Clinical Psychology Review 31 (2011) 428–439

Contents lists available at ScienceDirect

Clinical Psychology Review

Illness and symptom perception: A theoretical approach towards an integrative measurement model

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ARTICLE INFO

Article history:
Received 19 May 2010
Accepted 4 November 2010
Available online 12 November 2010

Keywords:
Symptom perception
Illness representation
Attitudes
Law of comparative judgments
Comparison
Self-concept

ABSTRACT

Several models have been proposed to conceptualize psychological representations of health, illness, and bodily sensations. These models differ as to the cognitive and affective components they include, whether they study the interaction of these components, and whether associations between psychological representations of bodily states and affective and behavioral reactions to these representations are considered conditional. These different conceptualizations and corresponding measurement approaches exist in parallel without resulting in synergistic effects or theoretical advancements within the field. In this paper, we review theoretical models on perception and attitudes and construct an integrative theoretical framework on psychological representation of bodily symptoms as well as more abstract representations of health and disease. The aim of this combination of approaches is to unify the strengths of different research domains in the conceptualization and measurement of mental representations of bodily states. Furthermore, the aim is to specify new, testable predictions and implications about the (conditional) relationship of these mental representations and affective and behavioral consequences. A core element in this integrative model is comparison. We review how comparison processes can change the cognitive and affective reference frame for illness and symptom perception and in turn affective and behavioral reactions. We discuss implications for measurement of illness and symptom representations as well as implications for clinical practice. Finally, we make suggestions for a research agenda to validate the proposed model as well as to address new questions derived from it.

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doi:10.1016/j.cpr.2010.11.002

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1. Introduction

According to the World Health Organization (2009), chronic disease is the major cause of death and disability worldwide. The World Health Organization estimates that non-communicable chronic health conditions, including cardiovascular diseases, diabetes, cancer, or respiratory diseases, account for 59% of the 57 million deaths annually and 46% of the global burden of disease. In recent years, morbidity and mortality related to chronic disease have increased worldwide (Yach, Hawkes, Gould, & Hofman, 2004).

In preventing and treating chronic disease, not only somatic problems need to be addressed. Prince et al. (2007) point out that anxiety and depression in chronic disease are highly prevalent and devastating for health in contributing to perceived symptom burden and to morbidity and mortality. They concluded that there is "no health without mental health" (p.859). Affective disorders as comorbid conditions in somatic chronic disease are stronger related to mortality than comorbidity of somatic disease with any other somatic condition (Moussavi et al., 2007). Furthermore, psychological factors play a central role in prevention of somatic disease (e.g., Jones, Roche, & Appel, 2009; Rothman, Salovey, Turvey, & Fishkin, 1993). In the treatment and prevention of chronic disease and comorbid psychopathology, clinical and health psychologists have an important role in helping to develop self-management through emotion regulation and behavior change.

In the course of this involvement of psychologists and psychiatrists in treatment and prevention of somatic disease and comorbid psychological disorders, numerous psychological models on health-related cognitions and emotions have been proposed. Recent research has produced riches of empirical evidence on how psychological representations of symptoms and illness are associated with preventive behavior in healthy individuals (Fischhoff, Bostrom, & Quadrel, 1993; Fisher et al., 2002) as well as with disease management, morbidity, and comorbid affective disorders in chronic disease (e.g., Broadbent, Petrie, Main, & Weinman, 2006; Hagger & Orbell, 2003; Horne et al., 2007; Kaptein et al., 2008; Rothman & Salovey, 1997). Thus, understanding the formation of mental models of bodily states might help to understand emotional and behavioral reactions to illness, and in turn might help to improve health self-management and prevention and treatment of comorbid affective disorders in chronic disease.

However, research on psychological representations of health and disease is highly heterogeneous. Several independent approaches have been developed in clinical psychology, health psychology, and social psychology to explore related constructs, such as illness representations (e.g., Leventhal, Meyer, & Nerenz, 1980), symptom-specific catastrophic cognitions (e.g., De Peuter, Lemaigre, Van Diest, & Van den Bergh, 2008; Sullivan, Bishop, & Pivik, 1995; Sullivan et al., 2001), unrealistic optimism (e.g., Klein & Weinstein, 1997), denial (e.g., Steiner, Higgs, Fritz, Laszlo, & Harvey, 1987), stoicism (e.g., Yong, Gibson, Horne, & Helme, 2001), positive and negative affect as trigger for illness and symptom schemata (e.g., Rietveld & van Beest, 2007), illness-related self-categorization (e.g., Adams, Pill, & Jones, 1997; Levine, 1999), or identity-based health motivations (Oyserman, Fryberg, & Yoder, 2007).

The aim of this report is to introduce a model on the formation of psychological representations of bodily states integrating approaches from these different disciplines in psychology. The goal of the model is to represent a constructive approach that unifies the strengths of different, so far isolated models. This new, integrative model provides a basis for the conceptualization and measurement of psychological representations of bodily states. Furthermore, it identifies moderator variables influencing the relationship between these mental representations and affective reactions (e.g., comorbid affective disorders) and behavioral intentions (e.g., health management).

2. Current approaches in research on psychological factors in illness and symptom perception

In the following, we will briefly describe a selected number of approaches that have been proposed to study psychological factors in the perception and representation of bodily sensations. We do not aim at giving a complete review of the field. Rather, the particular selection was made with two purposes: (1) to illustrate the wide variety of approaches in recent research on illness and symptom perception which exist in parallel without contributing to each other in a synergistic way; (2) to bring along the building blocks for a more integrative model of important psychological components in the perception of bodily states. Next, we will introduce an integrative measurement model for symptom and illness representations, the Symptom and Illness Attitude Model (SIAM) and describe its measurement implications. The SIAM is derived from theories on perception and mental representations, in particular the attitude construct. It is designed to be applied to different disease and symptom domains as well as to the perception of benign bodily sensations and health as a broader psychological construct. It aims at explaining the conditional character of the association of the psychological representation of bodily states and consequences, such as (preventive) health behavior and comorbid affective disorders. In the last step, we will propose a research agenda to validate the SIAM and to address new research questions derived from this model.

2.1. Multidimensionality of illness representations

One important aspect of mental representations of illness and symptoms is their inherent multidimensionality. Mental models on an illness can include thoughts and worries about the nature of the disease, or about causes, consequences, timeline, and control. Such multidimensionality has been conceptualized in Self-Regulation Theory (SRT) and illness representation research (Leventhal, 1970; Leventhal et al., 1980; for reviews see Coutu, 2008; Hagger & Orbell, 2003). Illness representation research has shown that the five dimensions originally proposed by the SRT are associated with risk perception, coping behavior, and psychological well-being (Hagger & Orbell, 2003).

However, the framework makes no explicit assumptions on the relative impact of different illness representation dimensions in different contexts and mood states. For example, it could be assumed that under high cognitive load, the affective component of illness representations gains a higher weight in shaping behavioral intentions than in neutral states (Wilson, Lindsey, & Schooler, 2000; see Strack & Deutsch, 2004 for a model on impulsive and reflective processing). Furthermore, dimensions may vary in their relevance in different contexts, such as work versus family. As a consequence of the absence of these explicit assumptions, the model does not allow à priori predictions on the direction and the nature (unconditional/conditional) of the relationship of mental representations and variables, such as anxiety, depression, or behavior. However, knowledge on moderators in the

relationship between mental models and behavior is crucial to design efficient interventions (Kraemer, Kiernan, Essex, & Kupfer, 2008). For example, specific situational variables may make specific illness dimensions more salient and activate dysfunctional illness representations (e.g., catastrophic cognitions and related avoidance of exercise: Leeuw et al., 2007). Instead of changing illness representations in general, it may be more efficient to identify and target such moderating variables in order to improve psychological well-being and health behavior.

Illness representation research emphasizes the affective component of illness perception by introducing a framework in which cognitive and affective illness representations are processed in parallel (e.g., Leventhal, Leventhal, & Cameron, 2001). However, from recent research on dual process models it becomes apparent that independent processing of affective and cognitive processing is unlikely (Olson & Fazio, 2009). Rather, this research suggests an interaction of both processing modes in shaping mental representations (see also Fishbein & Ajzen, 1975). Such interaction effects have not been addressed by illness representation research so far.

In the SIAM, we will build upon the multidimensional approach of illness representation research. We will focus on processes which can affect salience of single illness representation dimensions. Moreover, we will introduce models from other research domains targeting the interaction of affective and cognitive components in shaping mental representations. Changes in salience of single dimensions and interactions of affective and cognitive components would be important targets for interventions aiming at an improvement of health management and coping behavior.

2.2. Expectation-based biases in psychological representations: one or many?

Research on expectations about bodily states investigates processes through which beliefs and emotions guide perception and interpretation of bodily information. Expectations can be, for example, beliefs about consequences of an action, a stimulus, or more general of being in a certain context. These expectations will be paired with an affective evaluation. In a top down modulation process, expectations and their affective evaluation will guide attention, selection of information, and interpretation (e.g., Allport, 1987; Cioffi, 1991; Marcel, 1983). The interaction of affect and cognition in forming mental representations of a bodily state has been studied extensively, in particular with regard to medically unexplained symptoms (Brown, 2004), over-perception and under-perception of symptoms (Janssens, Verleden, De Peuter, Van Diest, & Van den Bergh, 2009) and related avoidance and approach behavior (e.g., Leeuw et al., 2007).

Related to the fear avoidance models of pain (e.g., Vlaeyen & Linton, 2000), instruments have been developed to measure symptom-specific fear, such as the Pain Catastrophizing Scale (Sullivan et al., 1995) or the Catastrophizing about Asthma Scale (De Peuter et al., 2006). Scores on these scales were found to be associated with exaggerated report of symptoms and to predict related behavior, such as avoidance of movement. Such avoidance reactions can lead into a vicious cycle of aggravation of symptoms, more avoidance, chronic symptom manifestation, and further decrease in health (e.g., Leeuw et al., 2007).

Since these approaches target fearful beliefs only, they neglect other, potentially competing expectations. A positive bias can be as influential as fearful beliefs. A study by Anderson and Pennebaker (1980) demonstrated that the framing of an ambiguous stimulus as pleasant or unpleasant by the experimenter can shape the mental model of the stimulus constructed by participants consistent with their expectations. It is relevant to consider also positive expectations in research on representation of bodily states, because positive expectations, such as unrealistic optimism—regarding oneself to be less vulnerable than the average person—are the rule rather than the exception (Helweg-Larsen & Shepperd, 2001; Hoorens & Buunk, 1993; Klein & Helweg-Larsen, 2002). These positive expectations may have as adverse effects as a negative bias: A lack of risk awareness related to internal sensations can lead to a delay in seeking help with severe or even fatal consequences as shown for example in stroke patients, patients with transient ischemic attacks (Mandelzweig, Goldbourt, Boyko, & Tanne, 2006; Sprigg, Machili, Otter, Wilson, & Robinson, 2009), or asthma patients (Campbell et al., 1995).

Research and theory on the activation of symptom schemata (e.g., Brown, 2004) do not explicitly address potential parallel or sequential activation of competing illness and illness-unrelated schemata. We do not know whether different expectation biases can co-exist in this domain and/or whether contextual information moderates which expectations predominate at a specific moment. Different symptom and illness-related and unrelated expectations and attitudes might compete in the activation of behavioral schemata. Thus, in outlining our model, we will introduce research and theory that targets the role of competing (or supporting) representations in the activation of schemata and behavior.

The SIAM addresses positive and negative bias related to health and illness, which has been investigated so far only in isolation in the contexts of separate psychological constructs, such as stoicism (Yong et al., 2001), defensiveness/denial (e.g., Asendorpf & Scherer, 1983; Feldman, Lehrer, Hochron, & Schwartz, 2002), and unrealistic optimism (Helweg-Larsen & Shepperd, 2001). In the SIAM we will make explicit assumptions on why and when some individuals might show a stronger tendency towards one form of bias or the other (catastrophizing vs. optimism). We will present research and theory development on variables which can play a role in the activation of different forms of bias.

2.3. The role of disease-unrelated emotions in illness and symptom representations

Psychological factors unrelated to symptoms or illness can compete with the activation of symptom and illness schemata. Emotional states unrelated to bodily states can serve as heuristics for the activation of congruent schemata on bodily sensations (Bower, 1981; Rietveld & Prins, 1998). Positive emotional cues might inhibit the activation of disease schemata which are inconsistent with positive affect, while negative emotions which are more consistent with illness might increase the accessibility of related schemata (Rietveld & van Beest, 2007). Studies using experimental induction of emotions unrelated to symptoms show a decrease of sensation report under positive emotions compared to neutral or negative emotional states (e.g., Von Leupoldt, Riedel, & Dahme, 2006). A similar variation of symptom report in relationship to emotions has been found for psychosocial stress and symptom report in everyday life (Main, Moss-Morris, Booth, Kaptein, & Kolbe, 2003; Warner & Bancroft, 1990).

The hypothesis of emotions as triggers for beliefs and schemata offers an explanation for the instability of illness and symptom representations in different contexts. However, negative schemata activated by congruent negative emotions need not necessarily be illness related. Thus, this hypothesis makes no assumptions on factors that moderate whether emotions trigger congruent *illness or symptom* schemata, or congruent schemata unrelated to illness and symptoms. Furthermore, no assumptions are made on potentially competing schemata and whether they can be activated simultaneously. Competing schemata and determinants of their activation will be of central interest in the SIAM model.

2.4. Consistency and stability of illness and symptom representations: the (underestimated) role of self-complexity

The question of moderators in the activation of competing schemata and related behavior has been addressed extensively in

recent research outside health psychology. Research on the self-concept and self-complexity (e.g., Linville, 1987; Rafaeli-Mor & Steinberg, 2002) targets the question of multiple and sometimes competing expectations, beliefs, motivations, and related schemata which can exist simultaneously within one person. A patient with a chronic disease is more than a patient. Besides being a patient, a number of other self-aspects can be salient related to personal attributes as well as social group memberships (e.g., gender, nationality, religion, profession, family, being a partner in a relationship, etc.). These multiple aspects of social and personal identity are not equally accessible at any given time in any given social context (Turner, Reynolds, Haslam, & Veenstra, 2006). In family life, the self-aspect "being a parent" might be more easily accessible in the working self-concept than the self-aspect "patient." The relative accessibility of self-aspects is associated with the selective accessibility of related experiences, beliefs, motives, and goals (Mussweiler, Gabriel, & v. Bodenhausen, 2000; Onorato & Turner, 2004). A shift in focus from one self-aspect to another changes the accessibility of associated concepts and schemata (e.g., Brewer, 1991; Sinclair, Hardin, & Lowery, 2006). A shift in identity focus, for example from being a patient towards being a parent, might make illness-related schemata less accessible than schemata related to parental identity. Motives, beliefs, and goals related to this self-aspect "being a parent" might even oppose illness-related schemata. Moreover, simultaneous activation of positively and negatively evaluated self-aspects can buffer against threat related to negative self-evaluation and lead to the activation of more functional schemata and behavioral pattern (Levine, 1999; Shih, Bonam, Sanchez, & Peck, 2007). In contrast to this buffering effect of high perceived self-complexity a low perceived self-complexity has been suggested to lead to spill-over effects of depressive mood associated with one self-aspect to other self-aspects (Linville, 1987). This process has been found to be related to a general increase in depressive mood in patients with chronic pain (Harris, Morley, & Barton, 2003). Given the strong negative impact of depression on health (Moussavi et al., 2007) the integration of the self-aspect "patient" within the self-concept and processes leading to either generalization effects or compartmentalization (Showers, 1992) of depression and anxiety should receive more attention in preventing and treating comorbid psychiatric conditions in somatic disease.

Besides impact of the working self-concept on psychological well-being, self-perception and self-complexity can also have a direct impact on health management. The self-aspect "health" needs to be salient in the working self-concept for health-related schemata to become easily accessible and to shape health behavior (Adams et al., 1997; Levine, 1999; Oyserman et al., 2007). Levine and Richter (see Levine, 1999) found that the evaluation of severity of illness and injury was depending on the experimentally induced salience of two different social self-aspects in a group of female participants: (1) professional life and (2) female gender. If the self-aspect "professional life" was salient in the working self-concept, symptoms and injuries that are likely to impede working efficiency (e.g., back pain or hand injuries) were rated to be more severe than when the self-aspect "female gender" was salient. In this case, signs of injury affecting physical attractiveness (e.g., scars) were rated as more severe.

A series of studies by Oyserman et al. (2007) demonstrated that health behavior can be perceived as a marker of social identity. They showed that doing sports and eating healthy was regarded by some members of ethnic minorities as typical "white" behavior. Not engaging in this "white" behavior was perceived as a mean of contrasting the self from the outgroup and to demonstrate a social group membership central to the self-concept. Moreover, when ethnic identity was experimentally made salient, health-related knowledge was less accessible and more fatalism about health was reported compared to a control group. Furthermore, a study on self-categorizing in asthma found that 50% of participants in this study did not identify themselves with the social group "asthma patients," despite a formal diagnosis by their physician (Adams et al., 1997). Such a lack in self-categorization was associated with misconceptions about nature and management of the disease and poor compliance with patients' medical regime.

These studies on the role of the self-concept in the representation of health, illness, and symptoms show that taking into account the multifaceted structure of the self can help to predict accessibility, content, and valence of illness beliefs and related schemata as well as generalization (or compartmentalization) of anxiety and depression. In the SIAM, we will focus in particular on processes changing salience of self-aspects and the consequences of simultaneously activated self-aspects which are related to simultaneously activated, competing, or mutually supporting schemata.

2.5. Summary of psychological factors in the perception of bodily states

To summarize, recent research has shown that psychological representations of illness, health, and bodily sensations are multidimensional. Furthermore, it has been found that these multidimensional representations are susceptible to expectancy-based biases, such as unrealistic optimism or catastrophizing cognitions. Moreover, besides expectancies related to bodily states, emotional cues unrelated to health or disease have been shown to affect psychological representations. These research approaches, however, do not address the question which dimensions will be most influential in the formation of psychological representations or which expectancies and schemata will be most likely to be activated in a given situation. These questions have been targeted in research on self-complexity. However, although the approaches reviewed above are highly interrelated, they have been pursued in isolation so far.

One reason for this might be that being based in different research traditions, such as clinical psychology, health psychology, and social psychology, they differ in the labels they use for components and processes included in underlying models. Furthermore, approaches differ in whether they assume psychological representations to be stable or whether they outline hypotheses about moderators of the accessibility of different illness and symptom beliefs. The heterogeneity of the field and of conceptualization of components and processes make it hard to identify overlap among approaches and to compare their relative strengths and weaknesses. This, however, would be essential for synergistic effects and advancements in this research domain.

3. The SIAM: an integrative model on illness and symptom representation

In the SIAM, we integrate the approaches reviewed above. The aim of this combination of approaches is to unify the strengths of different research domains in the conceptualization and measurement of mental representations of bodily states. Furthermore, the aim of the SIAM is to specify new, testable predictions and implications about the (conditional) relationship of these mental representations and affective and behavioral consequences. Our goal is a constructive approach that unifies the strengths of different, so far isolated models and in this combination can overcome weaknesses of single previous approaches.

The SIAM is based on the framework offered by attitude research. In attitude research, the question of the interaction of cognitions and emotions in the formation of mental models has been investigated intensively as well as the context dependency of these mental representations and of the activation of representation-related schemata (e.g., Allport, 1935; Brewer, 1991; Mussweiler & Strack, 1999a; Turner et al., 2006). The attitude framework is not restricted to the domain of social attitudes although it has mostly been tested and validated in this domain. It provides a content-free meta-approach which is particularly well suited to be transferred to both mental models of bodily sensations and mental models on health and illness.

The framework can be helpful to conceptualize (1) affective and cognitive components in the formation of mental models, (2) their interaction, and (3) the nature of the relationship of these representations with mood or behavior. In addition to models on attitudes, we will refer to Social Comparison Theory (Festinger, 1954), Temporal Comparison Theory (Albert, 1977), and the Selective Accessibility Model (Mussweiler & Strack, 1999a,b) as a theoretical basis to predict changes in mental representations of bodily sensations and health and disease in response to the reference frame in which they are formed.

Fig. 1 shows the building blocks included in the SIAM and their proposed interactions. These elements have been identified in recent research as outlined above, but have not been brought together in one model on psychological representation of bodily states. In the following paragraphs we will describe step by step the single components of the model: (1) the interaction of beliefs and affective evaluation of beliefs in the formation of psychological representations (Fig. 1a to c), (2) the role of the self-concept in shaping the affective evaluation of beliefs (Fig. 1d), (3) the role of relative strength of psychological representations in the association of these representations with affective consequences (e.g., comorbid depression and anxiety) and behavior intentions (Fig. 1e) and (4) potential barriers between behavior intentions and behavior as identified in research on social attitudes (Fig. 1f to h). In Fig. 1, the moderating influence of a variable is indicated by the letter "M". A moderator is a variable that is not necessarily strongly related to a predictor or an outcome variable, but has an effect on the strength of the relationship between the two variables, by interacting with the predictor. These moderator relationships will be described in detail in the following.

4. Mental representations of symptoms and illnesses through the looking glass of formal attitude research

Attitudes are defined as the association of beliefs about an object and an affective evaluation of these beliefs (Fishbein, 1963; Olson & Fazio, 2009). Analogous to this definition, representations of bodily sensations, illness, and health can be defined as associations of beliefs about a sensation, illness, or health with an evaluation. The conceptualization of psychological representations of bodily states as attitudes can help to understand the *psychophysical* properties of these constructs. The measurement of the psychological perception of stimuli is based on the Law of Comparative Judgments (Thurstone, 1927). This Law of Comparative Judgments is the basis for both the measurement of perception of physical stimuli as well as the measurement of the perception of *psychological value* of objects or stimuli, in other words, the attitude towards these objects or stimuli. Psychological perception is measured by using mutual comparisons between a number of stimuli or attitude objects on one or more evaluative dimensions. Thus, the measuring of attitude strength is a process analogous to the measurement of the *perception* of physical stimuli in psychophysics, such as the perception of size, weight, or color. All these measurements do not reflect a physical reality which could be measured and expressed as "true" value plus measurement error, but the *perception* of a true value which includes influences from contextual information (see Gestalt perception, Wertheimer, 1924).

Excluding one or more of the comparison standards from this process or including new ones will change the perception of the stimulus and affective reactions to the stimulus although the stimulus remains unchanged. This relative character differentiates attitudes qualitatively from the trait or state construct which are traditionally thought to be represented by absolute values, (for a critical discussion, see Mussweiler & Strack, 2000; Turner et al., 2006). In this paper, we will outline why we believe it is fruitful to follow this line of reasoning further and to combine theories and models in the domain of psychological factors in illness and symptom perception and the domain of attitude research.

In the next step, we will describe in more detail theoretical considerations in the assessment of illness and symptom attitudes which follow from the inherently relative character of perception. In

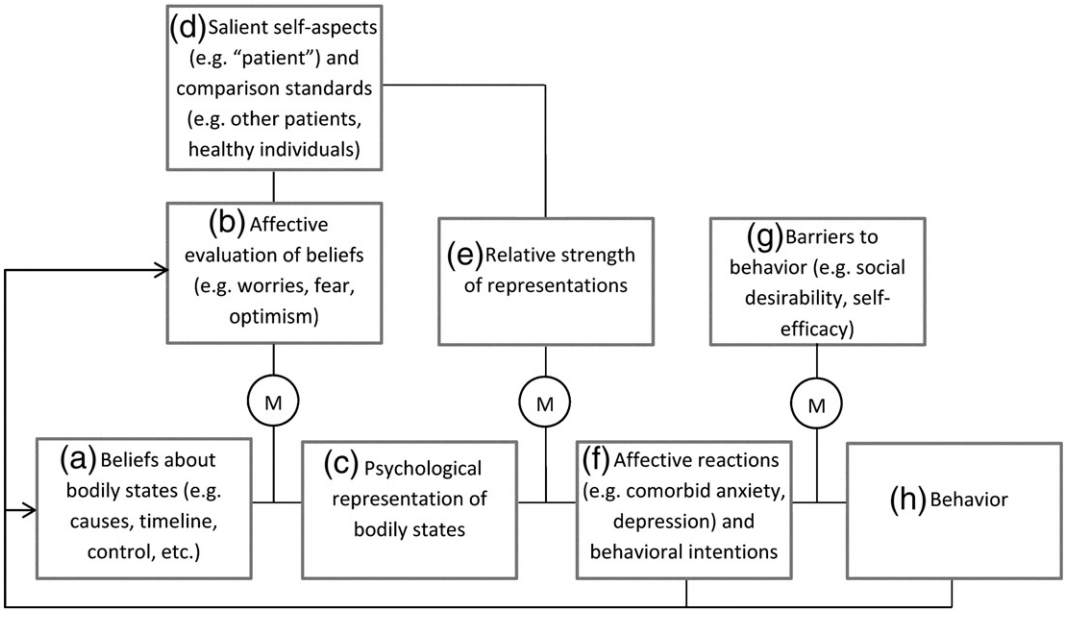

Fig. 1. Model on the formation of psychological representations of bodily states and their relationship with affective consequences and health behaviour. Vertical lines on horizontal lines labelled with the letter "M" denote a moderating influence of the variable on the relationship between two variables. Beliefs on sensations/health/illness (a), in interaction with their affective evaluation (b) will result in mental representations of bodily states (c). Affective evaluation is shaped by salient self-aspects and salient comparison standards (d) which will also shape the strength of representation of bodily states relative to other (competing) mental representations. Relative strength of mental representations (e) will moderate the strength of the association of representations of bodily states and affective consequences such as comorbid psychiatric conditions and intentions for behaviour targeting these bodily states (f). Whether or not behaviour intentions will result in actual behaviour (h) will depend on presence or absence of barriers (g), such as (perceived) inability to perform the behaviour or social desirability. Affective consequences, behaviour intentions, and behaviour will in turn also shape beliefs about bodily states and their evaluation.

addition, we will illustrate how the strength of an illness or symptom attitude compared to other attitudes can be assessed by mutual comparisons between several attitude objects along multiple dimensions, such as suggested by Thurstone (1928). Furthermore, we will elaborate on the role of comparison as fundamental process in the formation of illness and symptom representations.

5. Measuring illness and symptom "attitudes": beliefs and evaluation

To measure mental models of bodily states, the multidimensionality of these representations and the interaction of their cognitive and affective components need to be considered (Fig. 1a to c). In this section, we will describe first the formation of mental models on illness and health as general psychological constructs. Second, we will outline the formation of mental models on actual bodily sensations. We start with more general psychological representations of health and disease, because to be able to evaluate a sensation (either as pathological symptom or benign sensation) we need to decide in how far it deviates from our mental models of health and illness.

Illness representation literature has shown that it is relevant to acknowledge the multidimensionality of subjective believes about health and disease (e.g., the dimensions causes, consequences, timeline, or control, Leventhal et al., 1980). However, dimensions might differ in relevance and affective evaluation. For example, a person can have strong beliefs about the consequences of a disease, but can be in doubt about the causes. Furthermore, an individual may link beliefs about the consequences of a disease with a more negative evaluation compared to beliefs about causes. As it has been shown in the research reviewed above, salience of self-aspects, such as gender, profession, or minority/majority membership (Levine, 1999; Oyserman et al., 2007) will determine which beliefs about health and disease will be most accessible and how these beliefs will be evaluated. Strong beliefs which are (1) congruent with the self-aspect salient in the working self-concept and (2) have a strong affective evaluation will have the highest subjective probability to influence the formation of mental representations (Fig. 1a, b, and d).

How are beliefs about illness and health formed? In general, a belief is defined as the subjectively perceived relationship between an object and another object, stimulus, or concept (Fishbein & Ajzen, 1975). In other words, the formation of an illness (health) belief requires the formation of a link between the illness (health) and another aspect of the individual's internal or external world. This link can be established by various forms of learning, such as conditioning or learning by observation. According to the measurement model developed by Fishbein (1963; see also Fishbein & Ajzen, 1975), an attitude can be regarded as the interaction of the strength of a belief and its affective evaluation.

$$A_O = \sum_{i=1}^{n} p_i v_i$$

A: Attitude
O: Object
i: attribute, dimension
p: subjective probability or belief strength of O being linked to i
v: valence or affective evaluation of O regarding i
n: number of dimensions or attributes i

This equation is illustrated in Fig. 1a to c. Table 1 shows a fictitious example of an individual rating the strength of illness beliefs (p) about consequences, causes, timeline, identity, and control (Leventhal et al., 1980) on a scale ranging from 0 to 1. Furthermore, this table presents ratings of the same individual assigning valence values (v) to each belief on a bipolar scale ranging from −3 (very negative) to +3 (very positive). The sum of beliefs by valence in this example is −2.3, which on the range of potential scores from −15 to +15 reflects a slightly negative general attitude towards the disease. This example illustrates a way of measuring illness representation that accounts both for the multidimensionality of the perception of health and disease, and the interactions of affective and cognitive components in this perception.

Most traditional instruments for assessing illness representations measure either only the probability that beliefs will be considered in forming a psychological representation or they measure only the affective evaluation of these beliefs. Many items in these instruments imply a direction of affective evaluation of beliefs, such as "I fear that my illness will get worse." However, individual differences in perceived valence can be assumed for more ambiguous beliefs, such as "My illness will last a long time" or "I know what causes my disease." A strong belief about an illness will have little impact on the formation of a mental model if the individual feels indifferent about it. Individual differences in affective evaluation will result in a high uncontrolled (error) variance and reduce the likelihood to detect associations between illness belief measures, psychological adjustment to disease, and behavioral measures.

Scales on catastrophic illness cognitions ask participants to rate the strength of beliefs which have an unambiguous, highly negative valence. Such scales measuring beliefs with a fixed valence can be assumed to suffer less from uncontrolled variance in associated affective evaluation. Consequently, these scales might be better predictors for behavior intentions than illness and symptom beliefs or their evaluation alone. However, being restricted to high negative valence, these scales are not designed to be used in populations with ambiguous or unrealistically optimistic expectations about bodily sensations who tend to underreport physiological changes and to interpret severe symptoms as benign. Furthermore, their predictive value for behavior in everyday life might be limited, because the self-aspect patient might be more salient within the assessment situation than outside the research context. However, there is only little research on the potentially moderating effect of salience of self-aspects. Research which is targeting the role of the self in the representation of health, illness, and bodily states (e.g., Adams et al., 1997; Levine, 1999; Oyserman et al., 2007) is using different labels and concepts in describing health beliefs and their evaluation and do not relate this research to research on catastrophic cognitions or unrealistic optimism. As an integrative model the SIAM combines these different research perspectives.

6. Symptom perception: the psychological perception of sensory information

The perception of a bodily sensation includes the *physiological representation* of afferent information including localization, intensity, or quality of a sensation. In addition to this physiological representation, the psychological representation of a sensation includes an appraisal process which assesses the fit of the sensory information with more general subjective models on health and disease. In addition to the mere registration of sensory components, meaning is attributed. That is, a belief about a link of the sensation with a cause or

Table 1
Fictitious example of ratings for strength of illness beliefs (p), valence of illness beliefs (v) and the interaction of the two components on five dimensions.

Illness dimensions	Belief strength p	Belief valence v	p×v
Consequences	.90	−3	−2.70
Causes	.75	0	0
Timeline	.70	−2	−1.40
Control	.90	+2	1.80
Identity	.50	0	0
			A = −2.30

an outcome is activated and associated with an affective evaluation. Again, we will first look at the sections (a) to (c) in the model in Fig. 1 which can be formalized in the following equation:

$$P_s = \sum_{i=1}^{n} p_i v_i$$

P: psychological perception of a Symptom S
S: symptom
i: attribute of S, dimension of symptom evaluation
p: subjective probability or strength of the belief that S is linked to i
v: valence of S
n: number of attributes or dimensions i

We express this term as a sum of a number of interactions of beliefs and affective evaluations, because sensory perception can consist of a number of distinct qualities or attributes occurring simultaneously. Pain can be simultaneously throbbing and sharp, and dyspnea can be related to feelings of air hunger, obstruction, and/or effort at the same time. Different pathophysiological processes are characterized by distinct sets of these sensory qualities (Manning & Schwartzstein, 1995, 2001; Melzack, 1975; Petersen, Morenings, Von Leupoldt, & Ritz, 2009; Petersen, Orth, & Ritz, 2008; Scano, Stendardi, & Grazzini, 2005) and some will be more unpleasant than others (Banzett, Pedersen, Schwartzstein, & Lansing, 2008). Furthermore, beliefs about a sensation can be related to different illness and health representation dimensions, such as outlined in the example in Table 1.

Beliefs about sensations, i.e., a subjective link between a sensation and another aspect of the individual world can be established by various forms of learning. A series of studies by Van den Bergh and colleagues showed that cues, such as odors can be linked to somatic symptoms via associative learning and can serve as trigger for the interpretation of ambiguous sensations as symptoms (e.g., De Peuter et al., 2005, 2007; Devriese et al., 2000; Van den Bergh, Stegen, & Van de Woestijne, 1997, 1998). The individual can, but does not have to be aware of the role of this subjective link in guiding behavior, such as avoidance behavior. In panic disorder, benign causes for breathlessness or increase in heartbeat, such as exercise are avoided in a great number of patients without them being necessarily aware that they avoid exercise. Such avoidance behavior is discussed as contributing factor to the development of panic disorder (Broocks et al., 1997).

The proposed model can account for psychological underperception and over-perception and related behavioral and affective consequences. Following this model, weak beliefs linked to sensory information, i.e., a (p) close to zero should only result in the interpretation of a sensation as symptom (with a pathological meaning), if this belief is strongly negatively evaluated, i.e., (v) is high and negative. On the other hand, underreport can occur in the presence of a high (p), if (v) is close to zero, i.e., when sensory information is clearly subjectively linked to a cause or an outcome, but the patient is indifferent regarding this link. Indifference might be related, amongst other things, to stoicism or fatalism, i.e., the belief that complains about the symptoms is not appropriate or control of the symptom is not possible. Research has shown that sensory intensity is not always highly correlated with the attribution of meaning to a sensation (Rietveld & van Beest, 2007; Yong et al., 2001). This mismatch is most pronounced in anxiety disorders in which sensations of low intensity can lead to catastrophizing conclusions, such as fear of death. Thus, it is important to note that belief strength does not equal sensory intensity. However, in general, a higher intensity is likely to facilitate the activation of a belief and its affective evaluation. Again, beliefs and their evaluation will also partly depend on salient self-aspects. Age-related stoicism (Yong et al., 2001) towards bodily discomfort might be higher when age is made salient in the assessment situation.

7. Assessing the relative strength or mental representations: why and how?

The question of whether a psychological representation of illness, health, or a bodily sensation will contribute to comorbid affective disorders and shape behavior intentions depends on the representation as such, as well as on its relative strength compared to other salient representations, attitudes, or norms (Ajzen, 1991) (Fig. 1e). Salient self-aspects will not only determine the accessibility of beliefs related to bodily states, but also other, potentially competing or supporting beliefs related to other domains. For instance, a positive attitude towards medication will not necessarily result in intentions to comply with a medical regime when a person has a salient and highly positive attitude towards professional success and believes public medication intake at work to be in conflict with self-presentation. Similar cost/benefit considerations between illness-related and illness-unrelated self-aspects have been shown in research on hiding a medical condition at the work place (e.g., Barreto, Ellemers, & Banal, 2006; Ellemers & Barreto, 2006). This research shows how self-representational attempts can reduce psychological well-being (and work performance) although the attitude towards illness or the treatment as such is not necessarily negative. Furthermore, it has been shown that perceived severity of symptoms is not always directly related to comorbid anxiety (e.g., Wagner, Arridell, Wouters, & van Schayck, 2005). Thus, the contextual reference frame will have an effect on the relative strength of an attitude compared to other salient attitudes and the impact of these attitudes on the development of affective consequences and behavior. Therefore, to predict comorbid anxiety and depression and behavior intentions, it is as important to assess the relative strength of a psychological representation as to assess the representation itself. However, we do not propose an unidirectional causal relationship in the SIAM, but a feedback loop of comorbid affective states as well as behavior (Festinger, 1957) having an impact on beliefs and the affective evaluation of beliefs resulting potentially in a downward spiral sustaining anxiety and depression by impeding a re-evaluation of beliefs.

The relative psychological value of an attitude object or the strength of a psychological representation can be conceptualized as the psychological distance between attitude domains. Mutual distances between attitude domains can be computed using approaches such as Multidimensional Scaling (MDS, for an introduction to this method see Kruskal & Wish, 1994). In Appendix A, we provide an example of how MDS can be used to assess the relative strength of mental representations. Alternatively, relative strength can be assessed by self-report instruments asking for the relevance of the respective domains in daily life or in using reaction time tasks assessing the relative preference between two or more domains implicitly (e.g., Wittenbrink & Schwarz, 2007).

8. Consequences of the conditional character of psychological representations of bodily states

In the SIAM, we emphasize the conditional character of mental representations of bodily states and the conditional relationship between these representations and affective consequences, such as comorbid disorders and behavioral intentions. This is in line with research and theory that characterizes mental representations as "transient states of activation" (Smith & Conrey, 2007, p.256) or the conclusion of Thurstone (1928, p. 533) that "(…) we shall not declare such a measurement to be in any sense an enduring or constitutional constant." The relative character of mental models has long been demonstrated empirically (e.g., Dasgupta & Greenwald, 2001; Olson, Goffin, & Haynes, 2007). However, the psychometric characteristics and the context dependency of mental models have largely been disregarded in research on illness and symptom representation. In acknowledging the inherently relative character and the context dependency of mental models on illness, health, and bodily

sensations, it becomes necessary to acknowledge that relationships between measures of these representations and measures of affect or behavioral intentions are conditional.

The conditional character of the relationship between illness and symptom representations, affective consequences, and health behavior does not render measures of psychological representations of bodily states invalid. However, to predict changes in the relationship between these representations and affective consequences, such as comorbid depression and anxiety or behavior we need to take the context into account in which representations are formed—which will determine the comparative attitude strength relative to other salient representations. Knowing how dominant the psychological representation of an illness or a bodily state is in a given situation compared to other salient attitudes and representations is crucial to predict the impact these mental representation will have on psychological well-being and behavior intentions.

9. Social and Temporal Comparison Theory as framework to predict illness and symptom representations

A theoretical framework to explore the role of contextually salient standards which contribute to shaping representations of the self has been proposed by Social Comparison Theory (Festinger, 1954) and Temporal Comparison Theory (Albert, 1977; Zell & Alicke, 2009). We include these frameworks in our model as one determinant of affective evaluation of illness beliefs (Fig. 1d). These theories propose that individuals need comparison standards to construct their self-concept and to evaluate their opinions, skills, social status, or physical state. Comparisons will be most likely, when there are no objective evaluative standards accessible (Festinger, 1954).

Perception of illness and health as a broader concept or actual internal sensations presents such a case of a lack of objective standards because of its essentially relative character. In evaluating a bodily state, individuals have to use reference standards, such as the personal experience of stronger or weaker symptoms in the past, or beliefs about the perception of sensations by relevant others, such as patients or healthy individuals. Traditional scales on illness or symptom perception do not standardize these reference points for evaluation, but leave it to the patient to select an implicit and idiosyncratic anchor point for ratings. This might result in less reliable symptom ratings, because of the individual variability of implicit standards.

Effects of social comparison on illness attitudes have been demonstrated in diabetes, cancer, or chronic pain (for reviews, see Buunk & Gibbons, 1997; Suls, Martin, & Wheeler, 2002). Downward social comparison has received special interest in this research, because it has been shown that it can buffer against illness-related threat. Downward Social Comparison Theory (Wills, 1987) proposes that threatened people are more likely to compare themselves with others that are in a less favorable situation and that such downward comparisons are functional in boosting subjective well-being. These downward social comparisons reduce emotional discomfort (Gibbons & Gerrard, 1991; Jensen, Turner, Romano, & Karoly, 1991; Taylor, Wood, & Lichtman, 1983) and improve self-management of symptoms, for example in diabetes (e.g., Gorawara-Bhat, Huang, & Chin, 2008). A study using variations of the Implicit Association Test, a test of implicit attitudes based on reaction times, found that downward social comparison was changing the negative affective evaluation of asthma compared to when no explicit standard or a standard on a similar level was presented (Petersen & Ritz, 2010).

In contrast to downward comparison, upward comparison has often been found to have adverse effects, being linked to depressive mood, low-self-esteem and uncertainty (e.g., Allan & Gilbert, 1995). Depressed individuals tend to interpret social information more negatively than non-depressed individuals. Moreover, depressed individuals engage in unfavorable social comparison more often and react more negatively than non-depressed individuals (Baezner, Broemer, Hammelstein, & Meyer, 2006). Depressive mood has a high prevalence in chronic disease and has been found to impair health and health management (e.g., Chapman, Perry, & Strine, 2005; Prince et al., 2007). Repetitive and unfavorable temporal and social comparison which makes negative self-knowledge more easily accessible could be regarded as a specific form of rumination, which is defined as repetitive self-focused attention towards negative self-related topics contributing to depression (Nolen-Hoeksema, Parker, & Larson, 1994).

9.1. Assimilation and contrast in comparison processes

In including social and temporal comparison within the model, it is important to take into account that upward and downward comparison as such can lead to a positive as well as to a negative evaluative bias. Besides positive effects, downward social comparison has also been linked to undesirable effects for health management, such as unrealistic optimism and less prophylactic behavior (Klein & Weinstein, 1997). Furthermore, downward social comparison can also have negative effects on psychological well-being. The encounter with patients with the same, but further advanced symptoms might increase illness-threat by confronting the patient with thoughts about the future and the possibility of an aggravation (Buunk, Collins, Taylor, Van Yperen, & Dakof, 1990; Van der Zee, Buunk, Sanderman, Botke, & van den Bergh, 2000). On the other hand, upward comparison does not necessarily lead to depressive mood, but can encourage self-improvement cognitions and behavior if the individual believes that the goals accomplished by positive role models can also be achieved by them (Lockwood & Kunda, 1997; Bandura, 1997).

The Selective Accessibility Model (Mussweiler & Strack, 1999a,b) predicts that the effect of social comparison on illness and symptom representations depends on the hypothesis that is tested in the comparison process. With reference to this model, we propose that if the hypothesis is tested that one's illness and symptoms are different from those of a comparison standard, standard inconsistent knowledge about one's illness is made more readily accessible. In downward comparison in chronic disease, contrast focus can highlight positive aspects of one's health. Such a contrasting downward comparison can lead to more positive affect, a higher feeling of self-efficacy, and motivation to (further) engage in functional health behavior. If, however, downward social comparison is combined with assimilation focus, i.e., the hypothesis is tested that one's illness and symptoms are similar to the comparison standard self-knowledge might become more readily accessible which emphasizes the possibility of an aggravation (Buunk et al., 1990). Furthermore, identification with individuals who are doing worse might reduce feelings of self-efficacy and discourage engaging in functional coping strategies and increase negative affect.

10. Obstacles in detecting associations between psychological representations, affective consequences, and health behavior

Measures of psychological representations do not always correspond strongly with predicted affective consequences or with actual behavior (e.g., Ajzen, 2005; LaPiere, 1934). Besides context dependency of mental models, research has identified a number of further barriers and methodological shortcomings which can reduce the likelihood to identify a stable association between these variables (e.g., Ajzen, 2005) (Fig. 1g to h). Although these barriers have been explored mainly in the domain of social attitudes, they apply also to mental representations of bodily states and their relationship with behavior. External and internal factors that restrict individuals from expressing attitudes or from performing behavior are obvious limitations for identifying a relationship between mental models and behavior. These factors can be, for example, social or personal norms which classify the attitudes or the behavior as undesirable, fear

of negative reaction of others, a lack of ability to perform the behavior, or low perceived self-efficacy.

Furthermore, there are methodological shortcomings which can lower the likelihood to identify a relationship between mental models, affective consequences, and behavior. A lack of fit in levels of specificity on which mental models and behavior are assessed can be such an obstacle (Ajzen, 2005). For example, illness can be represented as a very general concept. However, it can be assumed that the more familiar patients become with a disease, the more specific their mental representations become in terms of aspects of single symptoms, details of the medical regime, or effects of the illness on physical, personal, or social levels. Assessing a general representation of the disease in these patients might not predict specific worries or specific forms of health behavior (e.g., use of medication, coping with acute symptoms, prophylactic behavior etc.).

In using mental representations to predict affective consequences and behavior, it has to be taken into account that coping with a disease is not always planned or intentional behavior. In fact, it has been proposed that most of the time, schemata will be activated automatically and that intentional, cognitively monitored activation will occur only when none of the existing schemata fits the perceptual data (e.g., symptom schemata; Brown, 2004). However, automatic activation of schemata is not in conflict with psychological representation of bodily states as proposed in the SIAM. The conceptualization of mental models as outlined in this report can be integrated easily within models of primary (automatic) and secondary (intentional) activation of schemata (e.g., Brown, 2004), because beliefs, i.e., subjective links between a sensation or an illness and other sensations, stimuli, or constructs in the subjective world of the perceiver can be acquired and activated either in an associative or in an intentional learning process. Allport (1935) defines attitudes or mental representations as "mental and neural state of readiness (…) exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related" (p.810). The individual can, but does not have to be aware of this state of readiness.

Implicit measures of attitudes which are automatically formed and activated have been shown to be better predictors for automatically activated behavior than explicit attitudes which need to be accessed intentionally to be reflected in self-report (e.g., Fazio & Olson, 2003). Thus, a match in modality of activation (automatic/intentional) and assessment (implicit/explicit) can be regarded to be important in identifying relationships between mental models of illness and symptoms and related behavior.

Several models have been devised to understand and predict health behavior, such as the Theory of Planned Behavior (Ajzen, 1991), the Health Belief Model (Janz & Becker, 1984), the Protection Motivation Theory (Rogers, 1983), or the Subjective Expected Utility Theory (Ronis, 1992). Differences and similarities among them have been reviewed elsewhere (e.g., Weinstein, 1993) and are not subject to this report. The aim of this report is to propose a model on factors that are relevant in the formation of illness and symptom representations and to devise a measurement model that allows an optimal assessment of these constructs by integrating theory on illness and symptom perception that has so far been isolated. Furthermore, the SIAM names psychological variables moderating the relationship of psychological representations and affective consequences and behavior intentions. In doing so, it provides at a meta-approach which focuses at processes connecting model components.

11. Research agenda

In this report we outlined an integrative theoretical approach to the measurement of psychological representations of bodily sensations and health and disease. To validate the proposed model in the domain of symptom and illness perception, we would need to show that the interaction of beliefs about a bodily state (e.g., the beliefs about a sensation as being linked to a pathological cause) and the valence of these beliefs (e.g., as being threatening) predicts affective consequences and health behavior beyond the variance explained by the single components. It could be hypothesized that symptom beliefs are only associated with comorbid affective disorder or behavior, such as avoidance of physical activity if their affective evaluation is clearly negative. This conditional relationship between can only be explored by including the interaction term in the equation.

Measurement instruments for illness representations, which have already been validated in recent research could be used to explore whether the interaction between subscales reflecting illness beliefs, such as beliefs about the timeline or causes of the disease and subscales reflecting affective illness evaluation, such as worries or positive re-evaluation is predicting variance of illness behavior beyond variance explained by the two components alone.

In a second step, we would need to explore the role of relative strength of illness and symptom representations compared to other salient attitude domains. If perception is inherently relative and dependent on context cues, the impact of illness and symptom perception on comorbid affective disorders or behavior intentions should change whenever new competing or supporting illness-unrelated attitudes become salient.

As outlined above, mental representations of illness and symptoms formed in a doctor's office might not survive the competition with representations related to other aspects of the self which are salient outside a medical context. We hypothesize that it would improve the predictive value of mental representations of illness and symptoms for affective consequences and health behavior to control for the strength of the illness or symptom attitudes compared to other attitude domains. If this could be supported empirically, it would be important to acknowledge potentially opposing or supporting illness-unrelated attitudes in the construction of rating scales for illness and symptom representation to provide potential targets for treatment. Treatment of comorbid depression or anxiety might need to target the whole network of mental representations related to the complete network of different self-aspects in the self-concept of a patient and not only the mental representations related to health, illness, and symptoms. While the notion that it is relevant to integrate a treatment in the everyday life of a patient is nothing new, the SIAM provides a theoretical basis and the measurement model for systematic research in this topic.

In a third step, we would need to test the impact of individual comparison standards on mental models of illness and symptoms. Implicit reference frames used by patients can be highly variable, such as other patients, healthy individuals, or symptoms on a good versus bad day. It has been demonstrated in two studies by Petersen et al. that social comparison direction and focus play a crucial role in self-evaluation of symptoms as well as in the reduction anxious mood in patients with COPD enrolled in pulmonary rehabilitation programs. Research is missing that explores the potential of intervention strategies targeting individual comparison styles to prevent and treat comorbid affective disorders and to improve health behavior.

For research in health psychology it is be relevant to consider that implicit individual comparison standards that are not accounted for in traditional ratings scales might constitute a major source of uncontrolled variance in symptom report. Even if a strong relationship between variables, such as mental representations of illness and symptoms and comorbid affective disorders or behavior is present, it might not be detected if one of the measures is burdened with high uncontrolled variance due to individual variability in anchor points for these ratings. Reducing this error variance by presenting explicit reference standards should result in more precise measures and better predictors for other variables, such as mood or behavior. This has been shown in research in other attitude domains where relative measures were more strongly correlated with self-reported behavior, observed behavior, and attitude

domain related knowledge compared to absolute ratings (Olson et al., 2007).

12. Conclusion

The SIAM represents a meta-approach based on an essentially content-free rationale which allows bringing together research and theory development of a number of so far unconnected research fields. We believe that the SIAM can be fruitful in providing a theoretical basis and a measurement model to target the relationship between psychological representations of bodily states and affective and behavioral consequence in an interdisciplinary way. We hope the model will help in facilitating synergistic effects between research domains within and outside clinical and health psychology. For clinical practice, the model can help to identify moderators in the formation of mental representations of health, illness, and bodily states which would be promising targets for efficient interventions to improve assessment of symptoms, functional symptom perception, and illness management as well as psychological well-being in chronic disease.

Acknowledgement

This work was supported by a grant of the German Research Society to the first author (PE1678/1-1).

Appendix A

Fig. 2 shows an example for the mental representation and relative centrality of asthma compared to other self-related attitude domains, such as family life, professional life, or leisure activities using the MDS approach. Psychological distance of single self-aspects was assessed in asking one participant (a female 19 year old student) to make mutual comparisons of the importance of nine self-aspects. Mutual distances on the map represent relative mutual similarities the patient perceived between these self-aspects. Asthma was a self-aspect low in importance for the self-representation of this patient, whereas having a social life and going out was highly central. Of course, relative centrality of asthma might have been different if other self-aspects had been included within the mutual comparisons or they had been made in another context, such as after an asthma attack or in the doctor's office.

Alternative to methods based on mutual comparisons such as MDS, the relative centrality of self-aspects can be assessed by rankings or ratings of a number of relevant domains. Rankings and ratings have the advantage to be more economic than mutual comparisons which require $k^*(k-1)/2$ ratings with k being the number of comparison objects. For nine comparison "objects" (self-aspects or relevant domains including health and disease) participants need to make 36 comparison ratings. Rankings can be obtained faster, but they cannot be used to explore latent dimensions underlying the rankings (Kruskal & Wish, 1994).

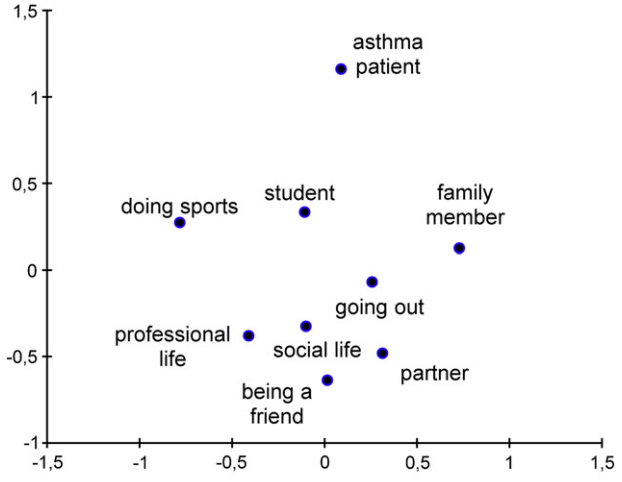

Fig. 2. Cognitive map representing mental model of different self-aspects assessed via mutual comparisons using MDS.

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