An 8-Week Study on Social-Cognitive Variables for Physical Activity and Fruit and Vegetable Intake: Are there Stage Transitions?

Vera Vergeld and Shu Ling Tan
*University of Münster, Münster, Germany*

Julian Wienert
Leibniz Institute for Prevention Research and Epidemiology – BIPS, Bremen, Germany

Dominique Alexandra Reinwand
University of Cologne, Cologne, Germany

Sonia Lippke*
Jacobs University Bremen gGmbH, Bremen, Germany

**Background:** Health behavior change can be modelled in terms of stages, and outcomes of transitions between stages can be categorized into progression, regression, and stagnation. Based on the Health Action Process Approach this study tested whether changes in social-cognitive variables are associated with transitions between stages regarding physical activity (PA) and fruit and vegetable intake (FVI).

**Methods:** N = 132 participants (M = 50.86 years, SD = 13.17, 61.4% women) were assessed at baseline and 8 weeks later. Data were analysed using multivariate analyses of variance (MANOVA) and post-hoc comparisons.

**Results:** Changes in motivational self-efficacy ($\eta^2 = 0.081$), maintenance self-efficacy ($\eta^2 = 0.119$), and recovery self-efficacy ($\eta^2 = 0.049$) as well as positive outcome expectancies ($\eta^2 = 0.070$), negative outcome expectancies ($\eta^2 = 0.055$), and coping planning ($\eta^2 = 0.065$) were associated with FVI stage progression. For PA, changes were not associated with stage progression.

**Conclusion:** To facilitate behavior change effectively, at least for FVI, it is essential to consider underlying mechanisms such as several aspects of self-efficacy in performing the desired health behaviors, outcome expectations, and planning how to overcome barriers. Additionally, the adoption of a stage approach may be a useful starting point to develop stage-matched interventions.

*Address for correspondence: Sonia Lippke, Jacobs University Bremen gGmbH, Campus Ring 1, D-28759 Bremen, Germany. Email: s.lippke@jacobs-university.de*

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INTRODUCTION

Health Behaviors, Depressive Symptoms, and Cardiovascular Risk

Nowadays, lifestyle-related diseases such as cardiovascular diseases (CVD), diabetes, and obesity are the most common, costly, and preventable of all health problems (Feigin et al., 2016; Mathers & Loncar, 2015). These problems will continue to impose an even greater burden in the future due to the aging of the population and thus, increase overall morbidity (Akushevich et al., 2013). Moreover, lifestyle-related diseases are even aggravating the severe consequences from infectious diseases such as COVID-19. During the last two decades, a wealth of epidemiological studies have documented the health benefits of regular physical activity (PA; Bauman et al., 2016; Li & Siegrist, 2012) and healthy dieting (Aune et al., 2017) (i.e. regular fruit and vegetable intake, FVI), especially in the prevention and treatment of CVD. PA and healthy eating are not only associated with a wide range of sustainable health benefits, but also with increased sleep quality, which in turn is associated with increased overall quality of life and subjective health (MacPhail et al., 2014) and can be a buffer of stressors due to acute challenges related to pandemic management actions such as physical distancing, for example.

Around five servings of fruit and vegetable per day are recommended and this is reflected in national prevention campaigns such as “five a day” by the German Society for Nutrition (2012) and the Dutch Nutrition Centrum (2011). One can summarize from associations like the American Heart Association (2014), the National Health Society (2015), the American College of Sports Medicine (Garber et al., 2011), the German Society for Prevention and Rehabilitation of Cardiovascular Disease and the Dutch Heart Foundation (2015) that one should be physically active for at least 150 min per week.

Despite the potential health benefits of lifestyle changes, individuals struggle to translate such recommendations into their daily lives even though they show good intentions to do so. Good intentions alone are not sufficient to adopt a new behavior. Numerous studies show that besides motivational factors (e.g. behavioral outcome expectations), volitional factors (e.g. action planning) play a key role in translating intentions into actual health behaviors (Inauen, Shrout, Bolger, Stadler, & Scholz, 2016; Teixeira et al., 2015).
Modelling Health Behavior Change

Models and theories in health psychology typically postulate certain factors that are assumed to underlie health behaviors and influence the process of single and multiple health behavior changes. A frequently used hybrid model for health behavior change is the health action process approach (HAPA; Schwarzer, 2008). The HAPA has been tested among different populations such as people with chronic diseases (Schwarzer, Luszczynska, Ziegelmann, Scholz, & Lippke, 2008). The HAPA model is also used as a theoretical framework in many intervention studies to explain and modify health behaviors, for example, to increase PA in Germany (Schwarzer et al., 2008), and to reduce students’ sedentary behavior (Sui & Prapavessis, 2018).

The HAPA model describes the health behavior change process of adoption, initiation, and maintenance of health behavior via two phases: (a) motivational phase—the intention to adopt the desired behavior is formed, and (b) volitional phase—the realization of behavior is central (Schwarzer, 2008). According to Schwarzer (1992), different stage-specific psychological and behavioral mechanisms support behavior change, including risk perception, outcome expectancies, self-efficacy, and action planning. A substantial amount of research has consistently confirmed the predictive value of these social-cognitive variables on behavioral intentions regarding regular PA and dietary intake (Caudroit, Stephan, & Le Scanff, 2011; MacPhail, Mullan, Sharpe, MacCann, & Todd, 2014; Schwarzer, Lippke, & Luszczynska, 2011; Storm et al., 2017).

Risk perception, outcome expectancies, and self-efficacy are assumed to be important in the non-intentional stage, which aims to form a behavioral intention. Risk perception refers to an individual’s subjective judgment about the perceived likelihood of a negative occurrence, such as a heart attack or high blood pressure. Outcome expectancies are beliefs that people hold about the effects of performing a certain behavior and can be either positive (e.g. “eating five portions of fruit and vegetable a day is good for my health”) or negative (e.g. “regular physical activity will require a lot of time”). Self-efficacy is defined as an individual’s belief in their capability to successfully meet novel or difficult demands and can help to initiate a new behavior.

The HAPA suggests three different types of self-efficacy with different self-efficacy needs based on each phase. It has been shown that high levels of motivational self-efficacy are a major factor during the motivational phase to build behavioral intentions (i.e. in non-intenders). During the volitional phase, maintenance and recovery self-efficacy are of importance among actors. Maintenance self-efficacy refers to the belief in one’s ability to perform a new health behavior over a long period—even in difficult situations. Recovery self-efficacy considers the belief about one’s ability to return to the new health behavior—even after a period of relapse to previous behaviors. The differentiation of self-efficacy was added to the model since self-efficacy was seen as task-specific.
and since the understanding that health behavior change requires mastery of different and specific tasks during each phase (Luszczynska & Sutton, 2006; Ochsner & Hornung, 2013; Schwarzer et al., 2008).

Individuals in the intender stage have already formed an intention to act in a certain way. However, they have not yet become active according to their intentions. Self-efficacy and planning are needed to successfully translate intentions into desired behavior (Schwarzer, 2008). Planning describes either making action plans (how and when a behavior will be performed) or making coping plans (mentally simulating how to overcome anticipated barriers to action). Self-efficacy and planning are important for bridging the gap between intention and behavior with regard to FVI and PA (Scholz, Schü, Ziegelmann, Lippke, & Schwarzer, 2008; Storm et al., 2017).

Individuals who already perform their intended behavior are understood to be in the actor stage. Maintenance and recovery self-efficacy and planning are assumed to maintain the initiated behavior regularly. In comparison to non-intenders or intenders, different studies show that actors demonstrate higher levels of self-efficacy and planning with regard to PA and FVI (Keller, Gellert, Knoll, Schneider, & Ernsting, 2016; Lima, Alvarez, & Godinho, 2013).

However, there has been critique on the stage assumptions in that stages might simply be arbitrary distinctions along an underlying continuum (Lippke, Ziegelmann, Schwarzer, & Velicer, 2009). However, if certain variables act in different stages differently, then stages are supported. These differences, also called discontinuity patterns, can be tested empirically, thereby making the existence of the stages testable (Lippke et al., 2009; Sutton, 2000). To examine these discontinuity patterns, in this current study paired comparisons and tests for non-linear trends will be applied.

In contrast, a linear trend would imply pseudo-stages, in which a continuum creates stages (Lippke et al., 2009; Sutton, 2000; Weinstein et al., 1998). Such discontinuity patterns can be empirically tested in examining the predictors of stage transitions (Weinstein et al., 1998), which is the main aim of this study. In the following such determinants of stage transitions are described in more detail.

Determinants of Stage Transition

A promising approach to investigate health behavior change is using longitudinal designs that take transition between stages as an outcome variable into account. In previous studies, baseline levels of social-cognitive HAPA variables have been used to predict transition between stages (De Vet et al., 2006; Parschau et al., 2012; Schü et al., 2009; Wiedemann et al., 2009). However, more recently, an increase or decrease in such variables has been associated with stage transition. For example, Parschau et al. (2012) showed that PA stage progression is associated with an increase in self-efficacy and planning, whereas regression from a stage to a previous stage is associated with decreases in self-efficacy and
planning. To our knowledge, corresponding studies for FVI are missing so far. Based on the theoretical background and identified research gaps, we formulated the comprehensive hypotheses for PA and FVI, which are outlined in Table 1.

Social-cognitive variables associated with stage transition based on the HAPA are independent variables, while stage transition is the dependent variable. The test of the outlined hypotheses is the aim of the current study.

**METHODS**

**Participants and Procedure**

Recruitment took place in cardiac rehabilitation facilities, heart-training groups, via internet platforms on diabetes and CVDs, and via web-based panels of two research agencies in Germany and the Netherlands. Trained research assistants and/or advertisements informed participants about the study. To obtain access to the web-based questionnaires, the participants registered on the project website with a self-chosen nickname and password. The inclusion criteria were as follows: between the ages of 20 and 85 years, no contraindications for PA and FVI, interest in improving PA and FVI, sufficient reading and writing skills in the relevant language (German or Dutch), access to a computer, and internet access. Participants provided written informed consent. Participation in the study was voluntary, and the data were anonymised. Data collection was carried out at baseline T1 and 8 weeks later at T2, respectively, via an internet-based self-report questionnaire.

The study was initially designed as a randomised controlled trial used to investigate the effectiveness of a web-based intervention to promote PA and FVI (Reinwand et al., 2013) and received ethical approval in the Netherlands (METC number 12-N-124) and Germany (DGPs; EK-A-SL 022013). The experimental design does not hold interest in the present study as only data from the waiting

| TABLE 1 | Overview of Hypotheses and Variables Associated with Stage Transitions |
|---------|-------------------------------------------------|
| Stagnation | Regression | Progression |
| Risk perception | – | Not applicable | ↑ |
| Positive outcome expectancies | – | Not applicable | ↑ |
| Motivational self-efficacy | – | Not applicable | ↑ |
| Negative outcome expectancies | – | Not applicable | ↓ |
| Action planning | – | ↓ | ↑ |
| Coping planning | ↓ | ↑ | |
| Maintenance self-efficacy | – | ↓ | ↑ |
| Recovery self-efficacy | – | ↓ | Not applicable |

*Note: – = no change; ↑ = increase; ↓ = decrease; all hypotheses apply for both behaviors, PA and FVI.*

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control group, which received no intervention throughout the first 8 weeks, is reported. Therefore, only participants from the waiting control group who provided data on both measurement points (T1 and T2) were included in the present study. Attrition between T1 \((n = 387)\) and T2 \((n = 132)\) was 66 per cent. Detailed dropout analyses have been reported elsewhere (Storm et al., 2016) and showed no significant differences between the participants who completed all waves of data collection and those who dropped out after T1 regarding age, gender, BMI, and country of origin \((all \; ps > .12)\).

**Measures**

Besides socio-demographic information such as gender and year of birth, employment status, height (in cm), and body weight (in kg) were assessed to calculate body mass index (BMI). All mentioned measurements were obtained at T1 (baseline) and T2 (8 weeks later) via internet-based self-report questionnaires in German and Dutch, depending on the country the participants were recruited in. All social-cognitive variables were measured on Likert scales ranging from *not true* (1) to *exactly true* (7), and a mean value was computed for each scale. All social-cognitive variables have been used and validated in previous studies (Lippke et al., 2009; Lippke, Schwarzer, & Ziegelmann, 2010; Luszczynska & Sutton, 2006; Parschau et al., 2012).

**Motivational Self-Efficacy.** Motivational PA self-efficacy was assessed with the item “I am confident that I can be physically active even if it is difficult for me”. Motivation self-efficacy concerning FVI was assessed with the item “I am certain that I can eat five portions of fruit and vegetable a day even if it is sometimes difficult for me”.

**Maintenance Self-Efficacy.** Maintenance self-efficacy regarding PA was assessed with two items \((r = .84)\) each beginning with “I am confident that I can be physically active on a permanent and regular basis (…)” and ending with “(…) even if I have to overcome barriers” and “(…) even if I have difficulties and problems”. The two items \((r = .85)\) assessing FVI-related maintenance self-efficacy began with “I am confident that I can eat five portions of fruit and vegetable on a permanent and regular basis (…)” and also ending with “(…) even if I have to overcome barriers” and “(…) even if I have difficulties and problems”.

**Recovery Self-Efficacy.** Recovery self-efficacy was measured with two items for PA \((r = .95)\) and FVI \((r = .87)\), respectively: “I am certain that I can again be physically active a minimum of five days a week for 30 minutes (…)” or “I am certain that I can again eat five portions of fruit and vegetable a day (…)”, “(…) even if I changed my concrete plans several times”, and “(…) even if I skipped a few times”.

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Risk Perception. Risk perception was assessed with an adaptation of the perceived vulnerability scale. Participants indicated the five items ($\alpha = .85$): “How likely is it that you will have at some time in your life (…)”, “(…) a high cholesterol level?”, “(…) a heart attack?”, “(…) high blood pressure?”, “(…) a stroke?”, and “(…) a cardiovascular disease?”

Outcome Expectancies. Participants’ outcome expectancies were measured by four items in total; two about positive (PA: $r = .78$; FVI: $r = .78$) and two about negative expectancies (PA: $r = .44$; FVI: $r = .64$). “If I am physically active five days a week for at least 30 minutes, then (…)”, “(…) this is good for my health”, “(…) I feel better afterwards”, “(…) it will cost me a lot of time”, and “(…) this will be a financial burden”. The items for FVI include “If I eat five portions of fruit and vegetable a day (…)”, “(…) this is good for my health”, “(…) I feel better afterwards”, “(…) it will cost me a lot of time”, and “(…) this will be a financial burden”.

Action Planning. Action planning was assessed with the use of three items for PA ($\alpha = .87$) and with three items for FVI ($\alpha = .91$). For both target behaviors, the item started with “For the next month, I have already planned in detail (…)”, “(…) which physical activities I would like to do”, “(…) where I will be physically active”, and “(…) on which days I will be physically active”. FVI started with the same stem, followed by the three items “(…) when I will eat five portions of fruit and vegetables”, “(…) which fruit and vegetables I will eat”, and “(…) how I will prepare the food”.

Coping Planning. Coping planning was measured with three items for each of the two target behaviors. PA ($\alpha = .81$): “For the next month, I have already planned in detail (…)”, “(…) when I have to be especially cautious not to stop being active”, “(…) what I can do in difficult situations to stick to my intentions”, and “(…) how I will continue to stay active even when something crops up”. FVI ($\alpha = .88$): “For the next month I have already planned in detail (…)”, “(…) when I need to be especially cautious not to fall into my old eating habits”, “(…) what I can do in difficult situations to stick to my intentions”, and “(…) how I will continue to eat healthy even when something crops up”.

Stage of Health Behaviors—PA and FVI. The behavioral stage for PA was assessed with the item “Please think about your typical weeks: Did you engage in physical activity at least five days per week for at least 30 minutes?” Regarding FVI, participants were asked, “Please think about what you have typically consumed during the last weeks: Did you eat five portions of fruit and vegetable per day?” Those answering “No, and I do not intend to do so” and “No, but I am thinking about it” were classified as non-intenders, those indicating “No, but I strongly intend to do so” were categorised as intenders, and those
replying “Yes, but it is difficult for me” and “Yes, and it is easy for me” were categorised as actors. The stage algorithms have proven valid in previous studies among people interested in health behavior change (Lippke et al., 2009).

Stage transition was measured by grouping study participants regarding their stage T1 and stage T2 allocation and whether they stagnated in their stage (being non-intender, intender, and actor both at T1 and T2), regressed (intender at T1 and non-intender at T2 or actor at T1 and intender or non-intender at T2), or progressed (all those who progressed at least one stage from T1 to T2). Change scores were computed by subtracting the T2 mean from the T1 mean for the respective variable.

Statistical Analysis

Data were analysed in SPSS 25 using multivariate analyses of variance (MANOVA) and post-hoc comparisons. We provide bootstrapped 95% confidence intervals (1,000 redraws). The assumption of homogeneity of variances was violated among the variables recovery self-efficacy (PA: \(F(2, 129) = 5.07, p = .008\)), positive outcome expectancies (PA: \(F(2, 129) = 4.61, p = .001\); FVI: \(F(2, 129) = 4.61, p = .012\)), action planning (PA: \(F(2, 129) = 4.61, p = .012\); FVI: \(F(2, 129) = 9.99, p < .001\)), and coping planning (PA: \(F(2, 129) = 4.70, p = .011\)) at baseline stages.

The assumption of homogeneity of variances was violated among the variables change in motivational self-efficacy (PA: \(F(2, 127) = 3.20, p = .044\); FVI: \(F(2, 127) = 5.37, p = .006\)), positive outcome expectancies (FVI: \(F(2, 127) = 5.30, p = .006\)), and action planning (FVI: \(F(2, 127) = 5.18, p = .007\)).

Sample sizes among baseline stages and stage transitions differed. Therefore, Games-Howell post-hoc comparisons were performed to analyse the differences in dependent variables across stages and stage transitions. The Games-Howell test is recommended for multiple comparisons if the homogeneity of variances assumption is violated and subgroups differ in size (Games & Howell, 1976; Toothaker, 1993). A significance level of \(p = .05\) was used. Effect sizes for differences in means are presented as \(\eta^2\). Those effect sizes that equal 0.01 were considered small, those of 0.06 were considered medium, and those larger than 0.14 were regarded as large (Cohen, 1988; Richardson, 2011).

RESULTS

Participant Characteristics

\(N = 132\) participants with mean age \(M = 50.86, SD = 13.17,\ Range = 22–83\) were included in the present study. Altogether, 61.4 per cent \(n = 81\) indicated being women, 40.2 per cent \(n = 53\) indicated being German and 67.4 per cent
(n = 89) of the participants indicated that they worked full-time or part-time. Mean BMI was $M = 26.92$ ($SD = 5.38$, Range = 16.88–46.26). Regarding regular PA, 26.7 per cent (n = 22) of the participants considered themselves to be non-intenders, 42.4 per cent (n = 56) interenders, and 40.9 per cent (n = 54) actors at baseline. Regarding fruit and vegetable intake (FVI), 28.0 per cent (n = 37) of the participants considered themselves to be non-intenders, 43.2 per cent (n = 57) interenders, and 28.8 per cent (n = 38) actors at baseline. Correlations between main study variables are shown in Tables 2 and 3.

Baseline Differences across Stages

There were significant differences among PA baseline stages with regard to motivational self-efficacy ($p < .001$, $\eta^2 = 0.266$), maintenance self-efficacy ($p < .001$, $\eta^2 = 0.158$), positive outcome expectancies ($p = .009$, $\eta^2 = 0.071$), negative outcome expectancies ($p = .001$, $\eta^2 = 0.101$), action planning ($p = .001$, $\eta^2 = 0.189$), and coping planning ($p < .001$, $\eta^2 = 0.113$), indicating that non-intenders provided the lowest values.

There were also significant differences among FVI baseline stages with regard to motivational self-efficacy ($p < .001$, $\eta^2 = 0.303$), maintenance self-efficacy ($p < .001$, $\eta^2 = 0.151$), recovery self-efficacy ($p < .001$, $\eta^2 = 0.266$), positive outcome expectancies ($p < .001$, $\eta^2 = 0.134$), action planning ($p < .001$, $\eta^2 = 0.315$), and coping planning ($p < .001$, $\eta^2 = 0.178$), indicating that non-intenders provided the lowest values.

Determinants of Stage Transition

Changes in social-cognitive variables across stage transitions are portrayed in Table 4 and Table 5. Regarding PA, n = 10 participants regressed from their initial stage to a previous one between baseline T1 and T2 (8 weeks later), n = 85 participants remained in their stage, and n = 35 participants progressed from their stage to the next stage.

Significant group differences were only found for change in motivational self-efficacy ($p = .001$, $\eta^2 = 0.100$) and change in action planning ($p = .044$, $\eta^2 = 0.048$). When performing Games-Howell post-hoc comparisons, no significant differences in dependent variables across stage transitions could be determined. Changes in risk perception, positive outcome expectancies, negative expectancies, maintenance self-efficacy, recovery self-efficacy, and coping planning were not associated with PA stage progression between T1 and T2 (Table 4; Supplement Figure 1).

Regarding FVI, n = 27 participants regressed from their initial stage to a previous one between baseline T1 and T2 8 weeks later, n = 63 participants remained in their stage, and n = 40 participants progressed from their stage to the next stage. There were significant group differences in change of
### TABLE 2
Correlations between Change Scores of Social-Cognitive Variables with Regard to Physical Activity

|               | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    |
|---------------|------|------|------|------|------|------|------|------|------|
| Risk perception |      |      |      |      |      |      |      |      |      |
| Positive OE   | .024 |      |      |      |      |      |      |      |      |
| Negative OE   | -.052| -.061|      |      |      |      |      |      |      |
| Motivational SE | .051 | .258*| -.210*|      |      |      |      |      |      |
| Maintenance SE | .004 | .169 | -.153 | .433**|      |      |      |      |      |
| Recovery SE   | .140 | -.074| -.179*| .234*| .402**|      |      |      |      |
| Action planning | -.075| .064 | -.178*| .184*| .046 | .064 |      |      |      |
| Coping planning | -.143| .129 | -.167 | .174*| .195*| .279*| .378**|      |      |
| Age           | -.108| -.098| .128 | -.045| -.149| .024 | -.033| -.061|      |
| BMI           | -.241*| -.061| <.001| .014 | -.037| -.068| -.025| .023 | .136 |

*Note: OE = outcome expectancies; SE = self-efficacy; BMI = Body Mass Index.

*p < .05;
**p < .001.
motivational self-efficacy ($p = .005$, $\eta^2 = 0.081$), maintenance self-efficacy ($p > .001$, $\eta^2 = 0.119$), recovery self-efficacy ($p = .040$, $\eta^2 = 0.049$), positive outcome expectancies ($p = .010$, $\eta^2 = 0.070$), negative outcome expectancies ($p = .028$, $\eta^2 = 0.055$), and coping planning ($p = .014$, $\eta^2 = 0.065$) between stage transitions (Table 5, Supplement Figure 2).
Progressing individuals showed higher scores on changes in positive outcome expectancies (95% CI [0.23; 0.82]), motivational self-efficacy (95% CI [0.22; 2.55]), maintenance self-efficacy (95% CI [0.49; 1.67]), and coping.
planning (95% CI [0.30; 1.88]) than those who stagnated. In addition, progressing individuals provided higher scores on changes in motivational self-efficacy (95% CI [0.08; 1.67]), maintenance self-efficacy (95% CI [0.63; 2.21]), and recovery self-efficacy (95% CI [0.28; 1.81]) than those who regressed between stages. Finally, an increase in negative outcome expectancies was higher among those who remained in their initial stage than those who progressed (95% CI [0.20; 01.37]).

DISCUSSION

The present study aimed to investigate whether changes in social-cognitive variables are associated with transitions between the three stages of the HAPA (Regression, Stagnation, Progression) in the domain of PA and FVI. Although there are a substantial number of studies examining the stages and mechanisms of PA based on the HAPA model, to our knowledge this was one of the first studies examining the transition processes of PA and FVI correspondingly. Moreover, this study assessed further and extensively the different types of self-efficacy beliefs and their relations to stage transitions to provide detailed associations among the variables with special emphasis on discontinuity patterns.

According to the participants’ self-report, 40.9 per cent met the criteria of being physically active at least 150 minutes in a regular week and 28.8 per cent
fulfilled the guidelines of eating at least five portions of fruit and vegetable a day. These numbers are comparable to recent studies on health behavior in Germany and the Netherlands (Herbolsheimer et al., 2016; Heuer, Krems, Moon, Brombach, & Hoffmann, 2015). Among our sample, about one-third of the participants managed to move from not intending to be physically active to forming an intention or even moved from the intention stage to the action stage. The same holds for regular FVI.

In line with Parschau et al. (2012), our findings demonstrated that FVI stage progression was associated with an increase in self-efficacy, which included motivational, maintenance, and recovery self-efficacy. Consequently, this was one of the first studies that assess different types of self-efficacy and their relations to stage transitions. These results also match previous findings of studies that examined the interplay between self-efficacy and FVI stage progression (De Vet et al., 2006; Wiedemann et al., 2009). The idea that the belief in the ability to perform a new health behavior over a long period, even in difficult situations, is important when an intention has already been formed (e.g. volitional phase).

Additionally, moving from one FVI stage to the next (e.g. progression from the non-intender stage to the intender stage) was associated with an increase in positive outcome expectancies and a decrease in negative outcomes. This is also in line with the findings by Wiedemann et al. (2009) and Armitage (2006). They found that participants who had more positive evaluations of a certain diet also had stronger intentions when compared to those at earlier stages of change. There is convincing evidence that the perceived consequences of FVI play an important role in individual goal setting, specifically when moving through behavioral stages (Schwarzer et al., 2017).

Furthermore, an increase in planning of how to overcome anticipated barriers (e.g. coping planning) for FVI was found among those who managed to translate their intentions into behavior and progressed. Unlike in previous studies (Armitage, 2006; Parschau et al., 2012), neither changes in action planning nor risk perception was related to FVI stage transition. Overall, the results support discontinuity patterns rather than linear or non-changing prediction patterns for the different stage transitions, and with that also support the assumption that behavior change can be modelled with stages and stage movements (e.g. Sutton, 2000).

Finally, and in contrast to our theoretical assumptions, contradicting previous research, changes in social-cognitive variables were not associated with PA stage progression. We cautiously attribute this to the low sample size, and hence the small effect sizes. The failure of the evaluated variables to predict stage transitions might also be due to the unspecific operationalisation. For instance, Wiedemann et al. (2009) suggested that in contrast to experimentally manipulated action planning, self-induced action planning, as measured in the present study, might not be sufficient to facilitate the transition from one stage to the next. The same might be true for unspecific items on risk perception.

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Limitations

Our study has some limitations that need to be discussed with regard to future research. First, this study follows the idea that behavioral stages are distinct and can be identified following specific stage theories of health behavior change which can be empirically identified (e.g. by investigating discontinuity patterns by non-linear, higher-order trends). However, it has to be noted that non-linear, higher-order trends only speak against a linear underlying continuum of health behavior change (Sutton, 2000). Following this understanding, investigating discontinuity patterns by non-linear, higher-order trends only represents the first step in understanding stage-change in health behaviors (Weinstein et al., 1998). A recent cross-sectional study that applied latent class analysis to identify non-intenders, intenders, and actors by social-cognitive variables and which compared them with the self-allocation of study participants to one of the three stages came to the conclusion that participants might underestimate themselves when self-indicating their stage allocation. This might point towards a problem in participants’ self-awareness when answering questions on social-cognitive predictors for health behavior change and a stage measure. However, this study also relied on the identification of discontinuity patterns (Wienert, Kuhlmann, Storm, Reinwand, & Lippke, 2019). Future studies should investigate this further.

Second, the small percentage of participants who progressed from non-intention to the intention stage, non-intention to the action stage, and from intention to the action stage, respectively, lead us to merge all participants who progressed into one group. This precludes any specific interpretation for each of these subgroups, for example, moving out of the pre-intentional stage or out of the intentional stage (Parschau et al., 2012; Wiedemann et al., 2009). Furthermore, given the comparably small sample sizes across groups, statistical tests are likely to be underpowered (i.e. < 80%), therefore increasing the risk for a Type II error. Hence, the results have to be interpreted with caution, as there is a chance that some null hypotheses are falsely retained. This should be investigated in more detail in subsequent studies by recruiting a larger sample in a progression-supporting environment.

Third, our study participants form a rather heterogeneous group of people interested in changing their behavior. A physician rating, medical diagnosis, or objective index of medical severity should be included as controls in future studies. In general, the sample size was small and the results have to be viewed with caution. Furthermore, our study relied on non-interventional data to initially test our assumption. Future studies might also explore the specific effects of behavior change techniques taught to the study participants to actively facilitate stage transition (Connell et al., 2019).

Fourth, it cannot be excluded that there was a ceiling effect of PA or FVI stage as the percentage of actors was already quite high at baseline. Even though the stage measure has proven valid before, it might be the case that participants overestimated their behavior. In the same sense, this study used self-report
measurements, which may suffer from a lack of accuracy due to under- or over-
estimation of the individuals’ actual health behavior. This is especially the case
for physical activity, which is a complex behavior that cannot be defined only by
frequency and has been shown to have no interaction with social-cognitive vari-
ables in some previous studies (e.g. Dishman, Dowda, McIver, Saunders, &
Pate, 2017). Accordingly, objective data to validate the reported behavior with
staging is warranted in future research.

Fifth, difference scores using subtraction to deduct one value from another can
result in additional bias. One of the biggest deficits of differences scores is the
assumed lack of reliability such as suboptimal internal consistency. Additionally,
the low correlation between change in action planning and coping planning is unu-
usual when compared to previous research. However, our finding rather validates
that action planning and coping planning are distinct constructs, with action plan-
ing functioning more in intenders adopting the new behavior and coping planning
rather helping to cope with obstacles, that is, in intenders and actors exhibiting
some behavior change. Replication of the findings is accordingly needed.

Sixth, the high attrition rate in our study needs to be addressed. Previous studies
show that web-based interventions typically come with high dropout rates (Eysen-
bach, 2005; Reinwand et al., 2013). Among the present sample, we did not find
any personal characteristics that could explain the high dropout (Storm et al.,
2017), and other research has shown that the appropriate use of the intervention
may differ given certain participant characteristics, for example, educational level.
We assume that a large number of the participants signed up for the internet-based
intervention due to their interest in the topic and motivation to change their behav-
ior as various recruitment strategies were employed (e.g. social media, rehabilita-
tion facilities). This could be one explanation for the high dropout rate as no
intervention was provided to this group. Furthermore, the length of the question-
aire, layout, or navigational difficulties through the intervention could partly
explain the high dropout. For future studies, we recommend to further investigate
the characteristics of dropout and nonresponse to eHealth interventions. In their
systematic review, Kelders et al. (2012) showed that user adherence is partly pre-
dicted by differences in technology and interaction in internet-based interventions.

Finally, although our study visualises longitudinal relationships, the presence
of an association between change in social-cognitive variables, PA and FVI does
not permit an interpretation of a potential causal relationship. We suggest an
experimental design for future studies with more frequent follow-ups, investigat-
ing the effect of manipulating such factors relating to behavior, as evidence of
causality can only be obtained from an intervention/experimental study.

Conclusion

To conclude, the results of our study provide partial support for the usefulness of
the stage construct by utilizing discontinuity patterns, and to model health
behavior change. The results on self-efficacy, outcome expectancies, as well as action and coping planning might inspire future research on stage-matched interventions for FVI. The importance of stage-specific predictors of PA stage transition have yet to be tested. In general, a larger sample size that allows for differentiated subgroup analyses and experimental design with more follow-up are desired in future research.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests.

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