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Stage-specific adoption and maintenance of physical activity: testing a three-stage model

Sonia Lippke*, Jochen P. Ziegelmann, Ralf Schwarzer

Health Psychology, Freie Universitaet Berlin, Habelschwerdter Allee 45, Berlin 14195, Germany

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Abstract

Objectives: To examine a parsimonious three-stage model of health behavior change that makes a distinction between non-intenders, intenders, and actors in terms of physical activity. It was hypothesized that intention formation, action planning, and behavior change were at different levels in these three stages, and that these were differentially predicted by self-efficacy, outcome expectancies, and risk perception.

Design: Longitudinal analyses with latent multi-group structural equation models using AMOS to test discontinuity patterns in latent means and associations of variables.

Methods: To examine the discontinuity hypotheses, orthopedic out-patients were assessed at the beginning and the end of their rehabilitation as well as at 6-month follow-up ($N=423$). Stages, self-efficacy, outcome expectancies, risk perception, intention, action planning, and behavior change were assessed in self-administered questionnaires.

Results: In multi-group structural equation models, discontinuity patterns emerged. Differences in latent means, interrelations of social-cognitive predictors, and the amount of explained variance were found between the three stages. Self-efficacy was imperative for all groups of patients. Risk perception was important in intention formation for individuals who had no intention before. The intentional and the actional stages of behavior change were similar in terms of planning.

Conclusions: The findings provided support for the usefulness of the three-stage distinction, and the stage-specific prediction of behavior change. To tailor interventions, one should assess stages and address stage-specific needs.

Keywords: Physical exercise; Rehabilitation; Self-efficacy; Planning; Stage models; Discontinuity pattern; Multi-group structural equation modeling; Behavior change

* Corresponding author. Tel: +49 30 838 55619; fax: +49 30 838 55634.
E-mail address: slippke@zedat.fu-berlin.de (S. Lippke).

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Introduction

People may decide to be physically active because they become aware of the risk for their health due to physical inactivity. Some individuals may translate their intentions into action, driven by different factors; for example, they have planned precisely when to start the activity. Others, who have been physically active before, may maintain their activity because they commit to their high intentions and plans, or they relapse because they have not set the goal to maintain. Finally, those inactive persons who remain undecided and sedentary may lack a firm belief in their competence to become active (Schwarzer, 2001).

These are examples of 'stages' and motives in the adoption and maintenance of physical activity. Two classes of social-cognitive models have been developed and tested to explain and predict human behavior: continuous models and stage models (Sutton, 2002). In the following, continuous and stage models will be described, and a new approach for the investigation of stage models will be proposed and empirically tested.

Linear continuous models to predict behavior change

In continuous models, individuals are placed along a continuum that reflects the likelihood of action. Influential predictor variables are identified and combined in one equation. The assumption is that one prediction equation meets all needs ('one-size-fits-all'; Kreuter, Strecher, & Glasman, 1999). This single theoretically or empirically derived equation places each person along a continuum. The goal of an intervention is to move the individual along this continuum towards action. Thereby, quantitative differences between persons are recognized but qualitative changes in the progress are not identified (Weinstein, 1993). One assumption is, for example, that the higher an intention the more likely the corresponding health behavior.

Continuous assumptions seem not to apply in every case (Kreuter et al., 1999). The adoption and maintenance of a new behavior is too complex to be reflected by merely one decision continuum. The initiation and maintenance processes might be different (Rothman, 2000). There might be more than a single predicting rule, and the combination of continuous models with stage models represents one approach to face these qualitative differences.

Stages of health behavior change

The main purpose of stage theories is to understand the mechanisms of qualitative behavior change. Stage models of health behavior change describe how individuals move through discrete stages while preparing and realizing behavior change. According to such models, persons at different stages will think and behave in qualitatively different ways (Weinstein, Rothman, & Sutton 1998).

Stages are categories into which people can be classified according to rules of the stage theory. This approach has to explain several distinct steps along the way to action (Weinstein et al., 1998). With the stage construct, the dynamic nature of health behavior change is emphasized and made measurable. By identifying influences and factors that induce movement from one category to the next, the process of behavior change might be supported more effectively (Adams & White, 2003; Kreuter & Holt, 2001).

Weinstein (1993) argues that different procedures might be important at different stages and therefore, various predicting rules are essential. Empirical findings support that one size does not fit all (Kreuter et al., 1999) and that not 'one-big-bullet' would predict all changes (Kreuter & Holt, 2001).

Examples of stage models

A variety of stage models have been developed such as the Transtheoretical Model (TTM; Prochaska, DiClemente, & Norcross, 1992) and the Health Action Process Approach (HAPA; Schwarzer, 1992). The latter has been selected as a theoretical framework for the present study because of three reasons: (1) tailored interventions based on TTM have been shown as being unsupported for facilitating long-term behavior changes (Adams & White, 2003), (2) the HAPA has been found superior to other social-cognitive models (Garcia & Mann, 2003); and (3) due to the fact that the HAPA combines explicitly continuous and stage assumptions.

The HAPA makes a distinction between a motivation phase and a volition phase of health behavior change. The basic idea is that individuals experience a shift of mindset when moving from the first phase (that is motivational) to the second (that is volitional). The moment when people commit themselves to an intention to exercise, they enter the volitional phase. In this phase, a division into two subphases appears to be meaningful where people can be labeled as either intenders or actors. Firstly, they intend to act but they still remained inactive. Secondly, they have initiated the intended action. Thus, three phases or stages can be distinguished. In the (a) *non-intentional stage*, a behavioral intention is being developed which is similar to the contemplation stage in the TTM. Afterwards, individuals enter (b) the *intentional stage*, where the person has already formed an intention but still remains inactive (or at least not active at the recommended performance level), while the exercise behavior is being planned and prepared. If these plans are translated into action, individuals reside in (c) the *actional stage*. They are then physically active at the recommended performance level.

In other words, there are stage-specific effects of social-cognitive variables on behavior change. At each stage, variables predict cognitions and behaviors characteristic for the stage a person is in. To demonstrate and test empirically these stage-specific prediction patterns, continuous models might be combined with stage assumptions.

Stage models versus continuous models

Recent investigations have combined stage models with linear, continuous models (Courneya, 1995; Courneya & Bobick, 2000; Courneya, Nigg, & Estrabrooks, 1998; Marcus, Eaton, Rossi, & Harlow, 1994; Nguyen, Potvin, & Otis, 1997; Plotnikoff, Hotz, Birkett, & Courneya, 2001; Resnick & Nigg, 2003; Rosen, 2000). In these studies, the stage membership has been predicted additionally or alternatively to intention and behavior in these linear estimations. However, stage is conceptualized as analogous to intention and behavior probability. Thereby, the advantage of the stage variable to the intention and behavior variables is rather small. In contrary, it may be more fruitful to investigate stage as a moderator and to examine stage-dependent processes. These processes are, analogous to the assumption of most social-cognitive models, intention formation, action planning, and behavior change.

Some critiques of stage models have questioned the existence of stages or whether stages are not just arbitrary divisions of an underlying continuum (Sutton, 2002; Weinstein et al., 1998). A stage model actually exists if, in different variables, discontinuity patterns are observable (Armitage & Arden, 2002). This would mean that there is a discontinuity in the degree to which variables act upon different stages. Individuals at a particular stage should have different characteristics in comparison to those individuals

located in other stages. These discontinuity patterns may consist of mean differences in some stages and no mean differences in other stages, or an increase from one stage to the next and a decrease to the one thereafter (Weinstein et al., 1998).

Non-linear trends in cognitions at different stages would indicate such a discontinuity pattern, as it was found by Armitage, Povey, and Arden (2003). Consequently, for behavior change, the influence of certain variables is dependent on the stage a person is in. This has to be examined in longitudinal studies (Burkholder & Harlow, 2003).

Only a small amount of data has been published on stage-specific predictions of behavior change (e.g. Courneya, Plotnikoff, Hotz, & Birkett, 2001; DeVries & Mudde, 1998; Dijkstra, Tromp, & Conijn, 2003; Plotnikoff et al., 2001). Plotnikoff and colleagues (2001) have found stage-specific predictions in a physical exercise setting. They observed that higher pros were helpful for all stage groups except preparation to remain in or progress to the next stage. Lower cons were only predictive for stage movement in individuals being in the intentional and actional stages. For all stage groups, self-efficacy was helpful to prevent relapse or to progress (Plotnikoff et al., 2001). In contrary, in smoking, self-efficacy was only predictive for stage movement in the intentional stage (DeVries & Mudde, 1998; Dijkstra et al., 2003). Both studies revealed that higher pros are only helpful for stage progression in the non-intentional stage (contemplation and precontemplation) but not in preparation and actional stages. Regarding intention for exercise behavior, Courneya et al. (2001) have found a beneficial effect of higher intention for forward stage transition in all stage groups.

Discontinuity of prediction between stages

Depending on these stages, different social-cognitive variables may be more or less influential. These different influences should be detected in discontinuity patterns (i.e. non-linear trends across stages; Weinstein et al., 1998). In particular, the assumptions in the HAPA-model are displayed in Fig. 1 and will be described in the following.

In the *non-intentional stage*, an intention has to be developed. In this phase, risk perception is merely seen as a distal antecedent within the motivational phase. Risk perception is sufficient to enable

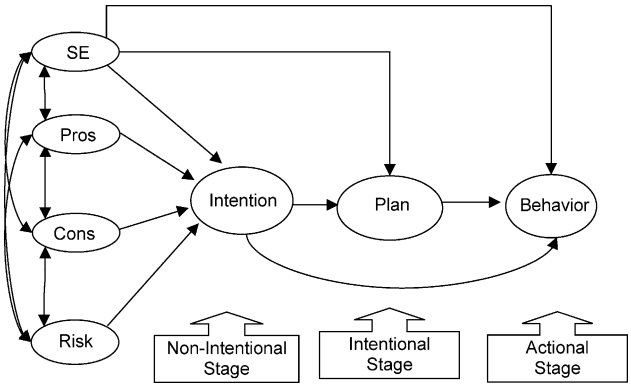

Fig. 1. Hypothetical model of relationships between factors according to the health action process approach. Note: SE, self-efficacy; Risk, risk perception.

the undecided person to form an intention. Furthermore, it is a prerequisite for a contemplation process and further elaboration of thoughts about consequences and capacities. Outcome expectancies ('pros' as positive outcomes and 'cons' as negative aspects related to the goal behavior) are assumed as being most important in the non-intentional phase, when balancing the pros and cons of a behavior. Further, the belief in one's capabilities to perform a desired action (self-efficacy) is substantial for goal pursuit. That is, perceived self-efficacy promotes intention formation and behavior implementation (Lippke, Ziegelmann, & Schwarzer, 2004a; Renner & Schwarzer, 2003; Schwarzer & Renner, 2000).

After a decision has been made, the *intentional stage* is entered. As long as the behavior has not been performed, the individual has a high intention but is not acting at present. The intention has to be transformed into detailed plans on how to perform the goal behavior. Detailed instructions on the goal pursuit may contain assisting intentions and precise action plans (Luszczynska & Schwarzer, 2003). These plans state when, where and how the goal behavior will be initiated (Lippke, Ziegelmann, & Schwarzer, 2004b). Thereby, cognitive links between concrete opportunities and the intended behavior will be built. Social-cognitive variables change their dominance and interplay. Risk perception has no further influence while outcome-expectancies remain important. Self-efficacy is also important in the planning and initiation process, especially if barriers occur or no enabling situation arises. Self-efficacy keeps the intention high and the plans flexible to compensate for setbacks and stay on track to initiation.

If the goal behavior has been initiated, the individual enters the *actional stage*. The behavior has to be controlled by cognitions in order to be maintained. Self-regulatory skills are substantial for the maintenance process. Effort has to be invested, useful situations for implementation of the new behavior have to be detected and distractions have to be resisted. The behavior will mainly be directed by self-efficacy (Schwarzer & Renner, 2000) because it regulates how effort is invested and persistence is managed if barriers and setbacks occur. The performed behavior has to be maintained, and relapses have to be managed by action control strategies.

In general, discontinuity patterns should be indicated by significant differences in means and relationships of the variables as described above. Recently, investigations on the HAPA model have tested the structural features of the model with longitudinal data without stages (Lippke et al., 2004a; Luszczynska & Schwarzer, 2003; Schwarzer & Renner, 2000) and in a two-stage approach (Renner & Schwarzer, in press). Different patterns in social-cognitive predictor sets have been found in behaviors such as nutrition and physical exercise. Fuchs (1996) tested a model similar to the HAPA separately in adoption and maintenance of physical activity. Renner and Schwarzer (in press) analyzed non-intenders and intenders separately for the domain of nutrition. Both studies revealed stage-specific patterns. No study was found on the three stages of the HAPA and, therefore, the present study focuses on this issue.

Examining the three-stage approach in the context of regular physical activities

The present study attempts to elaborate the discontinuity patterns and to examine the hypothesized relationships in the HAPA with all three stages. At first, the invariant factorial structure of the psychometric instruments will be tested. The first hypothesis is that the items comprising a particular instrument operate equivalently across the different stage groups (1) factor loadings and (2) covariances are invariant.

Secondly, hypotheses on the discontinuity patterns in latent means are the following: (3) self-efficacy will be lowest in the non-intentional stage and highest in the actional stage. Pros and cons will be lower in the non-intentional stage than in the intentional and actional stage. Only minor differences will be

found in pros and cons between the intentional and actional stages. Intention will discriminate between non-intenders and intenders as well as between intenders and actors. Planning will distinguish the non-intentional and intentional stages but not the intentional and actional stages. Non-intenders and intenders should change their behavior to a higher degree than actors do.

Finally, the stages should moderate the influence of the social-cognitive variables on goal setting and the translation of intention into behavior: discontinuity patterns are also indicated by qualitative differences in social cognitive variables, in the phases of intention formation and planning process. This shall be indicated by unique (not invariant) paths in the specified causal structure (HAPA model) across the stage groups. In particular, the hypotheses are: (4a) if non-intenders form an intention, this is highly directed by risk perception and outcome expectancies. Self-efficacy is substantial but lower than in the other stages. Only persons with high self-efficacy achieve behavior change. (4b) In the intenders, risk perception should have no further influence; outcome-expectancies remain important for high intention, while self-efficacy is more important than other social-cognitive variables. (4c) In actors, self-efficacy should be influential whereas all other social cognitive variables are of less importance than in the other stages. (4d) Intenders and actors should be similar in the way they translate intentions into behaviors, namely by a mediation of planning.

Method

Study design

The study was conducted in an out-patient orthopedic rehabilitation center, where patients received exercise therapy on a daily basis. A prospective design was used over approximately six and a half months. Prior to exercise therapy, patients were informed about the research by a sport therapist and were given an information leaflet about the study. To ensure anonymity and to encourage frank responses, all study materials had a code number, instead of the patient's name. After obtaining informed consent, patients were handed the pre-rehab questionnaires (baseline) regarding physical activity prior to rehabilitation, as well as social-cognitive variables, and demographic variables such as age, limitations in movement, and partner status. At the end of their rehabilitation period (2–3 weeks after baseline), patients were scheduled to meet with a research assistant (Wave 1) and were asked to fill out the second questionnaire. They were scheduled for follow-up with a questionnaire six months after discharge (Wave 2).

If patients failed to respond to the staging algorithm or if questionnaires contained more than 50% missing information, the corresponding data records were removed from the analyses (see Section 2.4).

A total of 624 participants took part on the study during the rehabilitation stay. Of these, 64 had to be excluded from the sample due to more than 50% missing values in their questionnaires. Of the remaining 560 participants, 450 returned their Wave 2 questionnaire. Of these questionnaires, 27 contained more than 50% missing information and had to be excluded from further analyses. As a result, the complete longitudinal sample consisted of 423 individuals.

No relevant differences were found between the remaining participants and the dropouts regarding social-cognitive variables, age, sex, and BMI (all $ps > 0.10$). Accordingly, the final data set included $n = 560$ patients of whom $n = 423$ participants had complete data for all three Waves.

Sample

The recruitment approach was as follows: Orthopedic patients in an out-patient rehabilitation center were enrolled in physical exercise therapy. They had to meet the inclusion criteria of being capable of exercising on their own and to be able to fill out a questionnaire. As the study involved telephone follow-ups, only patients with access to a telephone were recruited. The participation in the study was voluntary. Patients were diagnosed with a number of ailments, such as spinal diseases, surgery of bones, joints, muscles or ligaments, constraints in movement, chronic pain, arthrosis and arthritis, or stroke. The minority was in rehabilitation treatment due to an accident (10%).

Participants aged 15–80 years completed the surveys in the rehabilitation center ($M = 45.56$; $SD = 11.71$; Median = 44.50). The sample consisted primarily of women (62%), 68% were living with a partner, and 33% were smokers. The mean body mass index (BMI) of the women was 25.45 ($SD = 5.07$; Median = 24.13), of the men it was 26.63 ($SD = 3.59$; Median = 26.28).

Measures

This study presents data for stage assumptions and continuity assumptions of the HAPA from a larger interdisciplinary trial testing multiple theoretical models. The measurement points during the rehabilitation stay were analyzed and published separately (Lippke et al., 2004b), but stage-related questions have not been addressed before. The 6-month follow-up measurement point (Wave 2) is unique to the present paper and has not been included in previous analyses.

The questionnaires contained several psychometric scales, in addition to demographic information. Most of the following items were taken from Fuchs (1996) and adapted to the special sample of orthopedic rehabilitation patients. All item examples given below are translated from German. To have sufficient information for testing measurement equivalence, all social-cognitive factors were measured with five items and behavior change with three items. For reliability coefficients, see Table 1.

Identification of exercise stages. With this algorithm, three pre-rehab stages were assessed in a most parsimonious manner. Patients were asked "What is a typical week like for you (before the rehab started): Have you engaged in physical exercises for 20 min or longer, in such a way that you were at least moderately exhausted?" If persons responded 'yes' they were classified as actors. If they responded with 'no' they were further classified as intenders by endorsing one of the following statements "I have made the decision to take part in a new physical activity soon" or "I have made the decision to re-start a familiar physical activity soon." They were categorized as non-intenders by endorsing one of the statements "I am not thinking about exercising" or "I was thinking about exercising (again), but I have

Table 1
Reliability coefficients (Cronbach's Alpha) for the scales in the three subsamples

Sample	Risk perception (baseline)	Self-efficacy (baseline)	Pros (base-line)	Cons (base-line)	Intention (wave 1)	Action plans (wave 2)	Behavior change (wave 2)
Non-intenders	0.86	0.73	0.73	0.75	0.53	0.96	0.86
Intenders	0.83	0.72	0.79	0.63	0.58	0.97	0.87
Actors	0.88	0.67	0.71	0.71	0.57	0.95	0.85

not yet made up my mind." The stage and the following social-cognitive variables were assessed at baseline.

Risk perception was measured at Wave 1 by three items: 'Compared to other persons of your age and sex, how do you estimate the likelihood that you will ever (a) suffer from chronic pain, (b) suffer from movement limitations, and (c) get a severe disease?' Responses were given on five-point scales, anchored at *much below average* (1), *below average* (2), *average* (3), *above average* (4), and *much above average* (5).

The answers on self-efficacy and outcome expectancies were scored on a four-point scale from *not at all true* (1), *not true* (2), *a little true* (3), to *exactly true* (4). Self-efficacy, outcome expectancies and risk perception were assessed at the beginning of the rehabilitation (baseline); for Cronbach's Alpha see Table 1.

Perceived motivational and volitional *self-efficacy* at baseline was composed of five items. Participants reported how certain they were that they could exercise regularly, even when facing barriers. Motivational self-efficacy was measured with the stem "I am able to…" followed by three items "…change my lifestyle to an active one," "…exercise at least once per week," and "…exercise at least twice per week for at least twenty minutes." Volitional self-efficacy was measured with the stem "I am capable of continuous physical exercise on a regular basis,…" followed by two items "…even if I do not perceive positive changes" and "…even if I am accompanied by friends and other people who are not physically active."

For the assessment of *outcome expectancies* at baseline, the stem "If I would engage in physical exercise on two or more days, for at least 20 minutes,…" was followed by six items on positive and negative outcome expectancies. Pros were measured with "then I would feel better afterwards," "then I would be doing something good for my health," and "then I will cope better with daily hassles." Cons were assessed by "then I have to perform a lot of organizational tasks," "then other people around me feel bothered," "then I do not have enough time for other things."

Intentions to perform physical activities were assessed at Wave 1 with five items: "I intend to exercise for 20 minutes or longer on at least two days per week on a regular basis," "I intend to exercise occasionally for 20 minutes or longer on at least two days per week (at least once a month)," "I intend to perform fitness and muscle strengthening activities", "I intend to perform special exercises (e.g. for my back)" and "I intend to be physically active in my leisure time (e.g. go for a walk)." The answers on intention were assessed on a four-point scale from *not at all true* (1), *not true* (2), *a little true* (3), to *exactly true* (4). Intention was assessed at the end of the rehabilitation (Wave 1); for Cronbach's Alpha see Table 1.

Action plans were measured at Wave 2. Therefore, it was asked "How precisely did you plan your exercising on two or more days per week, for at least 20 minutes?" The participants had to rate the five statements: "I already planned precisely...which physical activity I will perform; when; where; how, and how often I will exercise." The answers on plans ranged from *not at all true* (1), *not true* (2), *a little true* (3), to *exactly true* (4). Action plans were measured half a year after discharge from rehabilitation (Wave 2).

As *behavior*, three domains of physical exercise were taken into consideration: (a) physical activities due to locomotion, (b) physical activities in daily life, and (c) deliberate rehabilitation-specific physical exercises. It was asked how these activities changed compared to times prior to the rehab. To rate these items, a five-point Likert scale with the anchors at *much lower* (1), *lower* (2), *not changed* (3),

more (4), and *much more* (5) was used. Physical exercise was assessed half a year after discharge from rehabilitation (Wave 2).

Age, sex and partner status were assessed in the baseline questionnaire. Height, body weight, being in the rehabilitation due to an accident, medical diagnoses, and smoking status were taken from medical records.

Missing values treatment

In the questionnaires, 70% of the participants answered all items, and 20% produced one or two missing values. No item had more than 13% missing values. Missing values in the intention and action planning items were imputed with SPSS MVA REGRESSION with age, gender, and responses to the other subscale items as predictors in linear multiple regression analyses (cf. Fidell & Tabachnick, 2003).

For the $n = 137$ patients with no data at Wave 2, another method to impute missing data was applied to test if the resultant pattern would change. Study drop out is a common problem in longitudinal and treatment evaluation studies in the areas of health and risk behaviors. Several strategies have been developed to handle missing data. One possible technique is, among others, the method of 'mean replacement.' Thereby, the subjects' missing outcome is replaced with means of those in the remaining stage subgroups (Hall et al., 2001).

Data analysis

Structural equation modeling with latent variables was employed to investigate the pattern of relationships within the overall data set. This method was chosen because of several reasons. Firstly, the underlying theoretical order among the factors and relationships among predictors can be tested. Secondly, a multi-sample structural equation model analyzes invariances across the subsamples. Invariances may be analyzed in the measurement of the theoretical constructs, in the relationships among theoretical constructs, the paths in a specified causal structure and in the latent means of constructs in a model. Thirdly, if the independent variables in a regression analysis are moderately to highly interrelated, there may be multi-collinearity problems. Finally, modeling with latent variables tests the relationships among factors free of measurement error. This is especially important if scale reliabilities are moderate (Bentler, 1990; Burkholder & Harlow, 2003; Byrne, 2001).

Multi-group structural equation modeling. A sequence of nested models ranged from an unconstrained multi-sample model with the parameters freely estimated across subsamples, to more parsimoniously nested models that include different levels of equality constraints (Kenny, 2002). The following models will be estimated in this study:

- *Unrestricted model*: noninvariant, unconstrained model;
- Model 2—measurement equivalent model: equal factor loading across the subsamples;
- Model 3: model 2 constraints plus equal factor variance and covariances;
- Model 4: model 3 constraints plus equal paths;
- Model 5: model 4 constraints plus equal factor residuals ('fully constrained').

The equality of variances and covariances is specified subsequently to the model 2 because the other constraints rely on assumptions of invariant measurements. The models 4 and 5 refer to the latent

construct level. This level deals with more substantive hypotheses about how the subsamples may differ and are similar, respectively, in their perception of variables' relationships. Therefore, the most parsimonious model that varies not significantly from the unrestricted model is examined in comparing the paths and the latent means (Byrne, 2001).

Model fit. Structural equation modeling (see Fig. 1) was estimated with AMOS using maximum likelihood estimates for each subsample (Byrne, 2001). The overall fit of the resultant models was assessed using a number of goodness of fit indices representing absolute, comparative and residual aspects of fit, specifically χ^2/d*f*, Tucker–Lewis index (TLI), Comparative Fit Index (CFI), and Root Mean Square Error of Approximation (RMSEA). The higher the probability associated with the χ^2, the closer is the fit between the hypothesized model and the perfect fit (Byrne, 2001). A χ^2/d*f* ratio less than 2.0 indicates good overall model fit (Marsh, Balla, & McDonald, 1988) with values greater than 5.0 considered as unacceptable, although it should be noted that the χ^2 statistic is sample size dependent. However, several problems are associated with the χ^2 test. In particular, it is based on restrictive assumptions, depends on sample size and that a model is an approximation of the reality, rather than an exact representation of the observed data (Bentler & Bonett, 1980). Therefore, a number of alternative fit indices have been looked at.

In this study, TLI, CFI, and RMSEA are reported. The TLI and CFI range from 0 to 1 and derive from the comparison of a hypothesized model with the independence model. Values greater than 0.90 indicate acceptable model fit (Bentler & Bonett, 1980). The RMSEA has been recognized as one of the most informative criteria in covariance structure modeling (Byrne, 2001). It takes into account the error of approximation in the population and it estimates how well the model would fit the population covariance matrix if all parameter values would be chosen optimally. An RMSEA of <0.10 is considered acceptable, and <0.05 is good (Byrne, 2001).

When the theory underlying the model indicates that a moderating relationship among predictors may vary by specific population subgroups, as the stage groups, Multi-Sample Structural Equation Modeling (MSEM) is preferable. A single χ^2 goodness-of-fit statistic evaluates a set of complex models—one for each group. To validate the usual assumptions that groups are equivalent, subsamples can be required to have identical estimates for all parameters (a 'fully constrained' model). Differences among the groups can be evaluated for their appropriateness by 'freeing' special parameters (allowing the groups to vary).

The theoretical model is separately applied to each subgroup and then the invariance analyses can be set up. Before the invariance models are estimated, it must be established that the model without any invariances (i.e. a model that is different in each group) is reasonable. This model can be used as a basis of assessment of more constrained models. The constraints are placed in a sequence of nested models. To compare the models, the χ^2 difference test and the Tucker–Lewis index (TLI) can be used to test the equality constraints (Byrne, 2001; Kenny, 2002). If the difference between the χ^2s is not statistically significant, then the statistical evidence points to no cross-group differences between the constrained parameters. If the χ^2 difference is statistically significant, then the evidence of cross-group inequality exists. The TLI is estimating the models for the groups separately and summing the χ^2s and the degrees of freedom. The differences in the TLI up to 0.05 are considered as trivial in practical terms (Byrne, 2001). For the test of significant paths and significant differences across the subgroups, $p \leq 0.10$ was used, because uni-directional hypotheses where stated. Structural Equation Modeling was performed using AMOS 4.01, and reliability and dropout analyses were performed using SPSS 12.0.1.

Results

Distribution of patients across the three stages

The sample of $N=560$ rehabilitation patients was assigned to the three stages according to the retrospective staging algorithm. About every fifth patient ($n=106$) reported to have been inactive and undecided to be physically active at the time before the rehabilitation (non-intenders). About one third of the sample ($n=195$) reported to have been inactive but with a decision to start exercising (intenders). The biggest fraction of the sample ($n=259$) reported to have already been active before the rehabilitation started (actors, stage 3). Due to dropout, only $n=423$ patients could be followed up. Of these, $n=67$ were classified as non-intenders, $n=155$ were intenders, and $n=201$ were actors.

Dropout analysis

First, the dropout rates across the three stage groups were compared: 37% of the non-intenders, 21% of the intenders, and 22% of the actors did not provide data at follow-up. This pattern was statistically significant, χ^2 (2, $N=560$) $=10.97$; $p<0.01$. In other words, the non-intenders were more likely to drop out.

Secondly, patients who were lost at follow-up were compared on baseline social-cognitive variables with patients who completed the whole study, and were differentiated into stage subgroups. In non-intenders, none of the seven constructs revealed significant differences across dropouts and those patients who completed all measurement points ($p>0.32$). Concerning sex, age and BMI, no differences in any subgroup revealed to be significant. However, patients who smoked dropped out with a higher probability (32%) than non-smoking patients (16% dropouts). This was true for all stage groups.

Thirdly, all subsequent analyses were computed on the basis of patients with complete data sets, and results were compared with the full sample with mean-replaced data for the dropouts. In most analyses, no differences were found. In case differences in the results and pattern occurred, these are reported.

Multi-sample structural equation modeling

To examine whether the single sample models were adequate, the structural model was separately tested in each group. Only if the hypothesized model was adequate in all subsamples, the model may work well in the multi-sample analyses. Therefore, the hypothesized model shown in Fig. 1 was tested in each sample.

Goodness-of-fit indices for the three subsamples are shown in Table 2. In practical terms, the hypothesized model represented the data well. Although the χ^2 was statistically significant, the other fit

Table 2
Goodness of fit indices for the three stage subsamples

Sample	*n*	χ^2	d*f*	χ^2/d*f*	*p*	TLI	CFI	RMSEA
Non-Intenders	67	451.88	310	1.46	<0.01	0.97	0.97	0.08
Intenders	155	520.39	310	1.68	<0.01	0.98	0.98	0.07
Actors	201	534.23	310	1.72	<0.01	0.98	0.99	0.06

indices showed good or moderate model fit with χ^2/df smaller than 2, TLI and CFI greater than 0.95 and RMSEA of 0.08 and smaller. Post hoc analyses and subsequent fitting procedures were not done because the modification indices indicated different modifications in the three groups. The aim was to keep a model that was most generalizable.

The fit indices revealed better fit with the mean-imputed entire sample. That indicated the moderate fit was mainly related to the small sample size. Consequently, because the model offered a reasonable fit in all the samples, the hypothesized multi-sample structural equation model was employed.

Testing for multi-group invariant factorial structure of the measuring instruments

To determine, whether (1) the items comprising a particular measuring instrument operated equivalently across the different stage groups, and whether (2) the factorial structure of the instruments was equivalent across stage groups, a confirmatory factor analysis was computed. This test of the validity of the measurement model was done with a three-group model in which no constraints were set. For comparing the constrained models with unconstrained models (model 1), nested models were computed. The constrained models were specified with equal factor loadings (model 2), and equal factor loadings along with covariances (model 3) (Table 3).

The first two constrained models were tenable, with practical fit indices showing good model fit. The χ^2 difference was not statistically significant ($p=0.10$). This confirms that models 2 and 3 account as well for the sample's variance/covariance as model 1. The other models proved to be applicable at $p<0.01$, suggesting that factor loadings, variances, and factor residuals were mostly sample specific.

Patterns of social-cognitive variables across the stages

With the finding that all factor loadings and covariances were invariant across the three stage groups, the assumption for the latent mean analysis (with invariant factor loadings) was met. At this point it was analyzed if the latent means of the constructs in the model were different across the stage groups. By restricting the means in one group, this group operated as a reference group against which the latent means of the other groups were compared. The group of intenders served as the reference group (see Fig. 2).

The group of non-intenders differed significantly from the intenders with its means on self-efficacy ($M=-0.26$; $p<0.01$), intention ($M=-0.2$; $p<0.05$) and planning ($M=-0.37$; $p<0.01$). The group

Table 3
Three group nested models and χ^2 differences with increased constraints

Model	χ^2	d*f*	*p*	χ^2/df	TLI	CFI	RMSEA	Model 1 delta χ^2	Model 1 *p*	Delta TLI
Unrestricted Model	1508.62	930	<0.01	1.62	0.98	0.98	0.038	–	–	–
Model 2	1560.64	970	<0.01	1.61	0.98	0.98	0.038	52.02	0.10	<0.01
Model 3	1572.86	980	<0.01	1.61	0.98	0.98	0.038	64.24	0.09	<0.01
Model 4	1774.92	1060	<0.01	1.67	0.98	0.98	0.040	266.30	<0.01	0.01
Model 5	1788.44	1066	<0.01	1.68	0.98	0.98	0.040	279.82	<0.01	0.01

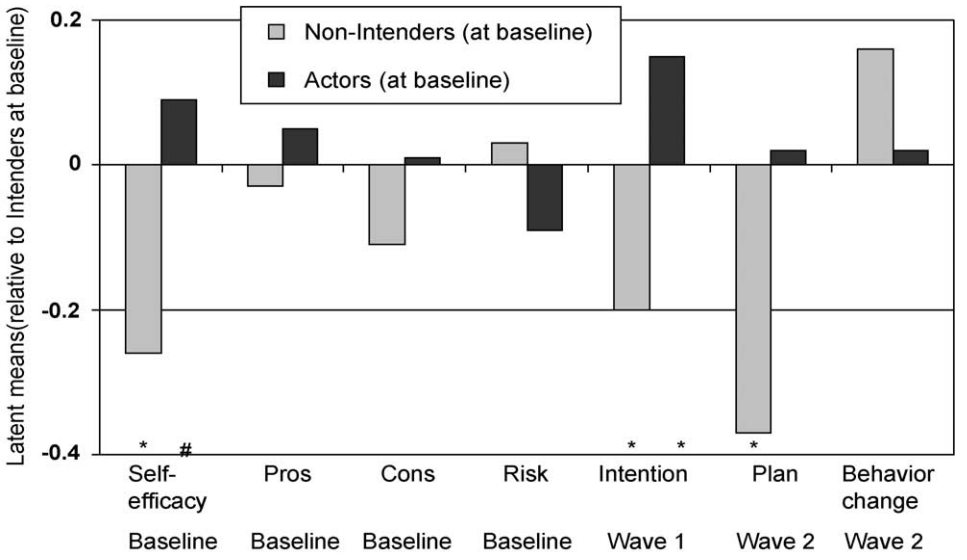

Fig. 2. Latent means across the stage groups. Note: $*p < 0.05$ (CR > 2.22); $\#p = 0.1$ (CR > 1.58).

of actors differed from intenders in self-efficacy ($M = 0.09$; $p < 0.10$) and in intention ($M = 0.15$; $p < 0.05$). The differences in behavior change between the three stage groups were of no statistical significance.

Examining the HAPA structure

To test the hypothesis that the paths in the specified causal structure implied by the HAPA model was unique (not invariant) across stages, multi-group models were specified. The final optimal model, model 3, was then tested, with constrained factor loadings and factor covariances to be equal across samples. From a statistical and a practical point of view, it could be maintained that constraints of model 3 were the best ones. The χ^2 difference test and the TLI indicated that this model did not differ significantly from the unconstrained model. Subsequently, the paths in this model were estimated.

The figure. 3 shows the relationships among the factors in the three subsamples in model 3. In all three stage groups, self-efficacy was significantly correlated with intention. Stage-specifically, self-efficacy played only a role in actors for planning and in non-intenders for behavior. Unexpectedly, neither pros nor cons were highly related with intention. Risk perception promoted intention in former non-intenders and actors but was without importance in intenders. High intentions were associated with action plans, and action plans were related to changing behavior within all stage groups. However, this was only of statistical significance in intenders and actors. Surprisingly, the higher an intention in non-intenders and actors, the smaller the behavior change.

The uniqueness in risk perception on intention, in self-efficacy on action plans and behavior, and the relationships of intention, plans and behavior revealed significant differences in the path coefficients (tested by AMOS, see Fig. 3). Thereby, discontinuity patterns were found.

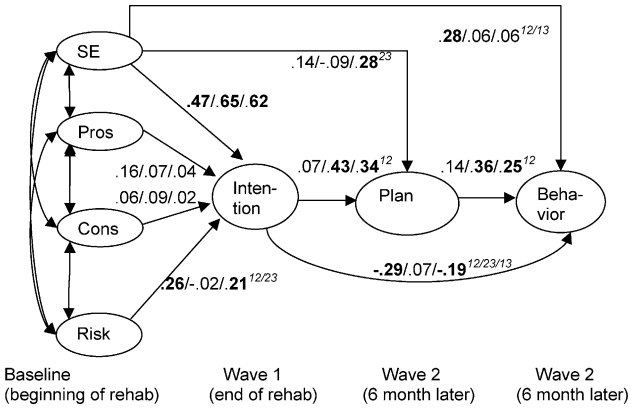

Fig. 3. Standardized coefficients for the measurement equivalence model (model 3) across the three stage subsamples. Note: SE, self-efficacy; Risk, risk perception. Path coefficients are reported non-intenders/intenders/actors. Significant path coefficients are in bold; and differences of the path coefficients are indicated by the truncated numbers: '12' means the non-intenders and the intenders groups differ significantly. '13' stands for significant differences across the non-intenders and the actors subsample and '23' indicated significant differences across the intenders and the actors subsample.

Finally, the explained variances (in Model 3) were different across the three stage groups. In non-intenders, about 34% of the variance of intention was explained, 3% of planning and 11% of behavior. In intenders, 46% of the intention's variance was explained, 14% of planning, and 17% of behavior's variance was explained. In actors, 40% of the variance of intention, 30% of planning, and 6% of behavior's variance was explained. This might also be an indicator of discontinuity patterns across the stages.

Discussion

The study investigated the discontinuity patterns across three stages of the Health Action Process Approach (Schwarzer, 1992) within the architecture of intention formation, planning and behavior change. 560 orthopedic rehabilitation patients were assessed at the beginning and at the end of their rehabilitation and for a follow-up 6 months later, of whom 423 provided data at follow-up. Attrition analyses indicated that more non-intenders dropped out than intenders and actors, and smokers were more likely to drop out than non-smokers. No other variables were reliable predictors of dropout. Discontinuity patterns were found in several social-cognitive indicators. Differences in terms of (a) latent means, (b) interrelations of the social-cognitive variables, and (c) amount of explained variance were found when comparing the stages of change. This provided support for the usefulness of stage models and for the stage-specific prediction of behavior change (Weinstein et al., 1998).

The hypothesized invariant factorial structures of the psychometric scales were confirmed since factor loadings and covariances were the same across different stage groups. Thus, across the three stages, the measurements were equivalent. Practically speaking, all patients in the study understood the questions in the same way independently of the stage they are in. More theoretically, the measurement errors were reduced (Burkholder & Harlow, 2003) and ensuring measurement equivalence is a logical prerequisite

for the evaluation of substantive hypotheses regarding group differences (Horn & McArdle, 1992). Only in case of measurement invariance, the differences between the stage-groups are clearly interpretable (Horn & McArdle, 1992).

The hypotheses on the discontinuity patterns in latent means were partially confirmed. Self-efficacy was—as hypothesized—lowest in the non-intentional stage and highest in actional stage. This finding was in accordance with previous findings (Resnick & Nigg, 2003; Rosen, 2000). In particular, patients who are not decided to be physically active feel less self-efficacious than patients who have formed the intention. Those patients who are already active, may experience their competence to perform the behavior and, accordingly, they perceive higher self-efficacy (Rothman, 2000). Pros and cons were lower in non-intenders but not at a significant level. As expected, no differences were found in pros and cons between the intentional and actional stages. Support for the distinction between non-intenders and intenders was provided by the significant different levels of intention and plans between the two groups. On the other hand, the lack of differences between intenders and actors in plans supported the assumption that these two stages are similar in terms of underlying volitional processes (cf. Renner & Schwarzer, in press). The finding in this study was that intenders differ from non-intenders in terms of their formed intention and plans. The finding is in accordance with the HAPA (Schwarzer, 1992): Intenders and non-intenders differ mainly in terms of having decided to be physically active. This is also the case in actors and, therefore, intenders do differ from actors in terms of plans, and only moderately in terms of intentions.

The hypotheses on discontinuity patterns in intention formation and the translation of intention into behavior could partially be supported as well. It was found that, if non-intenders form an intention, risk perception played a substantial role. For intenders, risk perception was no longer important for their intention. This stage-specific pattern was also found in the context of preventive nutrition (Renner & Schwarzer, in press). Assumingly, people who have not decided to perform a health behavior might lack information and, therefore, they are not aware of the risk that is caused by not taking precautions. In this group, the higher the risk perception, the more they 'understand' the need of adopting a health behavior. In other words, if risk perception is higher, the probability of forming an intention is also higher. In individuals who have already set the goal to start an activity, a higher perceived risk does no longer increase their intention because they have to plan, how to translate the goal into action. Planning becomes more salient (see Lippke et al., 2004a).

The effect of outcome expectancies was not large in any of the stage groups, and no differences were found between groups. This might be due to the special context of the rehabilitation setting. Studies in other settings should explore this further. Another explanation might be that self-efficacy was the most important factor for intention formation and behavior change. In the current study, in all stage groups self-efficacy was superior to all other variables in the prediction of intention, supporting the hypotheses on intenders and actors. Thus, self-efficacy appears to be crucial in all stages, as found in other studies as well (e.g. Plotnikoff et al., 2001). Self-efficacy in non-intenders tended to be—as expected—influential on intention but lower than in the other stages; however, this did not reach statistical significance. In line with the hypothesis, intention and planning mediated completely the impact of self-efficacy on behavior change. In other words, self-efficacious patients are more likely to form intentions (Schwarzer & Renner, 2000). Afterwards, people translate their intentions into plans, and, by this, the intended behavior is more likely to be performed (Luszczynska & Schwarzer, 2003). Patients who did not intend to be physically active but who report higher self-efficacy, move to the intentional or actional stages without the mediation process from intention formation to planning and behavior enactment. The latter finding

might be uniquely related to the current sample because rehabilitation patients were in an on-going change process. In particular, patients who were in the non-intentional stage may have changed more in terms of the above described psychological mechanisms. These psychological changes might occur between the measurement points. Therefore, further studies should have a closer look into such micro processes.

In non-intenders and actors, a higher intention was connected with less behavior change. This may be interpreted in two ways. Firstly, a high intention was no guarantee for behavior change. Other factors such as the belief in one's competencies were more important to actually change the behavior. Secondly, it has to be taken into account that behavior *change* was measured. Consequently, persons with a high intention to exercise did not change their subsequent behavior because they maintained their prior behavior: Actors had high intentions to exercise and they had already been active. After some time they are still as active as before, so they state that they did not change their behavior since they were maintaining their former behavior. The ones with low intentions and probably less behavior performance had more potential to change their behavior.

Typical stage patterns were replicated, with the lowest levels of self-efficacy and intention in the non-intenders and the highest ones in the actors. Moreover, across stages the pros were increasing whereas the cons were decreasing. Non-linear trends were found but could not be observed consistently. According to the principle of discontinuity, within each stage a unique pattern exists. The results are in line with previous findings (e.g. Courneya et al., 2001; DeVries & Mudde, 1998; Dijkstra et al., 2003; Plotnikoff et al., 2001). That means people are motivated differently depending on the stage they are in. Health behavior change is then governed by different influences of social-cognitive variables such as risk perception, and perceived self-efficacy. This has also been reflected here by intention formation and planning, both of which were clearly distinct between stages.

From these findings it might be concluded that the identification of stages contributes substantially to the differential prediction of behavior change. The idea of 'one-size-fits-all' should, therefore, be abandoned (Kreuter & Holt, 2001; Kreuter et al., 1999). Furthermore, if separate predictions within stage groups are chosen, different proportions in variance might be explained in these subgroups since these predictions fit better than they do in the entire sample. Another aim could be to explain more variance. However, this is difficult to demonstrate because the subgroups are more equal, and less variance remained to be explained. Marcus and colleagues (1994), for example, have revealed that a high percentage of variance of exercise behavior was explained by the stage six months earlier.

The present study is not free of limitations. First, all data is self-reported. The reliability coefficients were of moderate to good size. Secondly, a self-selection and selective dropout may have led to a sample of participants who are interested in the topic of physical activity. Non-intenders at baseline and smokers were more likely to drop out at follow-up. Although the problem of attrition was dealt with by recruitment and missing value replacement strategies, the generalizability of the findings is not clear. Finally, for the structural equation models, larger sample sizes would have been favorable. To deal with this problem, missing imputation methods were applied (Hall et al., 2001). In further studies, larger sample sizes should replicate the results on stage groups of small and different sizes to ensure reliable discontinuity patterns. The predictions have also to be validated in experimental studies (Burkholder & Harlow, 2003).

In addition to the need to replicate the analyses, these findings are important in two ways. First, implications may be given for theory building and, secondly, conclusions for exercise promotion may be drawn (Sutton, 2002). For theory building and research, it was found that stages are qualitatively distinct.

In testing the models, a new method was suggested to include stage assumptions into linear predictions, and more stage-specific analyses should be done. Furthermore, volitional variables such as planning should be included in studies on exercise change. For intervention practice, the results underscore the potential importance of tailoring treatments (Kreuter & Holt, 2001). If stages are identified, stage-specific needs can be taken care of, and—at least short-term—effects of interventions might be increased (Adams & White, 2003). Moreover, planning cognitions were shown as being important in the behavior change process, and, probably, it might be more effortless to modify action plans than other social-cognitive variables (Lippke et al., 2004b).

To sum up: (1) this was the first study that tested three stages as moderators in the prediction of behavior change. (2) The selected stages were a good predictor of subsequent differences in intention and planning. (3) Discontinuity patterns were found in terms of stage-dependent relationships of risk perception and intention as well as intention and behavior change. (4) Self-efficacy played a crucial role for intention formation in all three stages. It was shown that the architecture of social-cognitive variables, including intention and planning, is stage dependent. For physical exercise and general health promotion, these findings might be helpful for the design of effective interventions by targeting them to the individual's stage.

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