented to improve sunscreen use. Its results are presented in the *Chapter 6*.

Dental flossing

Epidemiological evidence found a global increase in oral disease, such as dental caries, periodontal disease, and tooth loss (Bagramian, Garcia-Godoy, & Volpe, 2009). Daily flossing or use of interdental brushes can remove dental plaque, which can prevent periodontal disease and tooth decay. It is recommended that people should perform tooth flossing twice a day in addition to regular tooth brushing (Kay & Locker, 1998; Marsh, 2006). Although adherence to oral hygiene behavior is essential and benefits are well-known, a large number of young adults brush or floss their teeth much less frequently than recommended (Petersen, 2008; Schüz, Sniehotta, Wiedemann, & Seemann, 2006). For young adults, using dental floss or interdental brushes is widely unfamiliar in major parts of the world (Bagramian, Garcia-Godoy, & Volpe, 2009), and there is a need to develop effective parsimonious interventions which requires input from health behavior theory.

Several interventions aimed to promote dental flossing have been conducted based on health theories. Beneficial effects of self-regulatory skills, such as planning, self-efficacy, and action control on dental flossing have been reported in previous studies (Münster Halvari, Halvari, Bjornebekk, & Deci, 2012; Schüz *et al.*, 2007; Sniehotta, Araujo Soares, & Dombrowski, 2007). However, few studies explored the joint role of these variables in one experimental study. Therefore, the interplay of self-regulatory factors that include self-efficacy, planning, and action control in a randomized controlled trial are examined in *Chapter 7*.

Aims and research questions of the present thesis

The objectives of the current thesis were to explore the psychosocial factors that facilitate behavior change based on the HAPA theory in the context of six kinds of health behaviors. Several research questions are addressed with six studies (3 longitudinal studies and 3 randomized controlled trials) conducted among Chinese people. In more detail, this thesis focusses on investigating the following two main research questions:

- 1) We investigated the suitability of the whole or partial HAPA model in the context of face mask wearing (*Chapter 2*), fruit and vegetable consumption (*Chapter 3*), and physical activity (*Chapter 4*) by three longitudinal studies. The emphases of the studies were on the mechanisms of post-intentional constructs: self-efficacy, planning, and action control. In particular, we hypothesized that: (a) planning and action control joined together as two parallel mediators and translated intention into face mask wearing; (b) a sequential mediator chain emerged from intention via action control and action planning to fruit and vegetable consumption; (c) planning mediates the effect of self-efficacy on physical activity as a function of motivation.
- 2) Another question addressed the effectiveness of self-regulatory interventions in the context of hand hygiene (*Chapter 5*), sun screen use (*Chapter 6*), and dental flossing (*Chapter 7*) by three randomized controlled trials. It was expected that participants in the intervention group not only reported higher in self-regulatory strategies, but also reported higher levels of health behavior following up. Moreover, it was expected that planning served as a mediator between experimental conditions and health behavior later on. We also explored the moderator role of intention (*Chapter 6*), self-efficacy and action control (*Chapter 7*) in the mediator model.

More details about the specific objectives and hypotheses for each study are included in the following six empirical chapters (*Chapters 2-7*). The final chapter (*Chapter 8*) gave a summary and general discussion of the main findings from the empirical chapters and

highlighted the implications of the HAPA theory in health behavior prediction and intervention.

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2

Avoiding Exposure to Air Pollution by Using Filtering Facepiece Respirators: An Application of the Health Action Process Approach*

* **Zhou, G.**, Gan, Y., Ke, Q., Knoll, N., Lonsdale, C., & Schwarzer, R. (*in press*). Avoiding exposure to air pollution by using filtering facemask respirators: an application of the health action process approach. *Health Psychology*.

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The Role of Action Control and Action Planning on Fruit and Vegetable Consumption*

* **Zhou, G.**, Gan, Y., Miao, M., Hamilton, K., Knoll, N., & Schwarzer, R. (2015). The role of action control and action planning on fruit and vegetable consumption. *Appetite*, *91*, 64-68. <http://dx.doi.org/10.1016/j.appet.2015.03.022>

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Planning Mediates Between Self-efficacy and Physical Activity Among Motivated Young Adults*

* **Zhou, G.**, Wang, D., Knoll, N., & Schwarzer, R. (*in press*). Planning mediates between self-efficacy and physical activity among motivated young adults. *Journal of Physical Activity & Health*. <http://dx.doi.org/10.1123/jpah.2014-0555>

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Improving Hand Hygiene Behaviour Among Adolescents by a Planning Intervention*

* **Zhou, G.,** Jiang, T., Knoll, N., & Schwarzer, R. (2015). Improving hand hygiene behaviour among adolescents by a planning intervention. *Psychology Health & Medicine*. <http://dx.doi.org/10.1080/13548506.2015.1024138>

6

Facilitating Sunscreen Use among Chinese Young Adults: Less Motivated Persons Benefit from a Planning Intervention*

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Self-efficacy, Planning, and Action Control in an Oral Self-Care Intervention*

* **Zhou, G.**, Sun, C., Knoll, N., Hamilton, K., & Schwarzer, R. (2015). Self-efficacy, planning, and action control in an oral self-care intervention. *Health Education Research*, 30(4), 671-681. <http://dx.doi.org/10.1093/her/cyv032>

8

General Discussion

General Discussion

It is well-known that health behavior has great influence on individuals' health and well-being. A considerable body of research has also shown that abundant variations of health behavior existed among individuals with different socioeconomic levels (Lantz *et al.*, 1998; Lynch, Kaplan, & Salonen, 1997). In order to explain such variations, a number of social cognitive models have been developed since (Ajzen & Fishbein, 1980; Bandura, 1986; Fishbein & Ajzen, 1975; Rosenstock, 1974; Schwarzer, 2008). Several prominent health behavior theories assumed that intention was the core predictor of behavior, neglecting the intention-behavior gap. However, the HAPA has included highly predictive constructs of the model of action phases (Hechhausen & Gollwitzer, 1987) and social-cognitive theory (Bandura, 1986), which are also used to explain health behavior variance and to improve behavior changes. To examine the suitability of the HAPA theory and apply it to change health behavior, the current thesis included six studies with longitudinal and experimental designs in the context of diverse health behaviors among Chinese samples.

The overarching aim of the current dissertation was twofold. The first aim, addressed in *Chapters 2, 3, and 4*, was to explore the suitability of the HAPA theory. In *Chapter 2*, a longitudinal study with three assessment points was conducted to explore the motivational and volitional predictors of wearing filtering facepiece respirators to avoid polluted air in Beijing. The full theoretical model was examined with a structure equation model (SEM) in which self-efficacy, risk perception, and outcome expectancies were specified as predictors of intention and planning and action control were specified as mediators between intention and subsequent behavior. To identify the psychosocial determinants of fruit and vegetable intake, a study adopted a longitudinal research design with three waves of data collection was conducted to uncover the role of action control and action planning between intention and behavior in *Chapter 3*. In *Chapter 4*, to elucidate the mechanisms under which self-efficacy

predicts physical activity, a longitudinal study with two measurement points examined the interplay of self-efficacy with motivation on planning and subsequent physical activity.

The second aim, addressed in *Chapter 5, 6, and 7*, was to use two selected self-regulatory constructs (action control and planning) from the HAPA framework to promote three kinds of health behavior, and to examine the active and facilitative elements in the interventions. In *Chapter 5*, a randomized controlled trial was designed to improve hand hygiene behavior by a brief planning intervention with three verbal reminders (boosters) among Chinese adolescent students. In the model, planning changes mediated between experimental conditions and hand hygiene changes. In *Chapter 6*, a brief theory-guided intervention to promote young adults' use of sun screen when being exposed to sunshine was conducted. A moderated mediation model was specified with intention as a moderator between intentions and planning, and with planning as a mediator between intention and behavior. In *Chapter 7*, to evaluate a theory-based oral health intervention in young adults with the aim to identify social-cognitive mechanisms of behavior change, a randomized controlled trial was conducted to explore the mediator role of planning and the moderator role of self-efficacy and action control.

The following discussion part is corresponding to the main two research aims. Results from the three longitudinal studies (*Chapters 2-4*) are discussed under the first subheading and results from the three experimental studies (*Chapters 5-7*) are discussed under the second subheading. Implications for theory and practice and future directions are outlined, followed with a conclusion for this thesis. A summary of the specific aims, as well as key findings and conclusions from the six empirical chapters are presented in Table 1.

Table 1.

Summary of Aims, Findings, and Conclusions from Six Empirical Studies

Aims	Findings	Conclusions
<i>Chapter 2.</i> Adherence to the use of filtering facepiece respirators on hazy days to reduce exposure to air pollution is examined with the aim to uncover psychological mechanisms that may be responsible for individual differences in motivation and behavior.	Self-efficacy and risk perception jointly predicted behavioral intention. Planning and action control jointly predicted behavior, serving as parallel mediators between the intention and face mask use.	Results support a theory-based psychological mechanism, with a focus on planning and action control, which might be influential in the adoption and maintenance of self-protective face mask wearing.
<i>Chapter 3.</i> The aim of the current study was to explore the roles of action control and action planning as mediators between intentions and dietary behavior.	The results revealed action control and action planning to sequentially mediate between intention and subsequent fruit and vegetable intake, controlling for baseline behavior.	Both self-regulatory constructs, action control and action planning, make a difference when moving from motivation to action. Our preliminary evidence, therefore, suggests that planning may be more proximal to fruit and vegetable intake than action control. Further research, however, needs to be undertaken to substantiate this conclusion.
<i>Chapter 4.</i> The aim is to examine the roles of motivation, planning, and self-efficacy as well as the mechanisms that operate in the change of physical activity levels.	Planning served as a mediator between self-efficacy and physical activity, controlling for baseline activity. In addition to this indirect effect, a moderator effect was found between self-efficacy and stages of change on planning. The mediation operated only in motivated, but not in unmotivated students.	Only when people are motivated to become more active, a mediation from self-efficacy via planning to physical activity seems to be likely.

<p><i>Chapter 5.</i> To improve regular hand hygiene in adolescents, educational messages based on medical information have not been very successful. Therefore, a theory-guided self-regulatory intervention has been designed with a particular focus on planning strategies.</p>	<p>At one-month follow-up, hand hygiene behavior as well as planning to practice hand hygiene were higher in the self-regulation than in the education group ($p < .01$). Moreover, changes in planning levels operated as a mediator between experimental conditions and changes in behavioral outcomes.</p>	<p>Teaching self-regulatory planning strategies may constitute a superior approach than educational messages to improve regular hand hygiene practice in adolescents.</p>
<p><i>Chapter 6.</i> The effect of a self-regulatory intervention with its focus on planning sunscreen use is evaluated in comparison to a standard educational condition. Moreover, it is studied whether planning mediates between the experimental conditions and the behavioral outcome. Further, it is examined who benefits more, already motivated or unmotivated individuals.</p>	<p>The self-regulatory intervention improved planning to use sunscreen but not the behavior directly. Planning emerged as the mediator between conditions and later sunscreen use, controlling for baseline behavior. Moreover, participants who were less motivated benefited more from the intervention.</p>	<p>Although it is generally assumed that planning interventions are best designed for already motivated persons, the present findings suggest that less prepared individuals might have more to gain from a brief self-regulatory intervention.</p>
<p><i>Chapter 7.</i> A theory-guided intervention on oral self-care was evaluated, and possible mechanisms among self-regulatory factors were examined.</p>	<p>The self-regulatory intervention improved levels of oral self-care, dental planning, and action control. Moreover, a moderated mediation model with planning as the mediator between experimental conditions and dental outcome, and self-efficacy as well as action control as moderators elucidated the mechanism of change. More self-efficacious participants in the self-regulatory condition benefitted in terms of more planning, and those who monitored their actions yielded higher levels of oral hygiene.</p>	<p>Dental self-efficacy, dental planning, and action control are involved in the improvement of oral self-care. Their joint consideration may contribute to a better understanding of health behavior change.</p>

Explaining health behavior by motivational and volitional predictors in longitudinal studies

In line with the review of the introduction part, the HAPA has been demonstrated as useful to predict diverse health behaviors with both motivational and volitional determinants. However, few studies have been conducted in China. China has a different cultural background compared with the west countries where the theory has been developed which could lead to differences in predictive power (Airhihenbuwa, 1995). Whether the HAPA theory is still suitable in the new context of health behavior or among Chinese samples, is still a question. Thus, three longitudinal studies have been conducted based on the HAPA theory in the context of face mask wearing (*Chapter 2*), fruit and vegetable consumption (*Chapter 3*), and physical activity (*Chapter 3*), which aimed to explore the suitability of the HAPA theory in China.

With the economic development in past thirty years, China has become the world factory to produce all kinds of products. However, the environment has been greatly destroyed and polluted with the development of industries. In recent years, with more frequent smog days and more respiratory system illnesses, the air pollution issue began to arouse the concern of Chinese people (Baccarelli *et al.*, 2014; Liang *et al.*, 2014). Several reviews have found that air pollution was associated with mortality (Englert, 2004; Samet *et al.*, 2000; Schwartz, 1994; Stieb, Judek, & Burnett, 2002). It has become normal to wear filtering facepiece respirators to avoid exposure to air pollution in Beijing, China. However, there are few studies to examine the psychosocial determinants of such health behavior. To accumulate new evidence of supporting the suitability of the HAPA in a new context of health behavior, in *Chapter 2*, a longitudinal study was conducted to examine motivational and volitional predictors of face mask wearing among young adults in Beijing. The results are mainly as expected as previous studies on other kinds of health behavior, such as low-fat diet

and smoking (Scholz *et al.*, 2009) and physical exercise (Sniehotta *et al.*, 2005), where action control and planning served as two parallel mediators between intentions and health behavior. Risk perception has been found of negligible importance in previous studies on physical exercise, smoking cessation, or nutrition (Schwarzer & Luszczynska, 2015). In the contrast, this study found risk perception was associated with face mask wearing, as well as outcome expectancies. The great concern about the effects of air pollution by the residents in Beijing might have led to risk perception as a key determinant of face mask wearing (Jia & Cai, 2014).

Nowadays, there are more and more overweight and obesity among young adults in modern China (Adair *et al.*, 2013; Li *et al.*, 2011). Most of them have an unhealthy dietary behavior or habit, such as eating more fat and less fruit and vegetables (Popkin, Adair, & Ng, 2012; Zhang *et al.*, 2015). To improve people to consume enough fruit and vegetables, it is necessary to uncover the psychosocial mechanisms underlying dietary behavior. Although action control and action planning are key post-intentional determinants of fruit and vegetable consumption, their joint role as mediators between intention and behavior is still unclear. In *Chapter 3*, a study with young Chinese adults aimed to identify the psychosocial predictors of fruit and vegetable intake. It focused specifically on the role of action control and action planning between intention and subsequent behavior. Nested models with action control and action planning as either independent or sequential mediators were examined. The study supported the sequential model with action control as a distal predictor and action planning as a proximal predictor. The study also replicated the independent mediator role of action planning between intention and fruit and vegetable intake. However, in contrast to previous studies, the research did not confirm the same effect for action control because of substantial correlation between action control and action planning.

Despite the enormous benefits of physical activity, research from all over the world demonstrated that most of people are still not engaging in enough physical activity (Kohl *et al.*, 2012). Previous studies based on diverse health theories pointed out that self-efficacy and

planning were main predictors of intentions to exercise and maintain the practice for an extended time period (Young *et al.*, 2014). In line with the results, the HAPA theory has construed planning as a mediator between self-efficacy and behavior. Whether such a chain-mediation works for participants across all stages of behavior change or only in specific ones was explored in *Chapter 4*. The mediational model of the self-efficacy-planning-activity chain has been replicated in Chinese young adults with a longitudinal study. This is congruent with previous studies (Anderson *et al.*, 2006; Ayotte *et al.*, 2010; Dishman *et al.*, 2005). More importantly, the study also explored the conditions under which this pathway operates. It was found that the mediational path from self-efficacy to physical activity via planning only emerged in later stage (volitional) individuals, not in less motivated ones. This is in line with the stage assumptions of the HAPA theory which postulates that people who are in the volitional stage are more likely to make plans, compared with those who reside in the motivational stage (Schwarzer, 2008).

Effectiveness of self-regulatory interventions in promoting health behavior

The aim and final end of construing theory in the health behavior domain is to give clear instructions by including active elements in future interventional practices. Whether a theory is useful or not depends on the probability of effects of interventions based on the theory. Although previous research has demonstrated effectiveness of interventions based on the HAPA theory in diverse health behavior domains, few studies have examined whether interventions that combined motivational and self-regulatory skills together are more effective than merely motivational ones. To achieve such an aim, three randomized controlled trials were designed to compare such differences in the context of hand hygiene among adolescents (*Chapter 5*), as well as in the context of sunscreen use (*Chapter 6*) and dental flossing (*Chapter 7*) among young adults.

Hand hygiene by physicians and nurses before and after contacting patients can decrease infections, which can save millions of lives every year (Pittet, 2001). It is demanding to wash hands properly with hand sanitizer for physicians and nurses (Boyce, 1999; Sax *et al.*, 2007). In the daily life, washing hands properly is also very important to peoples' health. Promotion of hand hygiene behavior has gone beyond the hospitals and has begun to include nonhospital populations, such as students at school (Correa *et al.*, 2012; Lau *et al.*, 2012; Martínez *et al.*, 2014; Nandrup-Bus, 2009). Although communicable diseases are no longer the main reasons of mortality in the developed countries, it is still problematic for developing countries like in China (Murray & Lopez, 1997). Teaching students in schools on how to wash hands properly might be an easy way to achieve great impacts on their health. An experimental study randomly grouped high school students into two groups in *Chapter 5*. The educational control group received educational leaflets on how to wash hands properly with water and soap and further three additional verbal notifications on hand hygiene. The self-regulatory intervention group received instruction on how to make plans on washing hands properly and further three times of reminding making plans, besides receiving the same didactic education information as in the educational group. One month later, participants in the self-regulatory group reported higher planning to practice hand hygiene than those in educational group, as well as more hand hygiene behavior. Moreover, it was also found that changes in planning operated as a mediator between experimental groups and changes in behavior. The study accumulated new evidence on the effectiveness of planning intervention in a new domain of health behavior.

Skin cancer is still spreading around the world, although it can be prevented by simple behaviors, such as using sun screen (González *et al.*, 2008). Prior campaigns to promote sun protective behaviors always included multicomponent interventions, which made them less parsimonious and hard to identify their active elements (Pagoto *et al.*, 2010). Brief interventions to improve sun screen use based on changing coping planning among Caucasian

populations have been documented to be effective (Craciun *et al.*, 2011). Chinese people have slightly different attitudes toward skin beauty than western people. Thus, whether combined motivational and self-regulatory skills interventions can promote sun screen use among Chinese young adults deserved to be evaluated. A randomized controlled trial, in *Chapter 6*, was implemented to compare the effectiveness of a self-regulatory intervention and a standard care intervention to motivate young adults to use sun screen. Participants in the standard group received educational materials on risks and outcomes of exposure to sunshine, while participants in the self-regulatory group were instructed on how to make plans to use sun screen besides reading the educational information. Although the participants in self-regulatory intervention failed to benefit on sun screen use behavior more than those in standard care group, they made more plans on using sun screen when exposed to sun. The progress also has been documented by mediation analysis, in which changes in planning served as a mediator between experimental groups and subsequent behavior. Moreover, a counterintuitive finding in the study showed that less motivated participants benefitted much more from such volitional interventions compared with motivated ones. This might be because intention and planning are closely related constructs, and promoting the unmotivated individuals with a planning interventions may increase their motivation in the first place, then followed by actual behavior.

To prevent periodontal disease and tooth decay, daily flossing or use of interdental brushes twice a day in addition to brushing teeth is recommended (Hujoel *et al.*, 2006). However, dental flossing is unfamiliar to many young adults and is also less frequent than recommended (Bagramian, Garcia-Godoy, & Volpe, 2009). Providing information related to disease could stimulate awareness to health behavior, while practicing self-regulatory skills might improve inclination to change individuals' actual behavior. Thus, it might be effective to use motivational plus a volitional intervention to promote dental flossing. In *Chapter 7*, two brief intervention arms were compared among Chinese young adults based on the HAPA

theory, an information-transfer education treatment and a self-regulatory treatment focusing on planning and action control. One month later, self-regulatory intervention promoted levels of dental flossing, planning and action control to floss. Moreover, a moderated mediation model was found with planning as the mediator between interventional groups and subsequent dental behavior, and self-efficacy and action control as two mediators uncovered the mechanism of change. People who were more self-efficacious benefitted in terms of more planning, and individuals who reported self-monitoring attained higher levels of dental flossing.

Theoretical implications: Adding action control into the HAPA framework

Until now, there have been a number of predictive studies that have supported the HAPA framework. Most of them used the multi-regression method to predict intention and behavior by corresponding determinants specified by the theory. The typical framework without action control has been greatly used by previous studies (Chow & Mullan, 2010; Craciun, Schüz, Lippke, & Schwarzer, 2012; Ernsting *et al.*, 2013; Luszczynska & Schwarzer, 2003; Reyes Fernandez *et al.*, 2015; Scholz *et al.*, 2009; Schwarzer *et al.*, 2007; Teng & Mak, 2011; Zhou *et al.*, 2013; Zhou *et al.*, 2015). Although the HAPA theory has included action control as a key post-intentional predictor, few research explored the position of action control in the framework, especially its relationship with planning. To elucidate the mechanism of volitional factors in the HAPA, two longitudinal studies with three waves were conducted in the context of face masks wearing (*Chapter 2*) and fruit and vegetable consumption (*Chapter 3*) among young adults. Two contrasting findings emerged. A parallel mediator model was found for face mask wearing, whereas a sequential mediator model was found for fruit and vegetable consumption. A recent review, which pointed out that action control could happen spanning from seconds or minutes to hours or months or even years prior to behavior (Verbruggen, McLaren, & Chambers, 2014), might explain such contrasting

results. This means that once people formed their intentions, action control might begin to work, until the end of behavior. Action control not only helps to recall the plans but also the intentions individuals made. Considering the paucity of previous studies on exploring the two variables together, we assume that these two mechanisms might be right in different contexts of behavior. The findings could contribute to add knowledge on post-intentional mechanisms of the HAPA theory.

In addition, to explore how self-efficacy predicts physical activity and under which conditions such mechanisms work, a longitudinal study with two waves three month apart was conducted in *Chapter 4*. The findings showed that self-efficacy predicted physical activity via planning and the mediation path only operated among more motivated individuals. The results are in line with the stage principal of the HAPA, which contributed the stage attribute of the theory and implies that tailoring interventions should be useful in future studies (Schwarzer & Luszczynska, 2015). In *Chapter 2*, the whole framework was specified in a new health behavior, that is facemask wearing. The model fit the data well, which also implied the suitability and flexibility of the HAPA theory.

Practical implications: Improving health behavior change by planning and action control

The current thesis included three randomized controlled trials which focused on manipulating self-regulatory skills (planning and action control) to improve three kinds of health behavior (hand hygiene in *Chapter 5*, sun screen use in *Chapter 6*, and dental flossing in *Chapter 7*). All three experimental studies confirmed planning as a mediator between interventional conditions and behavior. These findings strengthened the role of planning to promote behavior changes, which implied that large campaigns to improve health behavior should embrace a planning element.

Moreover, to get better interventional effects on behavior changes, some other suggestions should also be considered when practitioners design their campaigns. In *Chapter 5* a verbal notification to form multi-plans was used and results showed its effectiveness on hand hygiene behavior, so it could be applied by practitioners in the context of hospitals or food companies. In *Chapter 6* and *7*, motivational levels and self-efficacy have been found as moderators between experimental groups and planning. This gave the idea that effective interventions should elaborate not only planning self-regulatory skills but also motivation and self-efficacy. For example, before instructing people to make their own plans on initiating physical activity, exercise tutors should motivate individuals to form their intentions to do regular exercise as well as act as a model to promote their self-efficacy.

Action control as a key self-regulatory skill in the post-intentional stage has been manipulated in few intervention studies, although it has been found useful to improve health behavior (Schwarzer *et al.*, 2015). In *Chapter 7*, it was found that action control was a facilitator in promoting dental flossing. Although it was not found that action control operated as a mediator in the intervention, people who were higher in action control more likely translated their planning into actual behavior. Results from *Chapter 2* and *Chapter 3* attest to the mediator role of action control and found that action control was an important predictor for health behavior. This implies that practice should include action control as a key self-regulatory skill.

Future directions for research

Findings from the present thesis confirmed the HAPA as a suitable model to predict diverse kinds of health behavior. In line with previous studies, this thesis also demonstrated the independent mediator role of action control and planning between intention and behavior (Godinho *et al.*, 2014; Lange *et al.*, 2013; Richert *et al.*, 2010; Zhou *et al.*, 2013). However, the joint role of action control and planning played in the volitional process of behavior

change is still unclear. Although two studies explored the joint role of planning and action control in the contexts of face masks wearing (in *Chapter 2*) and fruit and vegetable consumption (in *Chapter 3*), it is hard to draw confident conclusions from such few studies. In the future, more studies are needed to explore whether planning and action control play a parallel or sequential mediator role between intention and behavior depends on the types of behavior. Results from *Chapter 4* showed that intention level moderated the well-built mediational chain from self-efficacy to physical activity via planning. Future research should further examine the interplay of motivation and self-efficacy on planning in physical activity to investigate whether such relationships remain stable across other kinds of health behavior (e.g., dietary behavior) and other culture groups (e.g., western population). Moreover, all the results from non-experimental studies do not allow for causal inferences. To further elucidate the mechanism of behavior change, more experimental studies should be conducted to manipulate the corresponding antecedents of specific behavior and replicate the results from the longitudinal research.

Planning interventions have been shown to be effective in diverse kinds of health behavior (Hagger & Luszczynska, 2014). In *Chapter 5*, a verbal notification on planning was used to help strengthen a brief planning intervention which achieved good results to improve hand hygiene behavior among adolescents. Consistent with the study, prior research has demonstrated these benefits of multi-planning interventions for fruit and vegetable intake (Wiedemann, Lippke, & Schwarzer, 2011). However, whether multi-planning was more successful to promote behavior changes than single planning in other contexts of health behavior should be tested in the future. In contrast with previous studies, the results from *Chapter 6* indicated that low intenders benefitted slightly more from a volitional intervention to promote sun screen use compared with pre-intenders. One explanation might be that intention had been improved before behavior changed. To study this, a design with further and more tightly spaced assessment points would have been necessary. This is an issue that

deserves further examination in future studies. In *Chapter 7*, a self-regulatory intervention on planning and action control together improved dental flossing. As previous planning interventions, planning changes served as a mediator between conditions and subsequent behavior. Although action control was manipulated in the dental intervention, results indicated that action control as a moderator not a mediator. There is one study that has confirmed the mediator role of self-monitoring, which is one of key elements for action control, in one oral health care focused on action control (Schwarzer *et al.*, 2015). Future intervention on action control should further elucidate the role of action control played in behavior changes. Moreover, there were only one month time intervals between the intervention and follow up in the three randomized controlled trials. One month is likely not enough for the formation of a new habit (Wiedemann, Gardner, Knoll, & Burkert, 2014). Future research should include a follow-up assessment after an extended time period to investigate the long-term effects of such interventions.

Overall, although the validity of self-reported assessments in all six kinds of health behavior have been proved to be satisfactory, further studies could apply objective measurement methods to replicate the findings from the present thesis.

Conclusions

The present thesis contributed to the investigation of psychosocial determinants of six kinds of health behaviors. Results from three longitudinal studies showed that the HAPA can be successfully applied to explain face mask wearing, fruit and vegetable intake, and physical activity in Chinese samples. Moreover, findings pointed out that action control and planning served as two parallel mediators in face mask wearing and as sequential mediator in fruit and vegetable intake. It was also found that a mediation from self-efficacy to physical activity via planning only operated among motivated individuals. Results from three randomized controlled trials showed that selected self-regulatory skills focused on planning and action

control from the HAPA theory might be effective to improve hand hygiene, sun screen use, and dental flossing in China. In order to be successful, future intervention programs should consider to provide multi-planning procedures in hand hygiene campaigns as well as motivate individuals to use sun screen and promote their self-efficacy and action control levels. In sum, the current thesis contributed to the development of theory as well as design and evaluation of theory-based interventions in diverse domains of health behavior.

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Curriculum Vitae

For reasons of data protection,
the curriculum vitae is not included in the online version

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the curriculum vitae is not included in the online version

Publications

(*indicates those that are part of the thesis)

- ***Zhou, G.**, Gan, Y., Ke, Q., Knoll, N., Lonsdale, C., & Schwarzer, R. (*in press*). Avoiding exposure to air pollution by using filtering facemask respirators: an application of the health action process approach. *Health Psychology*.
<http://dx.doi.org/10.1037/hea0000264>
- ***Zhou, G.**, Wang, D., Knoll, N., & Schwarzer, R. (*in press*). Planning mediates between self-efficacy and physical activity among motivated young adults. *Journal of Physical Activity & Health*. <http://dx.doi.org/10.1123/jpah.2014-0555>
- ***Zhou, G.**, Sun, C., Knoll, N., Hamilton, K., & Schwarzer, R. (2015). Self-efficacy, planning, and action control in an oral self-care intervention. *Health Education Research*, 30(4), 671-681. <http://dx.doi.org/10.1093/her/cyv032>
- ***Zhou, G.**, Zhang, L., Knoll, N., & Schwarzer, R. (2015). Facilitating sunscreen use among Chinese young adults: less-motivated persons benefit from a planning Intervention. *International Journal of Behavioral Medicine*.
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- ***Zhou, G.**, Gan, Y., Miao, M., Hamilton, K., Knoll, N., & Schwarzer, R. (2015). The role of action control and action planning on fruit and vegetable consumption. *Appetite*, 91, 64-68. <http://dx.doi.org/10.1016/j.appet.2015.03.022>
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- Zhou, G.**, Gan, Y., Knoll, N., & Schwarzer, R. (2013). Proactive coping moderates the dietary intention–planning–behavior path. *Appetite*, 70, 127-133.
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Working papers

- Zhou, G.**, Gan, Y., Knoll, N., & Schwarzer, R. (in progress). *The Role of Planning and Action Control on Avoiding Exposure to Air Pollution by Using Filtering Facepiece Respirators: A Latent Growth Curve Model*.

Erklärung

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

Unterschrift (Guangyu Zhou)

Berlin, April 2015