Dynamic Psychological and Behavioral Changes in the Adoption and Maintenance of Exercise

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Objective: Although health cognitions are regarded as key determinants for health behavior change, they are rarely studied from a dynamic perspective, evaluating the impact of changes in cognitions on changes in behavior. In the present study, we examine how changes in phase-specific and generic health cognitions influence first, the adoption of exercise and later, the maintenance of the newly acquired behavior. Methods: Participants were middle-aged, Finnish adults participating in a lifestyle intervention to prevent Type 2 diabetes (N = 389). Health cognitions and exercise were measured at baseline (preintervention) and twice after a lifestyle intervention took place (at 3 months and after 1 year). Results: The results show that both phase-specific and generic health cognitions changed during the intervention. However, these changes were most pronounced within those participants who started at a lower level to begin with. Most important, evidence for the dynamic interplay between changes in health cognitions and health behavior was observed: Phase-specific health cognitions facilitated the adoption as well as the maintenance of behavior changes. Conclusions: Thus, health cognitions are amenable to change, and these changes are adaptive in terms of initiating and maintaining health behavior change. This has implications both for practical intervention research, as well as for theory development.

Keywords: health behavior change, exercise, self-efficacy, planning

Unhealthy behaviors are the greatest global public health challenges of the 21st century. More specifically, physical inactivity and unhealthy diet have been identified as key risk factors for conditions such as obesity, Type 2 diabetes, cardiovascular diseases, and cancer, which together are responsible for 85% of deaths and 70% of the disease burden in the European Region (World Health Organization, 2002). Recognizing the unique opportunity that exists to substantially reduce deaths and the burden of disease on a population level by improving health behaviors, psychologists have sought to better understand the processes underlying individuals' health behavior.

Generic and Phase-Specific Health Cognitions During Behavior Adoption and Maintenance

Psychological determinants for the adoption and maintenance of health-promoting behaviors have mainly been identified within a

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social-cognitive framework. Continuum models such as the Theory of Planned of Behavior (Ajzen, 1991) commonly assume that individuals can be located along a continuum reflecting the likelihood of action predicted by a specific set of health cognitions, such as self-efficacy, outcome expectancies, and intentions (Renner & Schwarzer, 2003; Schwarzer, 2008; see also Connor, 2008, and Velicer & Prochaska, 2008, for a discussion). Continuum models imply that the influence of health cognitions (e.g., self-efficacy, Bandura, 1997) is consistent across the behavior change process including initiation and maintenance (see Rothman, 2000). Accordingly, health cognitions operate in a "generic" way. In particular, affective and emotional obstacles such as feeling anxious or depressed can arise independent of the behavior change phase, and lack of self-efficacy in overcoming these obstacles can endanger the behavior adoption as well as the behavior maintenance phase. Similarly, lack of social support or social pressure can challenge the course of behavior change in any phase. McAuley (1992, 1993) called such generic self-efficacy beliefs "barrier" self-efficacy and showed that it is predictive of physical activity in the adoption phase (during intervention at 3 months) and the maintenance phase (4 months' postintervention; see also McAuley, Jerome, Elavsky, Marquez, & Ramsey, 2003). More recently, Blanchard et al. (2007) observed in a longitudinal intervention study that barrier self-efficacy was a significant mediator of physical activity across different measurement points in time. Further supporting this notion, studies have shown that as barrier self-efficacy improved, eating habits also improved and weight loss was greater (Roach et al., 2003; Warziski, Sereika, Styn, Music, & Burke, 2008).

Stage models such as the Transtheoretical Model of Stages of Change (TTM; Prochaska & DiClemente, 1983) or the Health Action Process Approach (HAPA; Schwarzer, 2008) conceptualize health behavior change as a process that unfolds in qualitatively different stages implying that the impact of health cognitions is phase-specific rather than generic. Accordingly, the psychological factors underlying the initiation of a change in behavior are different from those that underlie the process of maintaining successfully enacted changes (e.g., Baldwin et al., 2006; Connor, 2008; McAuley et al., 2011; Rothman, 2000; Schwarzer, 2008). For example, the HAPA model proposes that different self-efficacy cognitions play different roles depending on the stage of the behavior change process (Schwarzer, 2008; Schwarzer & Renner, 2000, see also McAuley, 1992; McAuley et al., 2011). Specifically, in the motivational phase, people need to be confident in their capability to set ambitious goals and to take initiative to become physically active ("action self-efficacy"; Schwarzer & Renner, 2000; Schwarzer, 2008; see also "motivational self-efficacy"; Schwarzer et al., 2007). Conversely, they need to be confident in keeping the behavior up when facing obstacles during the maintenance phase, or when resuming after a setback ("coping self-efficacy," Renner & Schwarzer, 2003; Schwarzer & Renner, 2000; see also "maintenance self-efficacy," Luszczynska & Sutton, 2006 or "recovery self-efficacy," Schwarzer et al., 2007; cf. also "adherence self-efficacy," McAuley, Lox, & Duncan, 1993). In line with this contention, research has shown that "action selfefficacy" facilitates the motivational phase where people develop an intention to change, whereas "coping self-efficacy" mainly impacts the maintenance phase where they already act, but have to struggle with the maintenance of the behavior change (Gutiérrez-Doña, Lippke, Renner, Kwon, & Schwarzer, 2009; Renner et al., 2008; Renner, Spivak, Kwon, & Schwarzer, 2007; Schwarzer & Renner, 2000; cf., also McAuley et al., 1993; Rodgers, Hall, Blanchard, McAuley, & Munroe, 2002). In a similar vein, a distinction has been made between "action planning" and "coping planning." "Action planning" facilitates the translation of intentions into action by specifying specific situation parameters ("when," "where") and a sequence of action ("how") during the behavior adoption phase. "Coping planning" includes the anticipation of barriers and the generation of alternative behaviors to overcome them during behavior maintenance phase (Schwarzer, 2008; Sniehotta, Scholz, & Schwarzer, 2006; Sniehotta, Schwarzer, Scholz, & Schüz,

It is interesting to note that previous studies commonly conceptualize and assess health cognitions such as self-efficacy beliefs as being either phase-specific or generic. However, one could argue that the two types, generic and phase-specific health cognitions do not necessarily exclude each other. Accordingly, both types of conceptualizations might be valid and contribute to explaining health behavior change. To address the question of the relative impact of generic and phase-specific health cognitions, both types need to be examined simultaneously in the course of the behavior change processes.

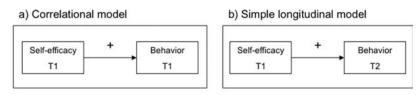
From a Static to a Dynamic View on Behavior Change

Beside these conceptual differences between continuum and stage health behavior models, most empirical approaches have

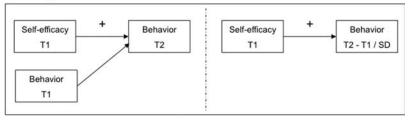
examined health behavior as a rather static phenomenon (cf., McAuley, 1993; Reuter et al., 2010; Scholz, Keller, & Perren, 2009; see Rhodes & Pfaeffli, 2010, and Velicer & Prohaska, 2008, for a discussion). Numerous previous empirical studies basically focused on determining which variables differentiate between people who display a certain health behavior and people who refrain from it. These cross-sectional studies commonly show that selfefficacy is associated with health behaviors (Figure 1). For example, Booth, Owen, Baumann, Clavisi, and Leslie (2000) showed that physically active respondents had a higher barrier self-efficacy compared with inactive respondents. Other studies have considered prospective associations between health cognitions measured at a first point in time and behaviors measured at a second point in time (Figure 1b). However, studies such as these fail to assess any changes in behavior. Hence, the results obtained are inconclusive to whether a positive association between cognitions and behavior reflects a causal relationship. More advanced prospective models look at the change in behavior over time (e.g., changes in physical activity either at the mean-level or in the rank order) and whether this change can be predicted by previously measured health cognitions (Figure 1c). Baldwin et al. (2006) for example reported that self-efficacy measured 2 months after the end of an 8-week smoking cessation program (SCP) predicted cessation 7 months later and that self-efficacy measured at 9 months after SCP predicted cessation 6 months later. It is important to note that this is still only a semidynamic perspective because only health behavior changes across time are assessed, whereas the predictors of the behavior changes remain static. This applies also for analyses specifying health cognitions as mediators of subsequent behavior changes (e.g., Hallam & Petosa, 2004). Thus, such prospective behavior studies show us that people who begin with high self-efficacy are more likely to change their behavior afterward than people who begin with low self-efficacy.

However, to understand what actually drives behavior changes, we need to adopt a dynamic perspective and to study whether changes in predictors are followed by changes in behaviors (Rhodes & Pfaeffli, 2010; Velicer & Prochaska, 2008). Thus, psychological change entailing changes in beliefs and attitudes and behavioral change entailing changes in actual behavior need to be conceptualized as dynamic processes; whereby, behavior changes should be preceded by psychological changes (Figure 1d). For example, an increase in one's perceived capacity to become physically active (action self-efficacy) should play an important role in prompting behavior initiation. Likewise, an increase in action planning should be followed by a higher behavior adoption rate because action planning facilitates the transition from intention to action (Renner et al., 2008; Reuter et al., 2010; Scholz et al., 2009; Schwarzer, 2008). Focusing on the maintenance phase, an increase in coping self-efficacy and coping planning should be associated with successful maintenance of behavior change (Sniehotta et al., 2006).

However, changes in cognitions and behaviors might be empirically difficult to separate from each other because in reality people might not show a marked change in health cognitions followed by a marked behavior change, but might show small changes in cognitions and behavior which constantly feedback upon each other instead. Thus, it may be more appropriate to conceptualize psychological changes as either accompanying or preceding behavioral changes. In both cases,



 c) Adjusted longitudinal model: Two alternative ways to look at static predictors and dynamic behavior



d) Change model: Dynamic predictors and dynamic behavior

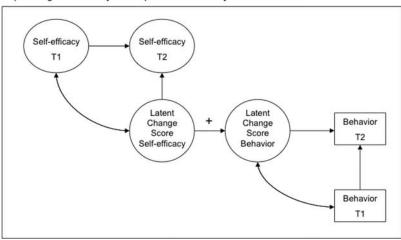


Figure 1. Static and dynamic models of the relation between health cognitions and health behavior change.

it indicates a dynamic process. Moreover, if changes in cognitions are predictive for behavior change, cross-sectionally measured cognitions should not contribute significantly to the prediction of behavior change.

Taken together, we assume that from both a theoretical and a practical view, adaptive changes in psychological determinants are of crucial importance to behavior adoption and maintenance. However, while a wealth of studies have examined the impact of attitudes and beliefs on behavior changes, the aspect of adaptive changes of generic and phase-specific health cognitions and their impact on the adoption and maintenance of health behavior has been comparably neglected so far.

The Present Study

The current study examines psychological changes and their subsequent impact on exercise changes and maintenance among overweight adults participating in a lifestyle counseling intervention to prevent Type 2 diabetes (Absetz et al., 2007). The intervention aimed specifically at health cognitions, that is, it promoted self-efficacy and planning of the "when," "where," and "how" of

specific behavior changes including increasing exercise. Hence, it provides an opportunity to examine health cognition changes and behavioral initiation over time from a dynamic perspective. Furthermore, follow-up measures extending to 12 months allow for examining adaptive changes that might explain successful maintenance of the behavior, and thereby extend the classical behavior adoption phase by a behavior maintenance phase (Rothman, 2000).

The aims of the present study were twofold: (1) In a first step, we tested whether initial health cognitions (action self-efficacy and action planning) as well as generic health cognitions (barrier self-efficacy) were positively related to health behavior adoption in order to replicate previous cross-sectional findings. We then took a dynamic perspective and tested whether adaptive changes in these phase-specific cognitions were related to the *adoption* of a novel behavior. Specifically, it was tested (a) whether changes in action self-efficacy and action planning, health cognitions related to the behavior adoption phase, enabled the initiation of behavior change, and (b) whether generic health cognitions (barrier self-efficacy) contribute exploratory power above and beyond these two phase-specific health cognitions.

(2) In a second step we tested whether adaptive changes in phase-specific health cognitions related to the maintenance of the newly acquired behavior (coping self-efficacy, coping planning) and generic health cognitions (barrier self-efficacy) predicted the actual maintenance of the newly acquired behavior. The maintenance of a behavior is commonly defined as an action sustained over a certain period of time (Rothman, 2000) such as 12 months as in the present study. To examine the question whether adaptive changes in cognitions were related to the maintenance of the newly acquired behavior, maintenance analyses were focused on those participants who had been inactive at baseline but who had become active at the second measurement point, 3 months later. When these exercise adopters maintained their exercise level over 12 months, they were classified as "maintainers." In contrast, if they showed a relapse between month 3 and month 12, they were classified as "relapsers."

Method

Study Design and Procedure

The present study was part of the GOAL program (Good Ageing in Lathi region, Ikihyvä Päijät-Häme) aimed at improving diet behavior, physical activity, and reducing obesity, objectives shown to be effective in delaying and preventing the onset of Type 2 diabetes (Tuomilehto et al., 2001). The study realized a prospective longitudinal design with a (preintervention) baseline (T1) measurement, and two follow-up measurements at 3 months (T2) and 12 months (T3). Questionnaires assessing health cognitions were conducted at T1 and T2, and physical exercise was measured at T1, T2, and T3. The intervention was delivered as group counseling with an intensive period of five fortnightly sessions between T1 and T2, and a booster session at 8 months. The sessions targeted participants' self-efficacy and planning skills for the adoption and maintenance of a healthy diet and physical activity using theory-driven techniques such as modeling, reattribution of previous experiences, verbal feedback, goal-setting, selfmonitoring, and planning (for a detailed description of program content, objectives, sample, and design, see Absetz et al., 2007; Hankonen, Absetz, Renner, Ghisletta, & Uutela, 2010; Uutela et al., 2004). A vast majority of the participants attended all six counseling sessions (N = 327, 84%).

Participants

In total, 389 participants (73% women) aged 50-65 years who were assessed as having an elevated Type 2 diabetes risk as indicated by the FINDRISC score (Lindstrom & Tuomilehto, 2003) were recruited at nurses' appointments in the primary health care centers in Päijät-Häme province, Finland. Exclusion criteria were mental health problem or substance abuse likely to interfere with participation, acute cancer, and myocardial infarction during the past 6 months. At the baseline, 95.5% of the participants were overweight or obese. Four participants had to be excluded from analyses because they did not fill in the baseline questionnaire (T1). Attrition rate from baseline (T1) to the first follow-up measurement was 5% (T2, N = 365) and 15% (T3, N = 325) to the second.

Participants provided written informed consent, and were treated according to American Psychological Association ethical standards. Moreover, the ethical commission in Päijät-Häme hospital district and the Ethical Committee of the National Public Health Institute (now National Institute for Health and Welfare) approved the project.

Measures

Self-efficacy for physical exercise. Self-efficacy for physical exercise was assessed by nine items in accordance to Schwarzer and Renner (2000; cf., also Hallam & Petosa, 2004; McAuley, 1992; McAuley et al., 2011; Schwarzer, 2008). The item lead-in was "In the following, we have listed different factors that might make it difficult to exercise on a regular basis. How certain are you that you could overcome the following barriers?" followed by the item stem "I am confident that I will engage in regular physical exercise . . ." and by the nine items detailing typical barriers that may hinder the behavior. In particular, action self-efficacy was measured with two-items ("... even if I have to make a detailed plan; . . . even if I have to rethink my entire way of exercising."), Cronbach's alpha at T1 = .92 and T2 = .86. Coping self-efficacy was assessed with three items ("... even if I have to try several times until it works; ... even if I need a long time to develop the necessary routines; . . . even if didn't get much support from others in my first attempts"), Cronbach's alpha at T1 = .90 and T2 = .88. Barriers self-efficacy was measured with four items ("... even when I have worries and problems; . . . even when I feel depressed; ... even when I feel tense; ... even when I am tired"), Cronbach's alpha at T1 = .94 and T2 = .94. All answers were given on a 4-point rating scale (1 = completely disagree and 4 = completelyagree).

Planning. Planning was assessed according to Sniehotta et al. (2005) and responses were given on a 4-point rating scale with 1 = completely disagree to 4 = completely agree. Specifically, action planning was measured with four items (e.g., "I have made a detailed plan regarding when to exercise"), Cronbach's alpha at T1 = .94 and T2 = .95. Coping planning was assessed with four items (e.g., "I have made a detailed plan regarding what to do if something interferes with my plans"), Cronbach's alpha at T1 = .92 and T2 = .91.

For all four types of health cognitions, action self-efficacy, coping self-efficacy barriers self-efficacy, action planning, and coping planning, measurement was comparable across time points indicated by invariance probed by confirmatory factor analysis (CFA). The percentage of participants at ceiling which could not further increase their self-efficacy or planning at T1 was between 4% (action planning) and 15% (coping self-efficacy). Following Randolph's (2007) definition for a substantial ceiling effect with $1.645^* SD + M > 4$, shows that all five independent variables were below the value of 4 supporting the notion that ceiling effects were not substantial in the present data.

The outcome measure, *physical activity* includes all moderate-to-vigorous PA that the participants engage in their leisure time such as gymnastics, ball games, and jogging, but none of the typically low intensity physical activities such as commuting or household chores. Specifically, exercise was measured as average minutes per day, monitored over a 1-week period, with every 10 min of activity recorded in a diary at T1, T2, and T3. For data

analyses, the daily PA reports were summed up over 7 days in order to form a weekly PA measure. When studying exercise maintenance, a cut-off point of 60 min per week was used. We used moderate-to-vigorous-intensity PA because it increases the magnitude of weight loss and results in greater reduction of fasting serum glucose than lower intensity exercise (Shaw, Gennat, O'Rourke, & Del Mar, 2006). Compared with self-report questionnaires, daily PA diaries commonly demonstrate a lower recall bias and thus, an enhanced reliability and validity (Wilcox & Ainsworth, 2009).

Statistical Analysis

The few previous studies examining changes in health cognitions and health behavior have commonly used a Baron and Kenny mediation approach (e.g., Napolitano et al., 2008; see also Rhodes & Pfaeffli, 2010), which unfortunately has the disadvantage of a greater influence on measurement errors and the lack of differentiation between mean-level changes and interindividual differences in intraindividual change.

In order to examine the relation between change in health cognitions and changes in behaviors, we used Multiple Latent Change Score Modeling (MLCSM; McArdle, 2009). MLCSM allows for separating baseline scores from change scores and corrects for measurement errors in both types of scores. Thus, specifying changes on the level of latent factors has the advantage

of representing absolute change on the level of error-free common scores (McArdle, 2009). By doing so, the problem of typically low reliabilities of difference scores is circumvented. Moreover, the latent change model provides estimates of latent change variance components. Statistically significant variances in changes indicate the existence of interindividual differences in intraindividual change. This suggests that participants profited to different degrees from the intervention for example, they did not increase self-efficacy to the same degree. Second, the change model also provides covariance estimates between change factors. These covariances are the basis for specifying directed effects across change factors.

Statistical analyses were conducted with Mplus 5.1 (Muthén & Muthén, 2007). Missing data were handled by the Full Information Maximum Likelihood algorithm which allows for unbiased parameter estimates and maximizing data availability (Graham, 2009).

To examine the first study question, whether changes in initial health cognitions (action self-efficacy and action planning) as well as generic health cognitions (barrier self-efficacy) were positively related the *adoption* of exercise, three factors were specified in the MLCSM for each of the three health cognition: (a) a latent baseline factor at T1, (b) a latent baseline factor at T2, and (c) a Latent Change Score capturing the change in the respective health cognition between T1 and T2 (Figure 1d and Figure 2). The SEM models estimated the mean as well as the variance of the baseline

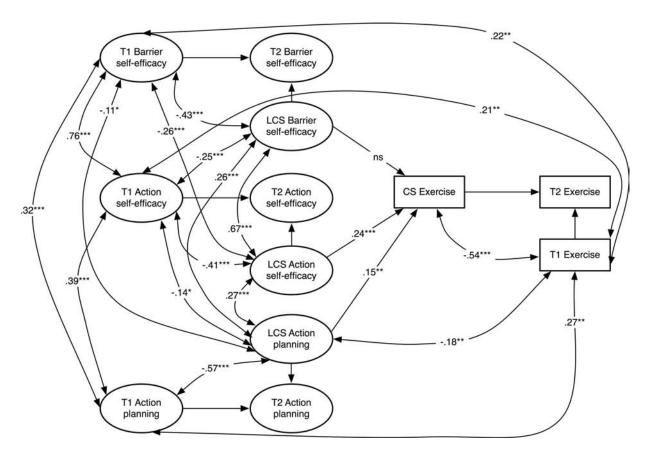


Figure 2. Changes in phase-specific and generic cognitions and their effect on behavior adoption: A multiple latent change score model (only significant parameters are displayed).

and change scores. Because the change across time is likely to depend on the initial baseline level, the baseline and change scores were allowed to correlate. Exercise was measured through one variable and was therefore specified as a manifest variable in the model. In total, three different MLCSM were tested predicting exercise initiation. In Model 1, the dynamic psychological changebehavior change perspective was tested assuming that changes in health cognitions predict changes in behavior. Accordingly, changes in action self-efficacy, barrier self-efficacy, and action planning should be related to change in exercise (Figure 1d and Figure 2). Next, Model 1 was compared with less comprehensive models to test whether the changes in health cognitions significantly contributed to a better data fit and explanation of the observed changes in exercise. Model 2 was used to test whether generic cognitions contribute beyond and above phase-specific health cognitions. Therefore, the impact of changes in barrier self-efficacy on change in exercise was set to zero. Model 3 tested whether changes in phase specific health cognitions—action selfefficacy and action planning-significantly facilitated change in exercise. Thus, these two paths were set to zero in Model 3.

The model's adjustment is evaluated on the basis of the χ^2 index and its degrees of freedom (df), the Comparative Fit Index (CFI), and the Root Mean Square Error of Approximation (RMSEA). A CFI >0.95 and a RMSEA <0.08 are indicative of a good fit between the model and the data. The χ^2 index allows for comparing the three models (Model 1 -3) that are nested, meaning that two alternative models that only differ in a set of parameters, estimated in one model but set to zero (hence not estimated) in the other, can be judged against each other to evaluate which best fits the data. If the χ^2 difference test, comparing two nested models, yields a nonsignificant result, the model with fewer parameters and, respectively, more degrees of freedom, is judged to fit the data better than the other model. In all models, all covariances between T1 levels and change scores were allowed to be estimated, and in all factors, the residual variances were allowed to be correlated.

To examine the second study question, whether adaptive changes in cognitions were related to the *maintenance* of the newly acquired behavior, analyses were focused on those participants who positively changed their behavior during the first three months. Accordingly, only participants who had been inactive at baseline T1 (less than 60 min of exercise per week) but who had became active at the second measurement point at T2 (at least 60 min of exercise per week) were included in these analyses. When these exercise adopters maintained their exercise level over 12 months till T3, they were classified as "maintainers." In contrast, if they showed a relapse between T2 and T3 they were classified as "relapsers." For analyzing this smaller subsample, Multiple Latent Change Score Modeling was conducted and additionally, repeated measures analyses of variance using composite scores for coping self-efficacy, barriers self-efficacy, and coping planning.

Results

A Dynamic Change Perspective on Behavior Initiation: Does Psychological Change Predict Behavioral Change?

At T1, before the participants had received any counseling, the expected positive correlations between phase-specific health cog-

nitions and exercise emerged: Participants who displayed higher action self-efficacy (r=.24, p<.001) and action planning (r=.26, p<.001) also demonstrated higher rates of exercise. Likewise, a positive correlation between the generic barrier self-efficacy and exercise (r=.22, p<.001) was observed. After replicating previous cross-sectional findings, the question emerges (a) whether changes in action self-efficacy, action planning, and barrier self-efficacy occurred; (b) whether these psychological changes predict changes in exercise initiation; and (c) whether both changes in generic and in phase specific self-efficacy beliefs were both important predictors of changes in exercise.

Psychological changes. During the first 3 months of the intervention, the mean level of action self-efficacy did not change when adjusted for unreliability. Specifically, the mean of the latent change score (LCS) between action self-efficacy measured at T1 and T2 is .04 and not significant (raw scale scores at T1, M = 3.0, SD = .49 and at T2 M = 3.0, SD = .55). However, the variance of the latent change score for action self-efficacy is significant (.27, p < .001), indicating change heterogeneity in the amount of change in action self-efficacy within the sample. Thus, participants showed interindividual differences in intraindividual change in their action self-efficacy. Accordingly, the analyses show a significant correlation between action self-efficacy at T1 and the latent change score for action self-efficacy measured at T1 and T2 (-.41, p < 001). Thus, participants who had started with a lower level of action self-efficacy profited more from the intervention and showed a higher amount of positive change in action self-efficacy than participants who had a comparably high action self-efficacy level to start with (cf., Figure 2).

The mean level of *barriers self-efficacy* increased significantly during the intervention with a latent change score of .09 (p < .01) (raw scale scores at T1, M = 2.8, SD = .63 and at T2 M = 2.9, SD = .66). However, the degree of change in barriers self-efficacy observed showed marked heterogeneity, as indicated by the significant variance of the latent change score (variance of the LCS barrier self-efficacy = .37, p < .001). Again, participants with a lower baseline level of barriers self-efficacy experienced larger increases over time (correlation of T1 level and LCS -.43, p < .001).

Action planning also showed a significant increase from T1 to T2 with a mean latent change score of .27 (p < .001) (raw scale scores at T1, M = 2.4, SD = .72 and at T2 M = 2.7, SD = .69). Similarly to the observed changes in action and barrier self-efficacy, a substantial heterogeneity in the amount of change in action planning occurred (variance of the LCS action planning = .57, p < .001). Participants who started at a comparably lower level of planning showed the greatest changes over time as indicated by the significant correlation between T1 level and LCS (-.57, p < .001).

Effect of psychological changes on changes in behavior. During the first three months of the intervention, the mean level of exercise did not change significantly. Specifically, the mean of the change score (LCS) between exercise measured at T1 and T2 was 3.7, and is not significant (M at T1 = 68.6 minutes per week, SD = 104.9; M at T2 = 72.2 minutes per week, SD = 111.7). However, the variance of the change score of exercise is significant (variance of the LCS exercise = 17,233.854, p < .001), indicating substantial heterogeneity in the amount of change in exercise within the sample. Thus, participants changed their exercise level to different

degrees. Accordingly, the analyses shows a significant correlation between exercise at T1 and the change score for exercise measured at T1 and T2 (-.54, p < 001). It is important to note that the power of variance in change is particularly low, especially when there are fewer than 4 repeated measures. Thus, the observed significant variance in exercise change with only two repeated measures indicates that the underlying effect size of the variance in change in exercise is quite strong (Hertzog, von Oertzen, Ghisletta, & Lindenberger, 2008).

In the next step, we analyzed whether changes in action self-efficacy, action planning, and barrier self-efficacy predicted changes in exercise.

Model 1 assumed that changes in all three health cognitions predict changes in exercise behavior. Statistically this equates to an estimation of the regression coefficient between the latent change score of the respective health cognition and changes in the individual exercise behavior. Thus, Model 1 estimates the regression coefficient for (a) phase-specific action self-efficacy, (b) generic barrier self-efficacy, and (c) phase-specific action planning on behavior changes. The Model Fit Indices indicate a satisfactory Fit to the data with CFI = .97, TLI = .96, and RMESA = 0.05 and a χ^2 of (195) = 421.53, p < .001 (cf. also Figure 2).

In Model 2, the regression coefficient between changes in the (generic) barrier self-efficacy and changes in behavior was set to zero. This more parsimonious model did lead to a comparably good model fit (CFI = .97, TLI = .96, and RMESA = 0.05 and a χ^2 of (196) = 422.85, p < .001). The chi-square difference test indicates no significant change in the model fit, $\chi^2(1) = 1.32$, ns. Thus, Model 2 suggests that only changes in health cognitions tailored to the behavior initiation phase, namely changes in action self-efficacy and in action planning, facilitated an increase in exercise behavior, whereas changes in generic health cognitions did not lead to a change in exercise behavior.

Model 3 was even more restrictive, also assuming that changes in the two phase specific health cognitions (action self-efficacy, action planning) were unrelated to changes in behavior. Hence, in this model, all three regression paths were set to zero. Model 3 shows a significant increase in the χ^2 value, with $\chi^2(1) = 18.1$, p < .001, in comparison to less restrictive Model 2, indicating a deterioration in the fit to the data (CFI = .96, TLI = .96, and RMESA = 0.06 and a χ^2 of (198) = 440.95, p < .001).

Thus, the χ^2 difference tests indicate that Model 2 fit the data best, confirming that changes in *action self-efficacy* and in *action planning* were significantly and positively associated with changes in exercise behavior. However, changes in the generic barriers self-efficacy did not contribute over and above phase-specific self-efficacy beliefs to the prediction of changes in exercise.

Maintenance of a Newly Acquired Behavior

After establishing that changes in action self-efficacy and action planning facilitated changes in the initiation of exercise behavior, the question arises whether changes in health cognitions also promote maintenance of the newly acquired behavior. Assuming that a change in health cognitions induced through the intervention was crucial for determining whether people maintained the newly acquired behavior or relapsed into inactivity, implies (a) that maintainers and relapsers did not differ at the beginning of the intervention in terms of maintenance specific health cognitions

such as coping self-efficacy and coping planning, and that (b) maintainers experienced a greater level of change in maintenance specific health cognitions than relapsers during the intervention. To analyze whether changes in maintenance specific health cognitions facilitated the maintenance of the newly acquired behavior, we identified participants who had been inactive at T1 but who became active during the intervention to T2. As a cut-off, we used 60 min per week of exercise. Altogether 58 participants fulfilled these criteria. Of these, 31 participants maintained their lifestyle change (≥60 min per week), and 27 participants relapsed (<60 min per week) at T3.

The results show that at T1, relapsers and maintainers did not differ significantly in their mean levels of coping self-efficacy (M = 3.09, SD = .45 vs. M = 3.05, SD = .56), coping planning (M = 2.24, SD = .75 vs. M = 1.97, SD = .77), or barriers self-efficacy (M = 2.71, SD = .56 vs. M = 2.65, SD = .72; all ps > .20).

MLCSM analyses that estimated multiple-group models for changes in health cognitions between T1 and T2 indicated that coping self-efficacy increased significantly within maintainers (mean LCS = .28, p < .001). Conversely, relapsers did not significantly change their coping self-efficacy between T1 and T2 (mean LCS = .09, ns). Thus, participants who were able to maintain their levels of exercise increased their self-efficacy in overcoming obstacles associated with the maintenance of the behavior change during the intervention period to a significantly greater degree than those who relapsed. Moreover, maintainers showed a significant latent change score for coping planning (mean LCS = .51, p < .01), whereas relapsers showed no significant change (mean LCS = .20, ns.). Similarly, for the generic cognition barrier self-efficacy, maintainers showed a significant increase (mean LCS = .14, p = .03), whereas for relapsers no significant change was observed (mean LCS = .05, ns).

Discussion

Why do people adopt health behaviors? This has been the key question of health psychology research over the past decades. Accordingly, the core attention has been paid to motivational processes, tackling the question how people change from a state of no interest in changing their behaviors to having decided to make a change. Recent theoretical models and empirical studies broadened this motivational view by including volitional processes, thereby extending the classical question of why people adopt health behavior to the question of how they maintain the behavior change. Thus, not only the initiation of a behavior change, but also the maintenance of these changes has gradually started receiving attention (Rothman, 2000).

Stage models assume that the initiation and maintenance phase are guided by different psychological factors (Lippke, Ziegelmann, Velicer, & Schwarzer, 2009; Prochaska & DiClemente, 1983; Reuter et al., 2010; Scholz et al., 2009; Schwarzer, 2008), whereas other conceptualizations assume more generic factors which may be equally influential in both phases (cf., Blanchard et al., 2007; Rothman, 2000). However, despite this shift to conceptualizing the successful adoption of health behavior as a dynamic process that unfolds over time, most empirical approaches have examined health behavior change as a rather static phenomenon. Commonly, static predictors (e.g., self-efficacy at T1) are used to predict

changes in behavior (e.g., change in exercise behavior between T1 and T2). We argue that we need to focus on changes in psychological factors preceding changes in behavior to understand changes in behavior. In the present study, we attempted to model whether changes in health cognitions facilitate the initiation and maintenance of health behavior. Specifically, we hypothesized that changes in action self-efficacy and action planning would be critical determinants for the adoption of physical exercise, and after people have been physically active for a significant period of time, the maintenance of their active lifestyle would be guided by coping self-efficacy and coping planning. Moreover, we were interested in whether generic health cognitions (barrier self-efficacy) contribute explanatory power over and above phase-specific health cognitions (action and coping self-efficacy/planning).

Psychological Change: Between-Person Differences in Within-Person Changes

When taking a dynamic perspective on health behavior change, the first necessary step is to demonstrate significant changes in the psychological predictors. This raises the question of which changes are meaningful? Change is most often defined as a meanlevel change, which refers to whether most people change in the same way during a specific time period. However, it appears more appropriate to assume 'between-person differences in withinperson changes" (Nesselroade & Baltes, 1979) because interventions are more likely to induce greater changes in those participants who exhibited a lower level of self-efficacy and planning to begin with. By modeling latent change scores (cf., McArdle, 2009), it is possible to estimate and test not only the classical mean of the changes, but also the variance of the changes and the covariance of the initial scores with the changes. Our results show that the observed mean level changes across time in self-efficacy beliefs and planning were only small in absolute size; thus, a "normative" change was not observed. However, it is important to note that this does not imply that the intervention was unsuccessful and the behavior changes were not related to psychological changes. It only signifies that the observed changes did not follow a generalizable pattern that applies to all participants. Further analysis shows significant variances of the latent change scores, indicating that participants who started with a lower level of action self-efficacy, barrier self-efficacy, or action planning profited more from the intervention and showed a higher amount of positive psychological change than participants who had a comparably high level to start with. This might also offer an explanation for previous studies that suggest an insignificant role for self-efficacy beliefs (e.g., Napolitano et al., 2008). Moreover, relations between the baseline level and the changes in psychological factors such as self-efficacy with health behavior changes may coexist in the same longitudinal study and may overlap to some extent. In a prospective study on exercise and diet behavior change, Maibach, Flora, and Nass (1991) found a negative relation between baseline selfefficacy and subsequent self-efficacy change similar to the present study. However, subsequent behavior change was predicted by both the baseline level and changes in self-efficacy, given that both were included in the model as predictors whereby baseline selfefficacy alone was not predictive of subsequent behavior changes. Maibach et al. (1991) concluded that to prevent changes in selfefficacy suppressing the relationship between baseline self-efficacy and subsequent behavior change, the inclusion of both static and dynamic constructs is necessary for a full account of the impact of self-efficacy (cf., also Reuter et al., 2010; Scholz et al., 2009). However, from a conceptual and practical point of view the impact of the changes in psychological factors appears to be more significant.

Psychological Change and Behavior Change

Our findings provide evidence that changes in health cognitions are predictive for the adoption and maintenance of health behavior. Regarding the influence of changes in action self-efficacy and action planning on the initiation of exercise behavior, the data show that changes in both positively predicted the uptake of an active lifestyle. It is interesting to note that change in generic self-efficacy did not facilitate the initiation of exercise behavior. Turning to the maintenance phase, the data show that those participants who managed to maintain their newly acquired exercise behavior showed a significantly greater change in coping selfefficacy and coping planning than those who resumed their previous, sedentary lifestyle. Moreover, a similar pattern was observed for generic self-efficacy: Maintainers showed a greater change than relapsers. Thus, stage models differentiating between a qualitatively different motivational and volitional phase receive unequivocal support from the present data.

One might argue that the results, or rather the lack of results for the generic "barrier" self-efficacy across the behavioral change phases, provide even more support for the notion that psychological factors exert their influence in a phase-specific way. Because barrier self-efficacy did change, in comparison to the two phasespecific self-efficacy beliefs through the intervention, but only exerted a significant influence within the maintenance phase, one could argue that it actually represents a phase specific rather than a generic psychological factor.

Moreover, the present results point to an important implication for measuring the impact of psychological factors, in particular self-efficacy, on behavior changes. For example, Baldwin et al. (2006) reported that preceding self-efficacy levels were only predictive of behavior initiation but not behavior maintenance. Conversely, Williams et al. (2008) reported that self-efficacy levels only predicted the maintenance but not the adoption of a behavior. Accordingly, both argued that self-efficacy, although a critical determinant of people's behavioral practices, may only be of significance in a specific phase of the behavior change process. The puzzling aspect is, however, that the effectiveness is suggested for different phases in the behavior change process. Moreover, in the present study, self-efficacy was predictive for both the initiation and maintenance phase, thereby raising the question: How can these inconsistencies reconciled? Similarly to the present study, both Baldwin et al. (2006) and Williams et al. (2008) assessed the initiation and maintenance of behavior and self-efficacy at different time points. However, the crucial difference between the three studies is that both earlier studies assessed the same form of self-efficacy at various time points, hence, self-efficacy was operationalized in a phase-insensitive way that assumes a generic influence of the self-efficacy measure. In contrast, in the present study, self-efficacy was measured in a phase-sensitive way that assumes that different types of self-efficacy play roles in specific phases; this was supported by the data. Thus, the inconsistencies between the different findings may be the result of phase-insensitive versus phase-sensitive operationalizations of self-efficacy beliefs. Supporting this notion, the generic, non phase-specific measure barrier self-efficacy, was not predictive for the different phases, but only for on specific phase. This matches the results of the previous study. It is interesting to note that the self-efficacy measure used by Williams et al. (2008) tapped into overcoming similar obstacles as those included in the present barrier self-efficacy measure—for example, being in a bad mood or feeling tired—and their findings confirmed that this type of self-efficacy predicts maintenance of behavior change. Considering the present results, changes in self-efficacy appear to play a crucial role in any phase of the behavior change process but the type of self-efficacy which is of influence, changes in a phase-specific way.

Limitations of the Present Study

The prospective, longitudinal design, with its relatively long follow-up and cognitive-behavioral intervention targeting key cognitions, provided a unique opportunity to analyze the dynamics of cognition and behavior change. The measurement models showed that the health cognition measures were reliable within and across time, thereby reducing biased estimations effects. However, the observed changes in the health cognitions may reflect ceiling effects and hence, an underestimation of the intervention effect for participants who begin with a high self-efficacy. Because the proportion of participants at ceiling (4% to 15%) was rather low and below the 20% recommend by Wang, Zhang, McArdle, and Salthouse (2008), biased estimations may not be very likely but cannot be ruled out completely. Exercise behavior assessment was based on a composite score encompassing 1-week of physical activity self-monitoring sheets, which may inevitably be accompanied by self-reporting biases. Although the approach used for statistical modeling in the present study has several advantages over more traditional alternatives, a randomized controlled design would have been stronger for establishing the intervention effects on health cognitions. While our study on the interplay between adaptive psychological changes and behavior changes focused on self-efficacy and planning, other constructs may possibly follow such logic. The present constructs build on an increasingly solid evidence-base (Schwarzer, 2008) who were also main the targets of our intervention (Absetz et al., 2007). Other health-related cognitions such as subjective norms or risk perceptions are also likely to show adaptive changes that could translate into behavior change (Renner & Schupp, 2011). In future studies, it would be fruitful to examine these also from a dynamic perspective.

Conclusions

Health cognitions are amenable to change, and these changes are adaptive—that is, they are accompanied or followed by behavior changes. In order to gain a deeper insight in the underlying process of health behavior change, we suggest adopting a dynamic perspective not only on the behavioral outcome, but also on the psychological predictors. In addition, studying both generic and phase-specific constructs and adaptive changes for different types of behavior in different phases of behavior change might substantially contribute to a more comprehensive understanding of the

underlying mechanisms and to the success in efforts to promote sustainable behavior changes.

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