

The Common Sense Model of Self-Regulation: Meta-Analysis and Test of a Process Model

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## Abstract

1  
2 According to the common-sense model of self-regulation, individuals form lay  
3 representations of illnesses that guide coping procedures to manage illness threat. We meta-  
4 analyzed studies adopting the model to (a) examine the intercorrelations among illness  
5 representation dimensions, coping strategies, and illness outcomes; (b) test the sufficiency of  
6 a process model in which relations between illness representations and outcomes were  
7 mediated by coping strategies; and (c) test effects of moderators on model relations. Studies  
8 adopting the common-sense model in chronic illness ( $k = 254$ ) were subjected to random-  
9 effects meta-analysis. The pattern of zero-order corrected correlations among illness  
10 representation dimensions (identity, consequences, timeline, perceived control, illness  
11 coherence, emotional representations), coping strategies (avoidance, cognitive reappraisal,  
12 emotion venting, problem-focused generic, problem-focused specific, seeking social support),  
13 and illness outcomes (disease state, distress, well-being, physical, role, and social  
14 functioning) was consistent with previous analyses. Meta-analytic path analyses supported a  
15 process model that included direct effects of illness representations on outcomes and indirect  
16 effects mediated by coping. Emotional representations and perceived control were  
17 consistently related to illness-related and functional outcomes via, respectively, lower and  
18 greater employment of coping strategies to deal with symptoms or manage treatment.  
19 Representations signaling threat (consequences, identity) had specific positive and negative  
20 indirect effects on outcomes through problem- and emotion-focused coping strategies. There  
21 was little evidence of moderation of model effects by study design, illness type and context,  
22 and study quality. A revised process model is proposed to guide future research which  
23 includes effects of moderators, individual differences, and beliefs about coping and treatment.  
24 *Keywords:* Illness perceptions; illness cognition; coping procedures; parallel-processing  
25 model; chronic illness

1 **Public Significance Statement**

2 This review indicates that relations between patients' illness beliefs and important illness-  
3 related outcomes (reducing disease progression, improving functioning, promoting well-  
4 being, allaying distress) across studies are accounted for by sets of coping strategies  
5 (avoidance, cognitive reappraisal, emotion venting, problem-focused coping, seeking social  
6 support). Behavioral interventions aimed at changing illness outcomes should not only target  
7 change in the beliefs linked to adaptive outcomes, but also the coping strategies related to the  
8 beliefs.

9

10

1 The Common-Sense Model of Illness Representations: Meta-Analysis and Test of a Process  
2 Model

3 The identification and interpretation of a deviation from the normally-functioning  
4 physical and somatic self is fundamental to initiating self-regulatory processes to restore or  
5 protect a state of health, or even protect life itself. When an individual experiences a physical  
6 symptom, how does his or her particular conception of illness relate to efforts to manage  
7 symptoms, and what processes lead the individual to engage in long-term self-regulatory  
8 action that will be effective in changing the course of the illness rather than symptom  
9 management alone? Prominent among social psychological approaches to understanding the  
10 regulatory mechanisms involved in managing perceived illness-related threats (e.g., Carver,  
11 Scheier, & Weintraub, 1989; Rodin & Salovey, 1989) is the 'common-sense' model of self-  
12 regulation. The model outlines the processes underlying individuals' lay management of  
13 health threats (Leventhal, Diefenbach, & Leventhal, 1992; Leventhal, Leventhal, & Breland,  
14 2011; Leventhal, Meyer, & Nerenz, 1980; Leventhal, Phillips, & Burns, 2016).

15 According to the model, an understanding of adaptation to health threats originates in  
16 an examination of threat from the individual's lay perspective. Specifically, it is necessary to  
17 understand the individual's cognitive and emotional representations of the threat that initiate  
18 subsequent coping procedures directed at threat and emotion management. These two parallel  
19 processes together represent a self-regulatory system with significant implications for illness  
20 outcomes such as disease, functional state, and psychological distress that are independent of  
21 the pathological markers of illness. For example, severe emotional reactions to symptoms  
22 arising from fear that the illness may be life threatening may lead to management by  
23 avoidance coping. Similarly, a cognitive representation that misattributes the cause of  
24 symptoms may lead to ineffective attempts at self-directed treatment (Leventhal et al., 1992).

1           Whereas research on the common-sense model of self-regulation has indicated that  
2 cognitive and emotional representations of illness are related to coping procedures adopted to  
3 manage illness threat and distress, and to illness-related outcomes such as recovery or  
4 symptom management (Brown, Westbrook, & Challagalla, 2005; Whitmarsh, Koutantji, &  
5 Sodell, 2003), few studies have explicitly tested the processes involved. Based on the  
6 hypotheses derived from Leventhal et al.'s model, a *process model* has been proposed in  
7 which "relationships [between illness representations, coping, and outcomes] represent a  
8 mediational model, in which coping mediates the effect of illness representations on health  
9 outcomes" (Hagger & Orbell, 2003, p. 146). Although there have been previous tests of the  
10 process model in participants with particular chronic illnesses (e.g., Brewer, Chapman,  
11 Brownlee, & Leventhal, 2002; Gould, Brown, & Bramwell, 2010; Gray & Rutter, 2007;  
12 Rutter & Rutter, 2002), there has been no systematic test of a full process model adopting  
13 multiple representation, coping, and outcome variables based on a cumulative synthesis of  
14 data across research on the common-sense model in chronic illness.

15           We aim to conduct a meta-analytic synthesis of studies testing relations from the  
16 common-sense model in chronic illness and use the correlations from the analysis to test the  
17 proposed process model. Not only do we expect that quantifying the overall effects of illness  
18 representations on outcomes mediated by coping to be of interest, we also expect to identify  
19 specific indirect effects that will indicate the extent to which illness representations are  
20 positively associated with outcomes related to recovery and effective management, or  
21 undermine recovery such as poorer functioning and well-being, and elevated distress. The  
22 mediational model may be informative in resolving inconsistent patterns of effects observed  
23 in previous studies and may potentially inform practice by identifying viable targets for  
24 intervention. In addition, the synthesis enables us to assess the influence of moderator  
25 variables that may explain variability in relations among model constructs across studies.

## 1 **The Common-Sense Model of Self-Regulation: Origins and Conceptualization**

2           The common-sense model was developed to understand how patients' lay perceptions  
3 of illness threats guide coping strategies to deal with those threats (Leventhal et al., 1980).  
4 The model is illustrated in Figure 1. The substantive *content* of an illness representation,  
5 derived from multidimensional scaling studies (Bishop & Converse, 1986; Linz, Penrod, &  
6 Leventhal, 1982) and open-ended interviews (Baumann, Cameron, Zimmerman, &  
7 Leventhal, 1989; Lau & Hartman, 1983), and formalized in psychometric instruments such as  
8 the illness perception questionnaire (IPQ; Weinman, Petrie, Moss-Morris, & Horne, 1996),  
9 comprises five main dimensions of the cognitive representation of illness: identity, timeline,  
10 cause, consequences, and perceived control. The *identity* of the illness is characterized by its  
11 symptoms and label; *timeline* reflects the rate of onset, duration, and fluctuation in the illness;  
12 *cause* is the perceived causal antecedents of the illness (e.g., genetics, infection, diet, aging,  
13 or other exacerbating factors); *consequences* reflects beliefs in the extent to which the illness  
14 will seriously impact life events (e.g., work, family, personal relationships); and *perceived*  
15 *control* is defined as whether the illness is expected to be, or has previously been, responsive  
16 to self-initiated or medically-prescribed treatment. A sixth dimension, *illness coherence*,  
17 representing patients' comprehension of their illness, was included in the revised illness  
18 perceptions questionnaire (IPQ-R; Moss-Morris et al., 2002). Illnesses may be more or less  
19 coherently represented, depending on the extent to which the patient's current illness  
20 representation matches stored prototypes of the illness and illnesses with similar content. The  
21 representation is also informed and modified by communications from health providers and  
22 intra-personal factors such as personality and individual differences (Leventhal et al., 1992).

23           The model also identifies emotional representations that reflect individuals' affective  
24 responses to illness and may independently affect selection of coping procedures in parallel  
25 to cognitive representations (Figure 1). According to Martin, Leventhal, and Leventhal

1 (2003), “affective and cognitive responses to symptoms may or may not be compatible. For  
2 example, a person might understand that a symptom (e.g., bloody stools) could have serious  
3 consequences if left untreated. This belief might motivate care seeking in the interests of  
4 early detection. However, for some people, the fear of potentially receiving an ominous  
5 diagnosis (e.g., of cancer) actually might inhibit self-referral behavior” (p. 210). Emotional  
6 representations were also included as an additional component in the IPQ-R (Moss-Morris et  
7 al., 2002). The measure has enabled tests of relations between individuals’ reflections on their  
8 emotional responses to the illness and outcomes such quality of life, and emotional coping  
9 responses such as emotion venting, alongside cognitive illness representations, (e.g., Evans &  
10 Norman, 2009; Knibb & Horton, 2008; Rozema, Völlink, & Lechner, 2009).

11       Illness representations are conceptualized as memory structures and may be activated  
12 by a novel somatic change or salient information and lead to a search for a matching illness  
13 prototype stored in memory. This is the first stage in the process of recognizing that one is ill,  
14 and initiates self-evaluation (e.g., recognizing other symptoms, observing whether they go  
15 away), self-management of illness (e.g., attempting to control the symptoms), and consulting  
16 a professional (Leventhal et al., 2011). These stimuli are depicted to the left of Figure 1. The  
17 progression to professional treatment may sometimes bypass both self-evaluation and self-  
18 management, when, for example, an acute event provokes immediate hospitalization leading  
19 to diagnosis of illness, or when screening procedures identify diseases such as breast cancer  
20 without any prior symptomatic information indicating to the individual that they are ill.

21       Also important are the moderating effects of socio-cultural and personal variables,  
22 labelled the ‘self-system’ by Leventhal et al. (1992), that may influence interpretation of, and  
23 response to illness stimuli, depicted at the top of Figure 1. For example, an individual may  
24 perceive a headache and muscle ache as symptoms of a benign illness such as a common  
25 cold. However, if such symptoms occurred after visiting a region where malaria is prevalent,



1 they might activate representations of serious infectious disease associated with elevated  
2 threat. Illness schema can be activated from sources which may be directly symptomatic and  
3 concrete, but also arise independent of symptoms based on more abstract internal states that  
4 interact with contextual knowledge (Orbell, Henderson, & Hagger, 2015).

5       Following the identification of illness and the activation of an illness schema  
6 associated with an illness label (e.g., multiple sclerosis, diabetes, rheumatoid arthritis, cancer,  
7 asthma), a dynamic self-regulatory process is initiated, comprising attempts to manage the  
8 health threat and concomitant emotional reactions (Leventhal, Brissette, & Leventhal, 2003;  
9 Leventhal et al., 1980). These self-regulatory efforts are labeled coping procedures in the  
10 common-sense model and follow from cognitive and emotional representations. For example,  
11 an individual with bowel cancer may view the illness as having painful symptoms, a chronic  
12 timeline, and controllable through dietary change, and therefore view a change of diet as an  
13 effective means to cope with the disease progression. An individual who believes the same  
14 disease is uncontrollable and finds it a source of emotional distress may adopt a denial coping  
15 response. The parallel arrowed pathways in Figure 1 depict links between the representation  
16 dimensions and coping procedures. Importantly, the adopted coping procedures will make  
17 ‘common sense’ to the individual in that they follow from their lay representations, regardless  
18 of the type and effectiveness of the coping procedure adopted (Leventhal et al., 1992).

19       While the common-sense model does not specify particular coping procedures, a  
20 number of theoretically-derived coping dimensions have been employed that broadly  
21 correspond to problem- or threat-focused and emotion-focused coping categories (Carver et  
22 al., 1989; Folkman & Lazarus, 1988). Consistent with the proposal that illness cognitions are  
23 schematic in nature (Henderson, Hagger, & Orbell, 2007; Leventhal & Cleary, 1980;  
24 Leventhal et al., 2011), studies have demonstrated that automatic activation of an illness  
25 representation is associated with activation of relevant coping procedures (Henderson, Orbell,

1 & Hagger, 2009). Information regarding ‘typical’ coping responses may, therefore, be  
2 represented in memory alongside information about the illness and activated and modified  
3 accordingly when information regarding the illness (e.g., felt symptoms) is made salient.

4         The common-sense model posits that cognitive and emotional representations will  
5 affect outcomes that indicate the progress of the illness (e.g., disease state), the individual’s  
6 functional capacity, and perceived health status. Representations guide the individual’s  
7 selection of an appropriate coping strategy, a ‘common sense’ solution to the illness threat. In  
8 a process of appraisal depicted in Figure 1 an individual will experience if the strategy has led  
9 to improvement, no change, or deterioration in symptoms and adjust his or her representation.  
10 These ‘feedback loops’ characterize the model as a dynamic framework: It describes the  
11 process by which individuals represent their illness, select coping procedures, and modify  
12 their representations through an appraisal of the coping and subsequent experience of illness.

### 13 **A Critical Appraisal of Research on the Common-Sense Model of Self-Regulation**

14         Hagger and Orbell (2003) tested the hypothesized relations among common-sense  
15 model constructs in a meta-analysis of studies applying the model in chronic illness. The  
16 studies measured illness perceptions and specific coping and outcome measures that were  
17 systematically classified into categories based on theory and research (Carver, Scheier, &  
18 Pozo, 1992; Carver et al., 1989; Stewart et al., 1992; Veit & Ware, 1983) and corroborated by  
19 expert consensus. The analysis revealed a consistent pattern of relations such that  
20 representation dimensions that signal an elevated level of threat, namely, serious  
21 consequences, illness identity, and a chronic timeline were positively associated with  
22 emotion-focused coping procedures including expressing emotions and denial. Perceptions of  
23 the illness as controllable were positively associated with problem-focused coping strategies,  
24 and with cognitive reappraisal. Relations between the illness representation dimensions and  
25 illness outcomes revealed positive associations of the threat dimensions with psychological

1 distress, and negative associations with outcomes such as physical and social functioning, and  
2 psychological well-being. Perceived control was positively associated with functioning,  
3 vitality and psychological well-being, and negatively related to disease state<sup>1</sup>. The pattern of  
4 effects identified by Hagger and Orbell (2003) have been subsequently corroborated in meta-  
5 analyses of subsets of the research literature on the common-sense model (Brandes & Mullan,  
6 2014; Broadbent et al., 2015; Dempster, Howell, & McCorry, 2015; French, Cooper, &  
7 Weinman, 2006; Hudson, Bundy, Coventry, & Dickens, 2014; Mc Sharry et al., 2011).

8         The typical pattern of relations between representations, coping, and outcomes  
9 derived from previous research neglects to account for the moderating influence of contextual  
10 factors. For example, transactional models of stress and coping indicate that problem-focused  
11 coping strategies may not be adaptive if adopted to manage illnesses that are not controllable  
12 (Lazarus & Folkman, 1984). Emotion-focused strategies may be more effective in these  
13 contexts as they help individuals manage negative emotional reactions caused by the  
14 perceived illness threat. This was recognized by Leventhal et al.'s (1992) 'goodness-of-fit'  
15 hypothesis, which indicates that the effectiveness of coping strategies on recovery and illness  
16 progression is context dependent. However, current meta-analytic data do not account for the  
17 effects of these contextual factors (e.g., Dempster et al., 2015; Hagger & Orbell, 2003).

18         From a theoretical perspective, meta-analyses of studies of the common-sense model  
19 suggest that representations that signal illness threat do not guide individuals to adopt  
20 problem-focused coping strategies as hypothesized by Leventhal et al. (1980) in their original  
21 conceptualization of the model. The meta-analytic research indicates that these beliefs tend to  
22 be related to coping procedures that are emotion-focused, or, at least, not problem focused,

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<sup>1</sup>Hagger et al.'s (2003) analysis did not include the emotional representation and illness coherence dimensions as few studies at the time had adopted the revised IPQ and there were insufficient studies reporting effect sizes for these studies. Studies and quantitative syntheses have since demonstrated statistically significant and positive relations between emotional representations and outcomes related to increased illness progression and decreased functioning (Broadbent, Petrie, Main, & Weinman, 2006; Mc Sharry, Moss-Morris, & Kendrick, 2011), while illness coherence has been related to better functioning and well-being (Paddison, Alpass, & Stephens, 2008; Karademas, 2012).

1 such as avoidance or denial. From a lay beliefs perspective, such coping responses make  
2 common sense; the immediate management of emotional upheaval is an important first step  
3 in active illness management because emotional distress is likely to interfere with  
4 individuals' capacity to formulate and engage in problem-focused coping strategies  
5 (Leventhal et al., 1980). This interpretation notwithstanding, threat perceptions are likely to  
6 guide problem-focused coping when the individual has a clear, concrete "reality-bound  
7 picture of a knowable threat and not a mysterious, remote, uncertain, and infinitely  
8 threatening view of the illness process" (Leventhal et al., 1980, p. 20). There is empirical  
9 support for this hypothesis, indicating that threat perceptions (e.g., high perceived  
10 consequences) are related to treatment-seeking coping behaviors such as medication  
11 adherence (Brewer et al., 2002), adherence to medical advice (Karademas, Karamvakalis, &  
12 Zarogiannos, 2009), and self-care behaviors (MacInnes, 2013). Contextual factors such as  
13 illness familiarity and coherence may determine whether threat perceptions lead to problem-  
14 or emotion-focused coping. Current meta-analytic data, therefore, capture overall tendencies  
15 to prioritize emotion management in response to the perceived threat posed by the illness, but  
16 may not reflect instances when the threat informs problem-focused coping efforts.

17         From an empirical perspective, it is important to note that no prior meta-analytic  
18 synthesis of relations among the constructs of the common-sense model has controlled for the  
19 effects of the other representation, coping, and outcome dimensions since they rely solely on  
20 zero-order relations. Given the consistently strong intercorrelations among representation  
21 dimensions, particularly among the threat dimensions (Hagger & Orbell, 2003), it is likely  
22 that there will be a considerable degree of shared variance among these constructs that will  
23 lead to substantively attenuated effects of illness representation dimensions on coping and  
24 outcome constructs in multivariate analyses relative to the zero-order correlations (e.g., Evans  
25 & Norman, 2009; Griva, Jayasena, Davenport, Harrison, & Newman, 2009). These findings

1 highlight the importance of conducting multivariate tests when synthesizing findings using  
2 meta-analysis. This will permit identification of the unique effects of each representation  
3 dimension on coping and outcome constructs controlling for the other dimensions (cf.  
4 Hagger, Chan, Protogerou, & Chatzisarantis, 2016; Hagger & Chatzisarantis, 2016).

### 5 **A Process Model of ‘Common-Sense’ Illness Representations**

6 Central to the common-sense model is the assertion that individuals’ cognitive and  
7 emotional representations of an illness threat will motivate a coping response to mitigate the  
8 threat and related distress. Conceptually, therefore, specific coping procedures are proposed  
9 to mediate the representation-outcome relations in the model (Figure 2). The inclusion of  
10 multiple representation dimensions along with numerous types of coping responses and  
11 illness outcomes means that specific effects of each illness representation on illness outcomes  
12 through coping strategies can be proposed and tested. From an analytic perspective, therefore,  
13 illness representations “may exert effects [on illness outcomes] by eliciting or suppressing  
14 both adaptive and maladaptive coping responses” (Gould et al., 2010, p. 635).

15 The accuracy of the process model can be evaluated on two levels. Taking a  
16 generalized perspective, evaluating the extent to which coping mediates relations between  
17 representation dimensions and illness outcomes will provide a test of the *sufficiency* of the  
18 model. This would be a substantial advance on previous meta-analytic tests of the model  
19 which have relied exclusively on zero-order correlations among constructs, a sub-optimal  
20 approach to testing unique effects in social cognitive models (Hagger, Chan, et al., 2016).  
21 Empirically, examination of the total indirect effects of all representation dimensions on  
22 illness outcomes with all coping constructs as multiple mediators affords an assessment as to  
23 the extent to which coping fully accounts for the impact of representations on outcomes. An  
24 alternative hypothesis would be that a total indirect effect is present, but direct effects also  
25 exist, such that representation dimensions have unique effects on the outcome that are not

1 explained by coping. However, if the total indirect effects are found to be trivial or zero in the  
2 presence of the direct effects, it would raise serious questions as to the adequacy of the  
3 process model and could be grounds for its rejection.

4         The process model also permits a more fine-grained evaluation of the specific coping  
5 mediated pathways by which individual representation constructs relate to outcomes. At this  
6 level, testing for specific indirect effects may provide an indication of pathways not evident  
7 when observing the total indirect effects, and may be ‘missed’ in an evaluation of the model.  
8 For example, illness representations signaling threat (e.g., beliefs that an illness is highly  
9 symptomatic, will have serious consequences, and has a chronic timeline) may compel an  
10 individual to take action to attenuate the threat, consistent with Leventhal et al.’s (1980)  
11 original hypothesis. Such actions may lead to adaptive improvements in illness outcomes.  
12 However, the same representations may also lead an individual to engage in coping strategies  
13 to manage negative feelings evoked by the perceived threat, such as emotion venting or  
14 avoidance. Such strategies may not lead to improvements in disease state and functioning,  
15 although they may make the person feel better. Illness identity, consequences, and timeline  
16 may have two sets of specific indirect effects on illness outcomes through different coping  
17 strategies that are not identified by observation of the total indirect effects alone.

18         The specific mediated pathways by which illness perceptions relate to outcomes  
19 through coping procedures have seldom been explored in research on the common-sense  
20 model. A few previous tests provide some preliminary evidence for the mediation hypothesis  
21 in the common-sense model. For example, studies have found that perceived consequences  
22 has a positive indirect effect on outcomes like anxiety and depression through emotion  
23 venting and acceptance coping strategies (Benyamini, Gozlan, & Kokia, 2004; Evans &  
24 Norman, 2009; Rutter & Rutter, 2002), while other studies have found a negative indirect  
25 effect on adaptive outcomes like improved mental health and better social functioning

1 through avoidance (Heijmans, 1999). These mediation analyses corroborate the pattern of  
2 effects in correlational analyses. However, some mediation analyses revealed indirect effects  
3 that did not conform to this pattern, but are consistent with Leventhal et al.'s proposal that  
4 threat representations motivate problem-focused coping procedures and better illness  
5 outcomes. For example, Brewer et al. (2002) found indirect effects of perceived  
6 consequences on cholesterol levels of hypercholesterolemic patients mediated by medication  
7 adherence, a problem-focused coping strategy. Such findings illustrate the potential for  
8 mediation analyses to reveal process-related effects not evident when observing total indirect  
9 effects or zero-order relations among illness representations, coping strategies, and illness  
10 outcomes.

11 To date, tests of the process model are limited in that they were selective in the illness  
12 representation and coping dimensions included in their mediation analysis and were restricted  
13 to single illnesses and samples. A stronger evaluation of the process model needs to include  
14 multiple illness representation, coping strategy, and outcome measures simultaneously across  
15 conditions and samples, and adopt appropriate multivariate confirmatory analyses (e.g., path  
16 analysis, structural equation modeling). Such an analysis would permit a test of the  
17 nomological validity of the process model including an explicit test of multiple mediation  
18 effects, and their magnitude and sign, positive or negative (Bagozzi, 1981; Hagger, Chan, et  
19 al., 2016). Our current analysis will also address the limitations of previous tests of the  
20 process model by providing a comprehensive test of the mediational pathways that includes  
21 all illness representation dimensions and multiple coping and outcome variables based on a  
22 cumulative synthesis of findings from empirical research on the common-sense model in  
23 chronic illness.

24 **The Present Review**

1           The current research is timely given the piqued interest in the common-sense model  
2 (Law, Tolgyesi, & Howard, 2012; Leventhal et al., 2011; Leventhal et al., 2016; Petrie &  
3 Weinman, 2012; Wearden & Peters, 2008) and its processes (Benyamini et al., 2004; Brewer  
4 et al., 2002; Gould et al., 2010), and the proliferation of research testing its component  
5 relations. Based on the foregoing review and critique we aim to test a process model derived  
6 from Leventhal et al.'s common-sense model based on a meta-analytic synthesis of findings  
7 from studies measuring illness representations, coping strategies, and illness outcomes in  
8 patient groups with chronic illnesses or conditions<sup>2</sup>. A critical mass of studies now exists  
9 making a model test based on a cumulative synthesis of the available literature feasible. Our  
10 analysis will extend previous research by employing a full matrix of correlations, providing a  
11 test of model sufficiency that takes account of shared variance among model constructs,  
12 identifying specific indirect effects, and evaluating contextual moderators of model relations.

13           **Zero-order intercorrelations.** The starting point of our analysis is to conduct a meta-  
14 analytic synthesis of studies on chronic conditions or illnesses. Across studies, we will  
15 examine the zero-order, univariate patterns of relations among the three sets of variables that  
16 constitute the process model: illness representation dimensions, coping strategies, and illness  
17 outcomes.

18           **Testing the sufficiency of the process model.** We will subsequently subject the  
19 corrected zero-order correlation matrix of the representation, coping, and outcome variables  
20 to meta-analytic path analysis (Hagger, Chan, et al., 2016) to test the proposed mediation  
21 effects in the process model. The hypothesized model is depicted in Appendix A  
22 (supplemental materials). For the sake of parsimony, six separate path analyses of the process  
23 model are proposed, one with each illness outcome (disease state, distress, physical

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<sup>2</sup>Although there is no universal definition of a chronic illness or condition, there is general consensus on the characteristics that constitute chronic illness (Goodman, Posner, Huang, Perekh, & Koh, 2013). For the purposes of the current research, we define a chronic illness as a departure from a state of physical or mental well-being lasting more than three months (US Department of Health and Human Services, 2011) that likely requires ongoing medical care and limits activities of daily living (US Department of Health and Human Services, 2013).



1 functioning, psychological well-being, role functioning, social functioning) as the dependent  
2 variable. In each analysis, the illness representation dimensions will be set as predictors of the  
3 coping constructs, and each coping construct will be set as a predictor of the outcome. The  
4 coping variables will serve as multiple mediators of each illness representation dimension on  
5 the outcome. To test the sufficiency of the model, we propose a generalized hypothesis in  
6 which the illness representation dimensions have statistically significant non-zero total  
7 indirect effects on each illness outcome mediated by the coping constructs with no direct  
8 effects of the representations on outcomes. An alternative model is also envisaged in which  
9 representations are related to outcomes via two pathways: directly, and indirectly through  
10 coping. In this case, the direct relations between representations and outcomes would be  
11 attributable to mediators other than the identified coping constructs.

12       **Testing model pathways.** The analysis will also permit examination of specific  
13 indirect coping pathways which might be missed by examining the total indirect effects  
14 alone. In particular, we sought to address inconsistent evidence that threat representations  
15 have positive indirect effects on maladaptive outcomes mediated by emotion-focused coping  
16 (Benyamini et al., 2004; Gould et al., 2010; Rutter & Rutter, 2002), but have also been found  
17 to predict adaptive outcomes mediated by the adoption of problem-focused coping strategies  
18 (e.g., Brewer et al., 2002). Representation dimensions may have multiple effects on adaptive  
19 (e.g., reduced distress, better functioning) and maladaptive (e.g., greater distress, increased  
20 illness state) outcomes through specific coping strategies. These pathways may not have been  
21 observed previously because researchers have not tested comprehensive models in which the  
22 indirect effects of all representation dimensions on illness outcomes are specified through  
23 multiple coping constructs.

24       **Testing for moderators.** Previous meta-analyses have observed considerable  
25 heterogeneity in relations among model constructs (Broadbent et al., 2015; French et al.,

1 2006; Hagger & Orbell, 2003). As a goal of meta-analysis is to identify and explain  
2 heterogeneity unattributed to methodological artifacts such as sampling and measurement  
3 error, we aim to examine the effects of five candidate moderators with methodological and  
4 conceptual bases: study design, illness type, medically-explained versus medically-  
5 unexplained illness symptoms, illness stage, and study methodological quality. We aim to test  
6 whether the relations among model constructs differed across moderator groups and plan to  
7 conduct sensitivity analyses testing whether the pattern of effects in the process model varied  
8 substantially across levels of the moderators.

9         Study design is an important methodological moderator given that effects in social  
10 cognitive models tend to be attenuated when variables identified as antecedents and  
11 consequents are measured at different time points. For example, attenuation may occur due to  
12 patients modifying their illness representations over the time course of the illness due to  
13 experience with treatment, or changes in symptoms. A time lag between self-report measures  
14 also reduces the impact of common method variance, which has the tendency to inflate  
15 correlations (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). We therefore expect relations  
16 between model constructs to be weaker in studies with prospective and longitudinal designs.  
17 We also plan to make the distinction between correlational and experimental studies as  
18 experimental designs also tend to exhibit weaker relations among constructs relative to  
19 correlational designs. However, few studies have experimentally manipulated illness  
20 representations so it might be unreasonable to expect this distinction to reveal moderation of  
21 model effects. We expect no moderation of the intercorrelations by study design as illness  
22 constructs are typically measured concurrently, regardless of design.

23         Contextual factors have been identified as key moderators of the effects of illness  
24 representations on coping strategies and illness outcomes (Leventhal et al., 1992; Leventhal  
25 et al., 1980). Illnesses vary in their symptomatology, impact on the patients' life, chronicity,

1 and responsiveness to treatment. We aim to examine the effects of specific illness types on  
2 relations between illness representation dimensions and coping and outcomes. Cancer is an  
3 illness likely to evoke strong negative reactions given its general cultural association with  
4 serious consequences (Erblich, Montgomery, Valdimarsdottir, Cloutre, & Bovbjerg, 2003;  
5 Henderson et al., 2007). We expect studies of cancer patients to report stronger effects of  
6 emotional representations and threat-related cognitive representations on emotion-focused  
7 coping. We also predict stronger effects of cognitive representations on problem-focused  
8 coping given the seriousness of the condition and relatively well-stipulated management  
9 regimens for cancers. We also expect to observe similar patterns of effects in studies of  
10 patients with cardiovascular disease and diabetes given the high prevalence and well-known  
11 debilitating outcomes of these illnesses. These illnesses are also likely to evoke strong  
12 emotional responses and elevated threat beliefs with similar effects on coping and outcomes  
13 in the model (Aalto, Heijmans, Weinman, & Aro, 2005; Mc Sharry et al., 2011).

14 Another candidate moderator is whether the illness or condition has a medically-  
15 supported etiology with clear prognosis and treatment or whether the condition is medically  
16 unexplained (Deary, Chalder, & Sharpe, 2007). Although the existence of a medical  
17 explanation does not necessarily imply congruence between expert and lay representations of  
18 the illness, the presence of a medical explanation provides a greater likelihood that the illness  
19 will be understood by patients and may be manifested in greater perceived coherence and  
20 control with respect to the illness; perceptions that may lead to the adoption of more adaptive  
21 coping strategies. In contrast, conditions with medically-unexplained symptoms (e.g., chronic  
22 fatigue syndrome, forms of chronic pain, fibromyalgia) are likely to be associated with less  
23 coherence, greater perceptions of chronicity and emotional representations, increased  
24 likelihood of attributing symptoms to the condition, and heightened concerns of the impact of  
25 the illness on life. Such perceptions may lead to emotion-focused or avoidant coping

1 responses (e.g., catastrophizing thoughts, denial, hypervigilance), which likely lead to  
2 outcomes that are maladaptive from a medical model perspective (Moss-Morris, Spence, &  
3 Hou, 2011). We therefore expect illness representation dimensions signaling threat to be  
4 related to emotion-focused coping strategies such as emotion venting among patients with  
5 medically-unexplained symptoms. Similarly, we expect stronger links between these  
6 dimensions and maladaptive outcomes such as increased distress and lower functioning in  
7 patients with medically-unexplained symptoms.

8         Stage of illness is a further viable moderator. Consistent with model hypotheses, the  
9 impact of representations on coping strategy selection is expected to vary in accordance with  
10 whether the illness is in an early-stage diagnosis or whether the diagnosis is distal and  
11 experience with the condition is more extensive. As threat perceptions and adverse emotional  
12 responses are likely to be elevated on initial diagnosis, we expect stronger effects of threat  
13 perceptions (consequences, timeline, and identity) and emotional representations on emotion-  
14 focused coping strategies, and weaker effects on problem-focused coping strategies, in  
15 studies of recently-diagnosed patients relative to those on patients for whom some time had  
16 elapsed since diagnosis. As patients receive more information and have greater experience  
17 with symptoms and treatment over time, they may adopt more problem-focused coping  
18 strategies in response to threat-related and control representations. Testing for the moderation  
19 effects of illness stage is therefore likely to capture a dynamic process in the model in which  
20 coping responses change with illness and treatment experience (Leventhal et al., 2016).

21         Consistent with research highlighting the potential of inadequate methodological  
22 quality to bias synthesized effects when conducting meta-analyses (Johnson, Low, &  
23 MacDonald, 2014), we aim to conduct an assessment of the quality of the included studies.  
24 Quality assessments will be used in sensitivity analyses to evaluate whether conclusions  
25 based on the analysis are affected if studies with a high risk of bias were included.

## 1 **Method**

### 2 **Literature Search and Inclusion Criteria**

3 An electronic literature search was conducted using Web of Science (1980 to  
4 December, 2013) as the primary database with identical searches conducted in the following  
5 databases: Scopus, OVID PsycARTICLES, and PubMed. The search included the keywords  
6 *illness perception, illness cognition, illness representation, illness belief, and common-sense*  
7 *model*. In addition, a cited reference search was conducted to identify articles citing key  
8 theoretical overviews of the common-sense model (e.g., Leventhal et al., 1997; Leventhal et  
9 al., 2003; Leventhal et al., 1992; Leventhal, Leventhal, & Contrada, 1998; Leventhal et al.,  
10 1980). Furthermore, efforts were made to obtain any ‘fugitive literature’ (Rosenthal, 1994) in  
11 the form of missing correlations or unpublished datasets by contacting authors directly (see  
12 Appendix B, supplemental materials, for a flowchart of the search, selection, and inclusion  
13 process).

14 We developed a priori criteria for the inclusion of studies in the meta-analysis. Studies  
15 were considered eligible for inclusion if they reported quantitative relations between one or  
16 more illness representation dimensions from Leventhal et al.’s (1980) common-sense model  
17 and at least one coping or outcome variable directly related to a chronic illness or condition.  
18 Qualitative research (e.g., Bishop & Converse, 1986; Morris & Ogden, 2012), narrative  
19 reviews (e.g., DiMatteo, Haskard-Zolnierok, & Martin, 2012), study protocols (e.g., Gray et  
20 al., 2012), theoretical articles (e.g., Rees, Fry, & Cull, 2001), non-English language articles  
21 (e.g., Balck, Preuss, Hendrischke, & Lippmann, 2012), studies on acute illnesses or  
22 conditions (e.g., Lau, Bernard, & Hartman, 1989; McCarthy, Lyons, Weinman, Talbot, &  
23 Purnell, 2003), studies measuring illness representations but no coping or outcome variables  
24 or scale-development articles (e.g., Chilcot, Norton, Wellsted, & Farrington, 2012; Hagger &  
25 Orbell, 2005), studies measuring illness representations in healthy populations (e.g., Figueiras

1 & Alves, 2007), studies using a composite illness representation score (e.g., Chilcot & Moss-  
2 Morris, 2013), studies on hypothetical reactions to illnesses (e.g., Karademas, Bati, Karkania,  
3 Georgiou, & Sofokleous, 2013), studies on screening behavior or other preventive measures  
4 in healthy samples (e.g., Anagnostopoulos et al., 2012), studies on conditions that are part of  
5 a normal variation in health state rather than a chronic illness or condition such as menopause  
6 (e.g., Hunter & O’Dea, 1999), studies involving representations of mental disorders (e.g.,  
7 Lobban, Barrowclough, & Jones, 2005), and studies adopting proxy measures of illness  
8 representations in others (e.g., Janse, Sinnema, Uiterwaal, Kimpen, & Gemke, 2005) did not  
9 meet the inclusion criteria and were excluded.

#### 10 **Included Studies and Characteristics**

11         The literature research identified 333 articles that met inclusion criteria on initial  
12 screening (Appendix C, supplemental materials). A substantial proportion of the eligible  
13 articles ( $k = 172$ ) did not report the necessary data for the analysis. The corresponding authors  
14 of these articles were contacted to obtain additional data. We were unable to source the  
15 unreported data for 39 articles, and several articles either reported data from multiple samples  
16 within a single study or comprised overlapping samples (multiple studies using the same  
17 data). Details of articles providing multiple and overlapping samples are provided in Tables 1  
18 and 2 in Appendix D (supplemental materials). The final sample comprised 254 studies with  
19 270 independent samples and a total sample size of 52,599. Summary characteristics of the  
20 included studies including sample sizes, study design, demographic details, illness types  
21 encompassed by the studies, moderator coding, and additional variables are provided in Table  
22 3 in Appendix E (supplemental materials). Studies focused on a diverse range of illnesses and  
23 conditions with forms of cardiovascular disease ( $k = 36$ ), diabetes ( $k = 32$ ), cancers ( $k = 22$ ),  
24 arthritis ( $k = 16$ ), forms of chronic pain ( $k = 12$ ), chronic obstructive pulmonary disease ( $k =$   
25 9), end-stage renal disease ( $k = 9$ ), chronic fatigue ( $k = 7$ ), multiple sclerosis ( $k = 7$ ), irritable

1 bowel syndrome ( $k = 6$ ), psoriasis ( $k = 6$ ), and hypertension ( $k = 4$ ) the most frequently cited.  
2 Studies were largely focused on older samples (median of the average sample age reported in  
3 studies = 52 years) with most studies having approximately equal ratios of females and  
4 males. Single sex samples were usually due to studies targeting illnesses that generally affect,  
5 or occur exclusively in, females (e.g., cervical cancer) or males (e.g., prostate cancer). Other  
6 than measures of illness representations, coping strategies, and illness outcomes, a number of  
7 studies also included concurrent measures of belief-based, social cognitive, and individual  
8 difference constructs. Prominent among these constructs were beliefs about treatment,  
9 particularly beliefs about medicines measured by the beliefs about medicines questionnaire  
10 (BMQ; Horne, Weinman, & Hankins, 1999), and personality constructs, including constructs  
11 from the ‘big five’ personality traits (e.g., Skinner, Hampson, & Fife-Schaw, 2002), optimism  
12 and pessimism (e.g., Heijmans & De Ridder, 1998b), and positive and negative perfectionism  
13 (e.g., Moss-Morris et al., 2011). Studies tended to include these additional variables as  
14 predictors of target outcomes alongside constructs from the common-sense model and  
15 findings are summarized in Table 3 (Appendix E, supplemental materials).

### 16 **Classification of Illness Representations**

17 Studies were relatively consistent in the instruments employed to measure illness  
18 representations, relying largely on previously-validated and standardized generic  
19 questionnaires based on Leventhal et al.’s (1980) illness representation dimensions of cause,

1 control, consequences, identity, and timeline<sup>3</sup>. Specifically, 95% of the included studies used  
2 either the illness perception questionnaire (IPQ; Weinman et al., 1996), the revised illness  
3 perception questionnaire (IPQ-R; Moss-Morris et al., 2002), or the brief illness perceptions  
4 questionnaire (BIPQ; Broadbent et al., 2006) to measure illness representations. The latter  
5 two questionnaires included two additional illness representation dimensions, illness  
6 coherence and emotional representations, and effect sizes for these dimensions were also  
7 included in the present analysis. The illness representation dimensions of the IPQ, IPQ-R, and  
8 BIPQ have direct equivalence given that they are all derived from the same root scale, and  
9 the dimension structure of the three measures have exhibited adequate construct, predictive,  
10 and discriminant validity and satisfactory internal consistency (e.g., Broadbent et al., 2006;  
11 Hagger & Orbell, 2005; Moss-Morris et al., 2002). The remaining 5% of the studies  
12 employed either the diabetes illness representation questionnaire (DIRQ; Skinner et al.,  
13 2003), personal models of diabetes interview and questionnaire (Hampson, Glasgow, &  
14 Toobert, 1990), the implicit models of illness questionnaire (IMIQ; Turk, Rudy, & Salovey,  
15 1986), the diabetes care profile (DCP; Fitzgerald et al., 1996), or non-validated measures of  
16 cognitive representations based on Leventhal et al.'s (1980) common-sense model (e.g.,  
17 Eiser, Riazi, Eiser, Hammersley, & Tooke, 2001; Kemp, Morley, & Anderson, 1999).

18       In order to ensure consistency in the measures of illness representation dimensions  
19 across studies, we conducted a content analysis of all illness representation dimensions  
20 employed across studies, identical to the procedure described by Hagger and Orbell (2003).

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<sup>3</sup>We noted considerable heterogeneity in measures of the cause dimension, which created difficulties in classifying its components into meaningful categories as it has been largely defined in terms of illness-specific causes or has been aggregated into dimensions that vary widely across studies. In line with Hagger and Orbell (2003), we excluded the cause dimension from the meta-analysis. It should also be noted that the revised illness perception questionnaire (IPQ-R; Moss-Morris, Weinman, Petrie, Horne, Cameron, & Buick, 2002) included an additional timeline dimension, timeline: cyclical. Due to the relatively small number of studies employing this subscale, we restricted our analysis to the timeline: acute/chronic dimension. Therefore, in the remainder of this article, timeline is synonymous with timeline: acute/chronic dimension. In addition, some instruments (e.g., IPQ-R, Moss-Morris et al., 2002; BIPQ, Broadbent, Petrie, Main, & Weinman, 2006) distinguish between personal control and treatment control while others employ a single control dimension (e.g., IPQ, Weinman, Petrie, Moss-Morris, & Horne, 1996). We adopted the classification with a single control dimension and therefore combined the personal and treatment control dimensions in studies measuring both components.



1 We coded the measures on the basis of content and label into the six illness representation  
2 dimensions: control, consequences, identity, timeline, emotional representations, and illness  
3 coherence. For instance, the seriousness, control, and symptoms dimensions from Hampson  
4 et al.'s (1990) personal models inventory were coded as equivalent to the consequences,  
5 control, and identity dimensions from the common-sense model. Similarly, the DIRQ (2003)  
6 perceived threat to health and perceived impact dimensions were coded as equivalent to the  
7 consequences dimension, and the effectiveness to prevent future complications and  
8 effectiveness to control diabetes dimensions were coded as equivalent to the control  
9 dimension. In order to provide external validity for our coding, the coding scheme was  
10 confirmed by three raters who independently conducted the classification procedure based on  
11 formal definitions of the six illness representation dimensions. Inter-rater reliability indicated  
12 perfect agreement among the raters (Cohen's  $\kappa = 1.00$ ).

13 Many of the included studies used modified versions of the IPQ-R to assess the  
14 specific illness or condition of interest. In addition, the IPQ-R was translated, validated and  
15 standardized for various populations. Studies followed standard IPQ-R scoring procedures  
16 such that higher scores on the consequences, identity, timeline, and emotional representation  
17 dimensions reflected more serious consequences, greater symptom frequency, chronic  
18 duration, and heightened negative emotional reactions. In contrast, high scores on the control  
19 and coherence dimensions represented greater perceived control over, and a clearer  
20 understanding of, the illness.

### 21 **Classification of Coping Strategies**

22 The present sample of studies used a large number of instruments to measure coping  
23 strategies, many of which were based on cognitive-motivational-relational models of stress  
24 and coping (e.g., Carver et al., 1989; Lazarus & Folkman, 1984). A key task in the present  
25 meta-analytic synthesis was to classify measures used to tap coping strategies in the current

1 sample and classify them into conceptually-distinct categories based on theory. Many of the  
2 studies in the sample adopted generic, previously-validated questionnaires to assess coping  
3 strategies, such as the COPE inventory (Carver et al., 1989), the ways of coping checklist  
4 (WCCL; Vitaliano, Russo, Carr, Maiuro, & Becker, 1985), ways of coping questionnaire  
5 (WOCQ; Folkman & Lazarus, 1988), and the Utrecht coping list (UCL; Schreurs, Van Der  
6 Willige, Tellegen, & Brosschot, 1988).

7       Following Hagger and Orbell's (2003) classification procedure, we identified six  
8 distinct coping categories, five of which reflected the general scope and content of the pool of  
9 generic coping scales, namely avoidance, cognitive reappraisal, emotion venting, problem-  
10 focused coping (generic strategies), and seeking social support (see Appendix F,  
11 supplemental materials, for classification of constructs from generic coping measures into  
12 coping categories). A sixth coping category, labelled problem-focused specific coping  
13 strategies, encompassed active attempts to address the illness by means of specific illness-  
14 related coping behaviors, such as medication and dietary adherence, illness-related self-care  
15 behaviors, and attendance at illness-related medical appointments (see Appendix G,  
16 supplemental materials, for the classification of non-generic coping measures into coping  
17 strategies). We employed three independent raters with expertise in health psychology and  
18 theories of stress and coping to code measures of coping into the six a priori categories based  
19 on formal definitions of the six coping categories and the content of the source items of the  
20 scales used to tap the constructs (see Appendixes F and G, supplemental materials). Inter-  
21 rater reliability coefficients indicated good agreement between the raters for each coping  
22 dimension category (Fleiss-corrected  $\kappa = .91$ ). Differences in classifications were discussed  
23 among the raters with respect to the category definition and item content with resolution  
24 based on consensus between all three raters.

## 25 **Classification of Illness Outcomes**

1           Given the range of measures used to tap illness-related outcomes in the current  
2 sample of studies, it was also important to categorize illness outcome measures into distinct  
3 categories. As with the coping strategies, we adopted Hagger and Orbell's (2003) procedure  
4 to code the outcome measures into relevant categories. We identified six distinct illness  
5 outcome categories a priori: disease state, physical functioning, psychological distress,  
6 psychological well-being, role functioning, and social functioning. Although Hagger and  
7 Orbell included a seventh category, vitality, this category was merged with the psychological  
8 well-being category in the present analysis due to considerable overlap in the content of  
9 measures used to tap constructs across these categories. While many of the studies adopted  
10 self-report psychometric instruments to tap the outcome variables such as the Medical  
11 Outcomes Short Form Health Survey (SF-36; Ware & Sherbourne, 1992) or the Hospital  
12 Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983), it is important to note that  
13 objective measures of outcomes were also coded, particularly for the disease state category,  
14 which reflects the degree of progression of the illness or condition (e.g., glycosylated  
15 hemoglobin (HbA1c) in diabetic patients, CD4 count in patients with HIV). Three raters  
16 coded the item content of the illness outcome measures from the source instruments with the  
17 operational definitions of the construct categories used in the current analysis with strong  
18 agreement across raters (Fleiss-corrected  $\kappa = .92$ ). Differences in classifications were  
19 discussed among the raters with respect to the category definition and item content with  
20 resolution based on consensus between all three raters. Results of the classification of each  
21 outcome measure or questionnaire subscale into outcome categories and the individual  
22 studies that utilized each measure are provided in Appendix H (supplemental materials).

### 23 **Meta-Analytic Strategy**

24           The effect size metric of interest in the present meta-analysis was the zero-order  
25 correlation coefficient. We conducted separate meta-analyses of intercorrelations among the

1 illness representation and coping strategy dimensions, and of correlations between the  
2 representation, coping and outcome dimensions, resulting in 138 effect sizes<sup>4</sup>. Hunter and  
3 Schmidt's (2004) formulas were adopted to correct the effect sizes for statistical artefacts.  
4 The Hunter and Schmidt approach is equivalent to a random effects model for meta-analysis  
5 and is considered optimal as it provides estimates that are generalizable to the population  
6 rather than to the sample of included studies alone (Field, 2001; Hagger, 2006; Hunter &  
7 Schmidt, 2000). We corrected the effect sizes for both sampling and measurement error and  
8 utilized the zero-order correlation coefficient as the effect size metric. The meta-analyses  
9 were conducted using the MetaQuick (Stauffer, 1996) and Comprehensive Meta-Analysis  
10 Version 2 (Borenstein, 2011) statistical software. In the event that a particular category of our  
11 key variables was represented by more than one construct in a specific study (e.g., the  
12 positive reintegration and acceptance scales from the COPE inventory were both classified  
13 into the cognitive reappraisal coping category), the average of the correlation coefficients was  
14 taken to provide a single test of the expressed relationship for use in the meta-analysis  
15 consistent with Hunter and Schmidt's (2004) methods. Studies reporting effect size data in  
16 other metrics (e.g., standardized mean difference) were converted to correlation coefficients.  
17 We corrected for measurement error using Cronbach alpha reliability coefficients of the  
18 constructs used in each effect size calculation. Where reliability statistics were unavailable,  
19 measurement error was inferred from available attenuation statistics using Stauffer's (1996)  
20 formula.

21 The analyses provided key summary statistics of the effects among illness  
22 representations, coping strategies and illness outcomes: the uncorrected averaged correlation  
23 coefficient for the effect ( $r$ ), the averaged correlation corrected for sampling error only ( $r_+$ ),  
24 the fully-corrected averaged correlation coefficient corrected for both sampling and

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<sup>4</sup>Raw data files used to conduct the meta-analysis for each effect are available online at <https://osf.io/g48nt/>

1 measurement error ( $r_{++}$ ), 95% confidence intervals ( $CI_{95}$ ) of the fully-corrected averaged  
2 correlation which provided a formal test of statistical significance for each effect, and the  
3 variance in the fully-corrected averaged correlation accounted for by the statistical artefacts  
4 of sampling and measurement error. If the vast majority of the variance in the averaged effect  
5 size can be accounted for by statistical artifacts – Hunter and Schmidt (2004) recommend a  
6 75% cut-off criterion – then the effect should be considered homogenous (i.e., free from bias  
7 other than sampling and measurement error). If the proportion of the variance falls below this  
8 criterion, then it is likely that there is substantial variance in the effect size across the studies  
9 that cannot be attributed to methodological artifacts and indicates the possibility that  
10 additional variance in the effect exists across the studies that can be attributed to extraneous  
11 or ‘moderator’ variables. We also report Cochran’s (1952)  $Q$  statistic, which provides a  
12 formal test of the hypothesis that variation in effect sizes across studies is greater than that  
13 expected on the basis of sampling error alone. Given that the number of studies ( $k$ ) varies  
14 across meta-analyses, the  $Q$ -statistic cannot be compared across analyses. An alternative is  
15 offered by the  $I^2$  statistic and its confidence interval (Higgins & Thompson, 2002). The  $I^2$  is  
16 the proportion of the observed variance in the averaged effect size relative to the variance  
17 attributable to sampling error alone expressed as a percentage (Borenstein, Higgins, Hedges,  
18 & Rothstein, 2017).  $I^2$  values of 25%, 50%, and 75% are said to represent low, medium, and  
19 high levels of heterogeneity in the averaged effect size, respectively (Higgins, Thompson,  
20 Deeks, & Altman, 2003). An  $I^2$  value that exceeds 25% with large confidence intervals and a  
21 lower bound that includes the value of zero is indicative of substantial heterogeneity in the  
22 effect (Huedo-Medina, Sánchez-Meca, Marín-Martínez, & Botella, 2006) and should prompt  
23 a search for extraneous moderators of the effect. Reporting the between-study or  
24 heterogeneity variance ( $\tau^2$ ) for each averaged effect size is also recommended. Small values  
25 for  $\tau^2$  are indicative of low heterogeneity in the effect size across studies. Finally, we

1 evaluated the presence of small-study bias in the sample of effect sizes by computing  
2 statistics based on plots of the effect size from each study against study precision (usually the  
3 reciprocal of the study sample size). Asymmetry in the predicted ‘funnel’ shape of the plots is  
4 considered evidence of small study bias, that is, the tendency for studies included in the  
5 analysis to exhibit large effects relative to their size. This is often interpreted as a potential  
6 indicator of publication bias and the tendency for journals to favor statistically significant  
7 findings in underpowered studies. Specifically, we used Egger, Davey Smith, Schneider, and  
8 Minder’s (1997) regression test, which indicates the extent to which effect sizes are predicted  
9 by study precision and Duval and Tweedie’s (2000) ‘trim and fill’ technique, which identifies  
10 studies that deviate from the expected shape of the ‘funnel’ plot and adjusts the plot for  
11 missing studies to make it more symmetric.

## 12 **Moderator Coding and Analyses**

13 Assuming substantive, non-trivial variability in the effect sizes of the relations in the  
14 illness representation, coping, and outcome constructs unattributed to the statistical artifacts  
15 we corrected for in the model, we aimed to examine the effect of moderators of the model  
16 effects. A series of candidate moderator variables was identified and coded in the current  
17 analysis: study design, illness type, medically-explained versus medically-unexplained  
18 symptoms, illness stage, and study methodological quality. Moderator coding is presented in  
19 Table 3 (Appendix E, supplemental materials). We evaluated the effects of the moderator on  
20 correlations between the illness representation, coping, and outcome variables across studies  
21 by conducting separate meta-analyses for each level of the moderator<sup>5</sup>. Differences in the  
22 corrected correlations across moderator groups were evaluated by inspection of the 95%  
23 confidence intervals about each correlation with Welch’s *t*-test providing a formal test of  
24 difference.

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<sup>5</sup>Raw data files used to conduct the moderator analyses for each effect including moderator coding are available online at <https://osf.io/g48nt/>

1        **Study design.** Study design was coded as cross-sectional, longitudinal, or intervention.  
2        Studies measuring all study variables at a single point in time were coded as cross-sectional.  
3        This included studies adopting longitudinal or intervention designs that only reported  
4        correlational data at a single time point or independent of the intervention. Studies adopting  
5        designs in which either coping or outcomes were measured at a distal point in time relative to  
6        the illness representation dimensions were coded as longitudinal. Studies including an  
7        intervention or experimental component targeting change in illness representations, and  
8        change in a subsequent behavior or illness-related outcome, were coded as intervention.  
9        However, these studies numbered very few (3.2%) and, in many cases, data were unavailable  
10       (1.5%), which precluded moderator comparisons between groups of studies adopting  
11       intervention or experimental designs and groups of studies with cross-sectional and  
12       longitudinal designs.

13       **Illness type.** Coding of illness type was based on the description of the illnesses  
14       reported in the study. Studies were classified as having cancer as the target illness if study  
15       participants had received a cancer diagnosis or were undergoing cancer screening. Studies  
16       were classified as having diabetes as the target illness if the patient group comprised either  
17       type I or type II diabetics. Studies were classified as targeting cardiovascular disease if the  
18       patient group was described as having experience with, or diagnosis for, a form of  
19       cardiovascular disease including acute coronary syndrome, angina, atrial fibrillation, cardiac  
20       chest pain, coronary artery/heart disease, heart failure, hypercholesterolemia, myocardial  
21       infarction, and stroke. In the case of each illness type moderator, the contrasting moderator  
22       group comprised the remaining studies in which the target illness was absent.

23       **Medically-explained versus medically-unexplained symptoms.** Illnesses and  
24       conditions were classified as those with medically-explained symptoms and medically-  
25       unexplained symptoms by two independent researchers with research experience in

1 behavioral medicine. Studies describing the target illness or condition of the study as having  
2 unknown or uncertain etiology, or if the symptoms of the illness or condition are known to  
3 have unknown or uncertain causes, were classified as having medically-unexplained  
4 symptoms with the remaining illnesses classified as having medically-explained symptoms.  
5 Inter-rater reliability for the coding of studies for medically-explained and medically-  
6 unexplained illnesses resulted in good inter-rater reliability (intraclass correlation = .83;  $CI_{95}$   
7 = .78, .86). Inconsistencies were resolved through discussion and consultation with medical  
8 definitions of the reported conditions alongside the description of the illness and patient  
9 group reported in the studies.

10 **Illness stage.** Illness stage was coded as time since diagnosis. Studies on patients who  
11 received their diagnosis at four weeks or earlier prior to study data collection were classified  
12 as recently diagnosed while studies on patient groups who had received their diagnosis more  
13 than four weeks prior to data collection were classified as having a non-recent diagnosis. A  
14 third category was identified for samples comprising both patients who had received a recent  
15 diagnosis and patients who had not received their diagnosis recently.

16 **Study methodological quality.** Study quality was assessed using a methodological  
17 quality checklist developed for the current study. Given that the current sample comprised  
18 exclusively of studies adopting survey methods and largely adopted correlational designs, our  
19 checklist was based on those developed for these types of study. Checklist content was  
20 adapted from the National Institutes of Health Quality Assessment Tool for Observational  
21 Cohort and Cross-Sectional Studies (National Institutes of Health, 2014) supplemented with  
22 items from other checklists developed for the assessment of studies with survey,  
23 questionnaire, and cross-sectional designs (Husebø, Dyrstad, Søreide, & Bru, 2012; Jack,  
24 McLean, Moffett, & Gardiner, 2010; Oluka, Nie, & Sun, 2014). The checklist assessed 16  
25 criteria, 13 of which were relevant to all studies while a further three (sample



1 representativeness, loss to follow-up, follow-up measures) were only relevant to longitudinal  
2 or intervention studies. A full list of checklist criteria, item descriptions, and required quality  
3 standards is presented in Table 4 (Appendix I, supplemental materials). Studies meeting  
4 quality standards were assigned a score of 1 for each criterion and those not meeting the  
5 quality standard or provided insufficient information to evaluate the criterion were assigned a  
6 score of zero. Cross-sectional studies could achieve a maximum score of 13 and longitudinal  
7 studies a maximum score of 16. We weighted the scores for purposes of comparison by  
8 dividing raw scores by the number of relevant items and multiplying by 10.

9       Studies were scored on the checklist by a researcher with experience in the use of  
10 methodological quality checklists<sup>6</sup>. One study could not be scored because the relevant data  
11 were not available and was omitted from subsequent analyses. A subset of the sample of  
12 studies ( $N = 20$ ) was independently scored by two other researchers with high agreement  
13 between raters across items (mean agreement = 94.17%) and inter-rater reliability (mean  
14 Fleiss'  $\kappa = .82$ ). Inconsistencies were resolved through discussion and attributed to minor  
15 interpretation errors of the quality standard for two criteria. The criteria were subsequently  
16 revised on the basis of the discussion and applied to the coding of the entire sample. We  
17 coded two methodological quality categorical variables for use in our analysis. After a tertile  
18 division of the studies by checklist score, studies with scores in the upper third were  
19 classified as high quality and those in the lower third classified as low quality<sup>7</sup>. This strategy  
20 allows comparisons of studies with extreme scores but also reduces the sample size. We  
21 therefore coded an additional moderator variable based on a cut-off checklist score (Husebø

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<sup>6</sup>A spreadsheet of methodological quality scores for each study included in the analysis is available online at <https://osf.io/g48nt/>

<sup>7</sup>There were multiple studies with scores on the methodological quality checklist at the tertile cut points, so we adopted an inclusive strategy so that all studies with scores falling on the cut-points were classified in the upper and lower thirds. This led to slightly unequal numbers of studies in the upper (high quality studies;  $k = 91$ ) and lower (low quality studies;  $k = 74$ ) thirds.

1 et al., 2012; Jack et al., 2010). Studies achieving weighted scores of 6 or greater on the  
2 checklist were classified as high quality and with scores below 6 classified as low quality.

### 3 **Testing the Process Model**

4 We used the meta-analytically derived corrected correlations to test hypotheses of the  
5 proposed process model in which the effects of illness representations on illness outcomes are  
6 mediated by coping strategies. Analyses were conducted using the MPlus v. 7.31 statistical  
7 software (Muthén & Muthén, 2012) with the corrected correlation matrices from the meta-  
8 analysis used as the input matrices<sup>8</sup>. In order to minimize complexity, we estimated separate  
9 path analyses for each of the six illness outcomes. Each model included the six illness  
10 representation dimensions as exogenous independent predictors of the illness outcome  
11 mediated by multiple pathways through the coping strategies. We tested two models for each  
12 outcome. The first (Model 1) assumed that the effects of the illness representations were fully  
13 mediated by the coping strategies, and, as such, no direct pathways were freed between the  
14 illness representation dimensions and illness outcome. This model assumes that the coping  
15 constructs are sufficient in accounting for relations between the representation dimensions  
16 and illness outcome. The model under consideration is a generalized process model, so we  
17 included all possible pathways between the representation and coping constructs and between  
18 the coping and outcome constructs. The second model (Model 2) included direct effects of  
19 the illness representation dimensions on the outcomes. This model assumed that the  
20 mediation effects were not sufficient in accounting for the representation-outcome relations  
21 and non-zero direct effects exist. Comparison of the fit of each model with the data provided  
22 an indication as to whether the coping constructs were adequate in accounting for the effects  
23 of illness representations on illness outcomes (Model 1) or whether substantive direct effects  
24 of the illness representations remain in the presence of the mediated paths through coping

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<sup>8</sup>Full correlation matrices used as input for the path analyses are available online at <https://osf.io/g48nt/>

1 (Model 2). Comparisons of nested models are usually made on the basis of incremental fit  
2 indexes based on the model  $\chi^2$  test, such as the comparative fit index (CFI). CFI values  
3 exceeding .95 indicate a well-fitting model and CFI differences across models exceeding .01  
4 indicate substantial model misspecification (Cheung & Rensvold, 2002). However, as the  
5 model including both direct and indirect effects (Model 2) was a saturated model,  
6 comparisons based on the goodness-of-fit  $\chi^2$  test and incremental fit indices would not permit  
7 model comparisons given that fit for Model 2 would be perfect (CFI = 1.000). Nevertheless,  
8 absolute CFI values for Model 1 give an indication of the levels of misspecification in the  
9 model (CFI values < .95) when direct paths from illness representations to illness outcomes  
10 are not set as free parameters. As an alternative, model comparisons were made on the basis  
11 of Akaike's information criterion (AIC) based on the log likelihood ratio test, with the lowest  
12 absolute values indicating the model with the best fit. The average study sample size was  
13 used as the input sample size for each model, due to the variability in the number of studies  
14 contributing to each cell in the corrected correlation matrix.

15 Hypothesized effects of the models were evaluated using parameter estimates  
16 expressed as standardized regression coefficients ( $\beta$ ) and their 95% confidence intervals. Two  
17 types of indirect effect were estimated: (a) total indirect effects representing the overall  
18 indirect effect of illness representation dimensions on each outcome through all coping  
19 constructs, and (b) specific indirect effects representing the indirect effects of individual  
20 representation dimensions on each outcome through each coping construct. For the model  
21 incorporating both direct and indirect effects (Model 2), we also computed the total effects as  
22 the sum of the direct effects of illness representation dimensions on outcomes and the total  
23 indirect effects through all coping constructs.

24 As our analyses were based on relatively large sample sizes, many smaller effects  
25 were likely to achieve statistical significance (Seaton, Marsh, & Craven, 2010). Although the

1 sample sizes used to estimate the models for each outcome variable were relatively  
2 conservative ( $N$  range = 10,574 to 12,594), and far short the total sample size ( $N = 52,599$ ),  
3 the likelihood of small effects obtaining statistical significance was still high. Given the  
4 dependency of the statistical significance of our parameter estimates in our model tests on  
5 sample size, we focused on effect size when evaluating the effects in our models. Based on  
6 Seaton et al. (2010), standardized parameter coefficients ( $\beta$ ) of .10 or larger were considered  
7 substantive and very small coefficients ( $\beta < .075$ ) regarded as trivial even if they achieved  
8 statistical significance. Parameter estimates for indirect effects, however, tend to be much  
9 smaller and with smaller standard deviations. A suggested effect size statistic is the mediation  
10 proportion or relative indirect effect ( $P_M$ ), which represents the proportion of the total effect  
11 mediated by the indirect effect (Ditlevsen, Christensen, Lynch, Damsgaard, & Keiding, 2005;  
12 Huang, Sivaganesan, Succop, & Goodman, 2004). In cases where both direct and indirect  
13 effects were present in the process model, such as when the illness representation dimensions  
14 predict outcomes directly and indirectly through coping constructs, the  $P_M$  statistic provides  
15 an indication of the relative contribution the indirect effect of interest makes to the overall  
16 effect.

17         In addition, we conducted sensitivity analyses to illustrate the extent to which the  
18 large sample sizes in the current meta-analysis affected the precision and statistical  
19 significance of the parameter estimates in our models, and whether these changes affected our  
20 inferences. In the sensitivity analyses, our models were re-estimated with substantively  
21 smaller sample sizes. Specifically, we used the largest sample size of the included studies ( $n$   
22 = 3,130) and a sample size that approximated the average of the five next-largest sample sizes  
23 of the included studies ( $n = 1,000$ ) as input sample sizes. Given that variability estimates and  
24 significance tests associated with the effect sizes are influenced by sample size, we expected  
25 the width of the 95% confidence intervals of the parameter estimates in the models to

1 progressively increase, and that smaller effects would be more likely to become statistically  
2 non-significant, with declining sample size. In such cases, the estimated effect may be  
3 rejected even if it is not trivial in size.

4 We also conducted additional sensitivity analyses comparing model effects across  
5 levels of the candidate moderator variables. We estimated the proposed models (Model 1 and  
6 Model 2) using the meta-analyzed mean correlation matrices in each moderator group. We  
7 compared overall fit of model across levels of the moderator using the AIC to determine  
8 whether the moderator affected our determination of which model exhibited best fit derived  
9 from the full-sample analysis. We also report the CFI for each model, with absolute values  
10 for Model 1 illustrating the level of misspecification in the model when direct effects were  
11 fixed to zero. In addition, we tested whether the pattern of effects in each model varied across  
12 moderator levels using multi-group path analysis. In these analyses, paths among the illness  
13 representation, coping, and outcome variables were set to be invariant across the models  
14 estimated at each level of the moderator by imposing a set of equality constraints. We  
15 conducted the multi-group analysis for Model 1 and Model 2, with additional constraints  
16 specified in Model 2 to test for invariance in the direct effects of the illness representation  
17 dimensions on the outcome variable. Adequacy of the multi-group models was evaluated  
18 using multiple recommended criteria for goodness-of-fit: the CFI, the normed fit index (NFI),  
19 and the root mean square error of approximation (RMSEA), with values exceeding .95 for the  
20 CFI and NFI and .050 or less for the RMSEA. Incorrectly-imposed constraints indicating  
21 paths that are non-invariant across levels of the moderator will result in misspecification in  
22 the model fit. As with the path models estimated on the full sample of studies, sensitivity  
23 analyses were conducted separately for each of the six outcome variables (disease state,  
24 psychological distress, psychological well-being, and role, social, and physical functioning).

25

## Results

## 1 **Corrected correlations**

2           Averaged correlation coefficients corrected for sampling and measurement error for  
3 all variables in the meta-analysis are appear in Table 5 in Appendix J (supplemental  
4 materials) with confidence intervals, variability and heterogeneity statistics, and analyses  
5 based on funnel plots. Intercorrelations among illness representation dimensions yielded a  
6 pattern consistent with results of previous meta-analytic findings (Hagger & Orbell, 2003).  
7 Specifically, the identity, serious consequences, timeline, and emotional representation  
8 dimensions were statistically significantly and positively related to each other, and  
9 significantly and negatively related to the perceived control and illness coherence  
10 dimensions. The only exception to this pattern was the coherence-timeline relationship,  
11 which was not statistically significant. Perceived control and illness coherence were  
12 significantly and positively correlated.

13           Relations between illness representations and coping strategies, and between coping  
14 strategies and illness outcomes, were also consistent with previous analyses. The identity,  
15 serious consequences, and timeline dimensions were statistically significantly and positively  
16 associated with emotion venting and avoidance coping strategies, and not significantly related  
17 to the cognitive reappraisal, problem-focused generic, and problem-focused specific coping  
18 strategies. Emotional representations were significantly and positively related to the emotion  
19 venting and avoidance coping strategies, and negatively related to cognitive reappraisal and  
20 problem-focused generic strategies. Analogously, the identity, consequences, timeline, and  
21 emotional representation dimensions were significantly and positively correlated with disease  
22 state and psychological distress, and significantly and negatively related to physical, role, and  
23 social functioning, and psychological well-being. Perceived control and illness coherence  
24 were significantly and positively related to cognitive reappraisal, problem-focused generic,  
25 problem-focused specific, and seeking social support coping strategies, and significantly and

1 negatively related to avoidance, with the exception of the relation between coherence and  
2 social support. Similarly, control and coherence were significantly and positively associated  
3 with physical, role, and social functioning, and psychological well-being, with the exception  
4 of the correlation between coherence and social functioning.

5         Focusing on the heterogeneity statistics, according to both Hunter and Schmidt's  
6 (2004) 75% rule and Cochran's  $Q$  statistic, all but 13 of the 138 effects were found to have a  
7 statistically significant degree of heterogeneity across studies, indicating the likely presence  
8 of moderator variables acting on the observed relationships. This was corroborated by the  $I^2$   
9 statistic, which showed at least moderate heterogeneity for the majority of the effect sizes  
10 (Huedo-Medina et al., 2006). Heterogeneity variance ( $\tau^2$ ) values were, however, relatively  
11 small. Tests of bias indicated that 44% of effect sizes were subject to some degree of small-  
12 study bias according to Duval and Tweedie's (2000) trim and fill technique, and 27% of  
13 effect sizes according to Egger and colleagues' (1997) regression test. While these results  
14 appear to point to deviations from the expected pattern in funnel plots and potential small  
15 study bias for some of the effects, the high degree of heterogeneity is a cause for concern  
16 given that problems have been identified with interpreting these statistics in the presence of  
17 substantial heterogeneity (Gervais, 2015; Johnson & Eagly, 2014; Moreno et al., 2009).  
18 Findings indicating substantial bias using these tests in the current analysis should, therefore,  
19 be interpreted in light of this concern.

## 20 **Moderator Analyses**

21         We examined the effect of moderators on correlations among the illness  
22 representation, coping strategies, and illness outcome constructs across studies by conducting  
23 our meta-analysis at each level of the candidate moderators: study design, illness type,  
24 medically-explained and medically-unexplained symptoms, illness stage, and methodological  
25 quality. Averaged corrected correlations, confidence intervals, and heterogeneity statistics

1 from the moderator analyses are presented in Table 6 in Appendix K (supplemental  
2 materials). In all cases, we found little evidence for moderator effects. Of the 138 effects<sup>9</sup>  
3 tested in each analysis, fewer than seven effects per moderator were significantly different  
4 across levels of the moderator and there was substantive overlap in confidence intervals in the  
5 vast majority of the tests. In addition, the analyses did little to resolve the heterogeneity in the  
6 effect sizes with moderate-to-high heterogeneity according to  $I^2$  values and significant values  
7 for  $Q$  observed for effects within each moderator group. Of the correlations that did exhibit  
8 statistically significant differences, many included moderator groups with low numbers of  
9 studies ( $k < 10$ ); in such cases the confidence intervals,  $t$ -tests, and heterogeneity tests may  
10 not be reliable. Overall, there was little indication of systematic variation in effect sizes  
11 attributable to the candidate moderators in the current analyses.

## 12 **Path Analyses of the Process Model**

13 Sufficiency of the process model derived from the common-sense model (Appendix  
14 A, supplemental materials) was tested using a series of mediated path-analytic models using  
15 the averaged corrected correlation matrices among the illness representation, illness outcome,  
16 and coping constructs as input<sup>10</sup>. Separate analyses for each illness outcome construct

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<sup>9</sup>There were fewer than the full 138 tests in some of the moderator analyses because some moderator groups had insufficient studies ( $k < 2$ ) to conduct the analysis.

<sup>10</sup>Correcting for methodological artifacts is known to increase the magnitude of effect sizes, perhaps more than is appropriate, which may lead to over- or under-estimation of the true effect sizes (see Johnson & Eagly, 2014; Köhler, Cortina, Kurtessis, & Gözl, 2015). For example, interdependency between the reliability estimates of predictor and criterion variables of a particular effect could effectively lead to ‘double correction’ for measurement error (Köhler et al., 2015). Such corrections may lead to an inflation of effect sizes and increase the probability of finding statistically significant effect sizes. In order to ascertain the extent to which interdependency of reliabilities was a problem, we followed the recommendations of Köhler et al. and computed correlations between the predictor and criterion reliability estimates used to correct our effect sizes for measurement error. Results revealed that the correlations were generally small (median = .25, inter-quartile range = .37), which indicates that there may be some bias attributable to correction for this artifact but it is unlikely to be substantive in most cases. We also reestimated our models using the uncorrected averaged correlations and compared the results to the analyses using the corrected correlations (see Table 5, Appendix J, supplemental materials). Results are presented in Tables 21 to 23 in Appendix O (supplemental materials). Unsurprisingly, the analysis demonstrated that the effects for the analyses using raw data tended to be smaller than those for the corrected data. However, the pattern of effects remained in both sets of analyses, indicating that the corrections tended to alter the strength rather than pattern of effects.



1 (disease state, psychological distress, physical functioning, psychological well-being, role  
2 functioning, and social functioning) were conducted to minimize model complexity.

3       **Model sufficiency.** We estimated two models to test the sufficiency hypothesis.  
4 Model 1 specified direct effects of the illness perception dimensions (identity, consequences,  
5 timeline, control, illness coherence, and emotional representations) on coping constructs  
6 (avoidance, cognitive reappraisal, emotion venting, specific and generic forms of problem-  
7 focused coping, and seeking social support), direct effects of the coping constructs on the  
8 illness outcome, and indirect effects of all the illness perceptions constructs on the illness  
9 outcome mediated by the coping constructs. Model 2 was identical to Model 1 but also  
10 included direct effects of the illness representations dimensions on illness outcomes.  
11 Goodness-of-fit statistics for each of the six models are provided in Table 7 (Appendix L,  
12 supplemental materials). The direct and indirect effects model (Model 2) had better fit with  
13 the data than the indirect effects only model (Model 1) as indicated by lower AIC values in  
14 every case. In addition, absolute CFI values for Model 1 indicated substantive  
15 misspecification in the model ( $CFI < .95$ ) in all cases except the model for disease state. This  
16 provides converging evidence that the indirect effects only model did not account sufficiently  
17 for relations between the illness representation and outcome variables. We therefore rejected  
18 Model 1 in favor of Model 2. Subsequent examination of direct and indirect effects in Model  
19 2 was warranted to evaluate the extent to which the coping variables mediated the illness  
20 representation-illness outcome relations. Parameter estimates for the direct (Table 8), indirect  
21 (Table 9), and total (combined direct and indirect effects; Table 10) effects for each model  
22 are provided in Appendix L (supplemental materials).

23       **Direct effects.** Direct effects of illness representation dimensions on coping strategies,  
24 of coping strategies on illness outcomes, and of illness representations on outcomes provided  
25 indication of the unique predictors of the coping and illness outcome variables while

1 simultaneously accounting for the effects of other constructs in the model (see Table 8).  
2 Focusing first on the direct effects of the illness representation dimensions on illness  
3 outcomes, we found statistically significant, non-trivial effects of perceived consequences  
4 and illness identity on all outcomes, with the exception of the consequences-distress effect  
5 which was small by comparison. Effects were positive for disease state and distress and  
6 negative for the functioning outcomes and well-being. Perceived control had positive non-  
7 trivial direct effects that were statistically significant and greater than .10 on physical, social,  
8 and role functioning, and well-being, while effects on disease state and distress were smaller  
9 and trivial in effects size. The pattern of direct effects for these representation dimensions on  
10 outcomes followed the same pattern as the zero-order correlations among these constructs. A  
11 notable exception was the direct effect of control on disease state which was positive in the  
12 models but had a negative zero-order correlation. Emotional representations had statistically  
13 significant non-trivial negative direct effects on well-being and role functioning, and positive  
14 effects on distress and social functioning. The timeline dimension had statistically significant  
15 non-trivial positive direct effects on role functioning and well-being. Effects for emotional  
16 representations and timeline deviated from the pattern of effects in the zero-order  
17 correlations: these dimensions were negatively correlated with functioning.

18 Focusing on the direct effects of the illness representation dimensions on coping, we  
19 found statistically significant non-trivial effects of the representation dimensions on the  
20 coping constructs. Dimensions with the largest effects were emotional representations which  
21 positively predicted avoidance, emotion venting, and seeking social support strategies, and  
22 negatively predicted problem-focused generic coping and cognitive reappraisal. Control had  
23 statistically significant non-trivial positive direct effects on generic and specific forms of  
24 problem-focused coping, cognitive reappraisal, and social support. There were also  
25 statistically significant non-trivial positive direct effects of identity on avoidance, cognitive

1 reappraisal, and emotion venting. Other effects of the illness representation dimensions on  
2 coping constructs were smaller and trivial by comparison.

3         Direct effects of coping strategies on illness outcomes tended to be larger than the  
4 effects of the illness representation dimensions on coping, and were consistent with the  
5 theory-derived predictions from the process model and previous analyses (Hagger & Orbell,  
6 2003). We found statistically significant non-trivial direct effects of avoidance on all  
7 outcomes, with positive effects on disease state and distress, and negative effects on physical,  
8 role, and social functioning, and well-being. A similar pattern of direct effects was found for  
9 emotion venting, the only exception was that emotion venting negatively predicted disease  
10 state when the correlation between these variables was not significant, which may be  
11 indicative of a suppressor effect. Problem-focused generic coping had statistically significant  
12 non-trivial negative direct effects on disease state, distress, and role functioning, and positive  
13 effects on physical functioning and well-being. Problem-focused specific coping had  
14 statistically significant non-trivial positive direct effect on role functioning, with smaller  
15 trivial effects on other outcomes.

16         Overall, findings of the direct effects indicate that illness representations had  
17 statistically significant non-trivial direct effects on illness outcomes, consistent with the better  
18 overall fit of the model that included direct effects (Model 2) relative to the model that  
19 assumed no direct effects (Model 1). Effects for the coping strategies on illness outcomes  
20 tended to be larger compared to the effects of the illness representation dimensions on coping  
21 constructs.

22         **Total indirect effects.** While we rejected our hypothesis that the effects of illness  
23 representations on illness outcomes would be completely mediated by coping strategies, this  
24 conclusion did not rule out the possibility of indirect effects consistent with hypotheses of the  
25 common-sense model. Examination of the total indirect effects to establish the extent to

1 which the effects of illness representation dimensions on illness outcomes were mediated by  
2 the coping strategies was warranted (Leventhal et al., 1980). Total indirect effects are  
3 presented in Table 9 (Appendix L, supplemental materials).

4 We found statistically significant non-trivial positive total indirect effects of perceived  
5 control on physical functioning, role functioning, and psychological well-being, and negative  
6 effects on psychological distress and disease state. There were statistically significant non-  
7 trivial negative total indirect effects of identity on physical, role, and social functioning, and a  
8 positive effect on distress. Chronic timeline had statistically significant non-trivial positive  
9 indirect effects on psychological social functioning, physical functioning, and well-being, and  
10 negative effects on distress and disease state. We found statistically significant non-trivial  
11 positive total indirect effects of emotional representations on disease state and distress, and  
12 negative total indirect effects on physical functioning, social functioning, and well-being.  
13 Other indirect effects were small and trivial by comparison. Overall, these effects provided  
14 support for the indirect, coping-mediated effects of illness representation dimensions on  
15 illness outcomes consistent with the process model.

16 We also estimated the mediation proportion for each total indirect effect ( $P_M$ ), which  
17 reflects the proportion of the total effect accounted for by the indirect effect<sup>11</sup>. This is directly  
18 relevant to the evaluation of model sufficiency as it provides an indication of the extent to  
19 which the total indirect effects of illness representations on outcomes through coping  
20 contribute to the total effect. A substantial  $P_M$  value indicates that the mediated pathway

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<sup>11</sup>One of the limitations of the  $P_M$  statistic is that it is difficult to interpret when total effect comprises negative and positive direct and indirect effects, such as the effect of perceived control on disease state in the current analysis which was made up of a positive direct effect ( $\beta = .034$ ) and a negative total indirect effect ( $\beta = -.079$ ). The total effect ( $\beta = -.045$ ), therefore, represents the sum of the direct and total indirect effects. In this case, the positive direct effect has the effect of attenuating the negative indirect effect. However, as the total effect serves as the denominator for the  $P_M$  calculation, it may give misleading scores for the  $P_M$  when the total effects comprise negative and positive effects, as in the previous example. This may lead, for example, to the  $P_M$  exceeding unity such that it does not represent a true proportion (Preacher & Kelley, 2011). A solution was to estimate  $P_M$  using the modulus of the total effect in its calculation. The  $P_M$ , therefore, reflects the proportion of the total effect accounted for by the indirect effect regardless of whether the combination of the direct and indirect effects leads to an attenuation of the total effect due to the combination of negative and positive scores.

1 makes a viable contribution to explaining the link between representations and outcomes,  
2 while a trivial value indicates that the mediated path was of little relevance relative to the  
3 direct effect. Results revealed that many of the indirect effects accounted for substantial  
4 proportions of the total effects of illness representations on illness outcomes<sup>12</sup>. Prominent  
5 among these were the control, emotional representations, timeline, and coherence  
6 dimensions, for which the total indirect effects accounted for substantive proportions of the  
7 total effect. For the identity and serious consequences dimensions, the majority of the indirect  
8 effects accounted for a trivial proportion of the total effect, with the notable exception of the  
9 indirect effect of consequences on distress. Findings provide support for the process model,  
10 verifying that the indirect effects make a substantive contribution to the overall effects in the  
11 model.

12       **Specific indirect effects.** Our analyses also enabled us to isolate specific mediated  
13 effects involving each of the illness representation, coping, and outcome variables that  
14 constituted the total indirect effects. Specific indirect effects are presented in Table 9  
15 (Appendix L, supplemental materials). An interesting trend in the current findings was that  
16 some of the total indirect effects of representation dimensions on outcomes were either zero  
17 or relatively trivial in size. However, in some cases the total indirect effects comprised both  
18 positive and negative specific indirect effects. These specific indirect effects were  
19 approximately equal in magnitude but opposite in sign (i.e., positive and negative) leading to  
20 a null or very and trivial small total indirect effect. A consideration of the pattern of specific  
21 indirect effects, therefore, may reveal important information on the pattern of effects of the  
22 illness perception variables on outcomes that cannot be gained from observing the total  
23 indirect effects alone. The specific indirect effects may facilitate interpretation as to whether  
24 the indirect effects of illness representation dimensions have effects on illness outcomes

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<sup>12</sup>Although no published guidelines exist, we considered  $P_M$  values  $> .25$  to be of substantive value as it corresponds to a proportion of the total effect accounted for by the indirect effect above the 25<sup>th</sup> percentile.

1 considered adaptive (e.g., reduced distress, better functioning) or maladaptive (e.g., increased  
2 distress and disease state), through coping procedures, or whether both adaptive and  
3 maladaptive patterns of indirect effects through coping are present. We evaluate the pattern of  
4 the specific indirect effects for each illness perception dimension on each illness outcome in  
5 turn.

6 Perceived consequences had zero total indirect effects on disease state and physical  
7 and role functioning, and the effect on well-being although statistically significant was very  
8 small ( $\beta < .01$ ). This was unexpected given that primary studies and meta-analyses have  
9 consistently reported statistically significant, substantive negative correlations between  
10 perceived consequences and functioning and well-being, and positive correlations with  
11 distress and disease state. However, theory suggests that perceived consequences may also  
12 have positive effects on adaptive illness outcomes by motivating individuals to take action to  
13 mitigate the threat and there is previous evidence to support this (e.g., Brewer et al., 2002).  
14 Based on this evidence, it is possible that both positive and negative specific indirect effects  
15 would be present, and that these effects would amount to null or relatively small total indirect  
16 effects. Close inspection of the specific indirect effects revealed consistency in the pattern of  
17 effects of consequences on each outcome via the coping constructs as mediators. Specifically,  
18 consequences tended to predict maladaptive outcomes through avoidance coping and  
19 adaptive outcomes through problem-focused coping. For example, consequences had  
20 statistically significant and positive effects on disease state and distress through avoidance,  
21 and significant negative effects on these outcomes through problem-focused generic coping.

22 The effects for consequences were corroborated by the mediation proportion statistics.  
23 The specific indirect effects for consequences through avoidance and problem-focused  
24 coping accounted for a substantial proportion of the overall indirect effect. There were also  
25 significant negative effects of consequences on functioning and well-being through avoidance

1 and significant positive effects on these outcomes through problem-focused generic coping.  
2 Together these effects were similar in magnitude and opposite in sign leading to the null or  
3 relatively small total indirect effects of consequences on outcomes. The effects for the  
4 consequences dimension, therefore, comprised both positive and negative indirect  
5 associations with adaptive and maladaptive outcomes through coping. This is consistent with  
6 the view of consequences as a representation of threat, which may motivate patients to take  
7 action to deal with the threat or to engage in procedures to manage the concomitant emotional  
8 upheaval. The specific indirect effects, therefore, reveal the multiple pathways by which  
9 consequences impact on outcomes not indicated by the total indirect effect.

10         Similar positive and negative patterns of specific indirect effects were found for the  
11 identity dimension on illness outcomes. Total indirect effects revealed statistically significant  
12 effects for identity on distress, significant negative effects on physical, role, and social  
13 functioning, and null effects on disease state and well-being. Decomposition of the specific  
14 indirect effects revealed that the total indirect effect comprised effects of opposing sign. For  
15 example, identity had significant positive indirect effects on disease state and distress through  
16 avoidance, and significant negative indirect effects on physical, role and social functioning,  
17 and well-being through this mediator. Mediation proportion statistics indicated that a  
18 substantial proportion of the indirect effect of identity on each outcome was through  
19 avoidance. There were also statistically significant positive effects of identity on physical and  
20 social functioning, and well-being mediated by problem-solving generic coping, although the  
21 size of these effects was small and trivial by comparison. Analogously there were statistically  
22 significant but small negative effects of identity on distress and disease state through  
23 problem-focused generic coping. These oppositely-valanced effects had the effect of reducing  
24 the size of the total indirect effects for this representation dimension. The total indirect effects  
25 of identity on outcomes were, therefore, substantially weaker due to indirect effects of

1 opposing sign. Again, this is consistent with the view of identity as representing illness threat  
2 and its potential to affect both adaptive and maladaptive outcomes through multiple  
3 pathways.

4         Specific indirect effects of perceived control on outcomes were consistent with the  
5 pattern of the zero-order corrected correlations, and the direct and total indirect effects, for  
6 this construct. Control has been identified as having a pivotal role in driving the adoption of  
7 problem-focused coping strategies, so the effects on outcomes were expected to be mediated  
8 by the generic and specific forms of problem-focused coping. Perceived control over the  
9 illness exhibited statistically significant and positive total indirect effects on physical and role  
10 functioning and psychological well-being. This was corroborated by the specific indirect  
11 effects, which indicated significant positive effects of perceived control on these outcomes  
12 mediated by generic and specific forms of problem-focused coping. Mediation proportion  
13 statistics corroborated this pattern, with substantive proportions of the total indirect effect of  
14 perceived control on each outcome accounted for by the specific indirect effects through  
15 problem-focused coping. We also found significant negative specific indirect effects of  
16 control on disease state and psychological distress mediated by problem-focused coping and  
17 cognitive reappraisal, effects that were in keeping with the predicted pattern. Overall,  
18 perceived control was related to adaptive outcomes including improvements in functioning  
19 and well-being and reductions in disease state and distress.

20         Illness coherence had statistically significant positive total indirect effects on role  
21 functioning and well-being and negative indirect effects on distress and disease state. Such  
22 effects indicate that individuals with a clearer understanding of the illness may be better  
23 equipped to identify relevant coping strategies as they are likely to have relevant information  
24 regarding which strategies may be more effective. Problem-focused coping and cognitive  
25 reappraisal were, therefore, expected to be key mediators of effects of coherence on



1 outcomes. However, observing the specific indirect effects revealed that the effect of  
2 coherence on outcomes was not mediated by problem-focused coping, with the exception of  
3 the significant positive effect of coherence on role functioning through problem-focused  
4 specific coping. Instead, the specific indirect effects of coherence on outcomes were mediated  
5 by avoidance and emotion venting in most cases, and substantive proportions of the indirect  
6 effect were accounted for by the specific effects through these mediators. For example,  
7 coherence was statistically significantly and positively related to physical, role, and social  
8 functioning through emotion venting and avoidance, and significantly and negatively related  
9 to distress through these variables. These effects are notable because emotion venting and  
10 avoidance are typically involved in mediating effects of illness representations on  
11 maladaptive outcomes. These specific indirect effects illustrate that, in some cases, illness  
12 representations and the adoption of emotion-focused coping strategies may lead to functional  
13 improvements and adaptive outcomes.

14         The specific indirect effects for timeline on outcomes tended to be consistent with the  
15 total indirect effects. There were consistent, albeit small, statistically significant and positive  
16 specific indirect effects of chronic timeline on physical functioning, social functioning, and  
17 well-being mediated by problem-focused generic coping, and significant negative effects on  
18 disease state and distress through problem-focused generic coping. Mediation proportion  
19 statistics also indicated that effects through problem-focused generic coping accounted for  
20 the largest proportion of the total indirect effect of timeline on all outcomes except role  
21 functioning. It is important to note that this pattern of effects was inconsistent with the zero-  
22 order correlations between timeline and outcomes. Timeline denotes chronicity and has been  
23 associated with poorer functioning and well-being, and elevated distress in a previous meta-  
24 analysis (Hagger & Orbell, 2003). The correlations, however, may not reflect the unique

1 effects when other illness representation dimensions are taken into account and when  
2 decomposing overall effects into specific indirect effects through coping strategies.

3         The specific indirect effects for emotional representations on illness outcomes tended  
4 to closely mirror the direct and total indirect effects for this variable and indicated that this  
5 dimension was generally associated with maladaptive outcomes. Specifically, emotional  
6 representations were statistically significantly and positively related to distress, mediated by  
7 avoidance and emotion venting, and significantly and negatively related to psychological  
8 well-being mediated by avoidance. Emotional representations were also significantly and  
9 negatively related to social, role, and physical functioning mediated by avoidance and  
10 emotion venting, and significantly and negatively related to well-being and physical  
11 functioning through problem-focused generic coping strategies. Mediation proportion  
12 statistics revealed that the indirect effects of emotional representations through avoidance and  
13 emotion venting accounted for substantive proportions of the total indirect effects, and effects  
14 through other mediators were trivial by comparison. These findings indicate that emotional  
15 representations tend to be related to maladaptive outcomes such as poorer functioning,  
16 greater psychological distress, and increased disease state through adoption of emotion-  
17 focused coping strategies and lower engagement in problem-focused coping strategies.

18         **Sensitivity analysis for sample size.** Results of our sensitivity analyses in which we  
19 estimated our proposed model for each outcome variable using smaller sample sizes ( $n =$   
20 3,130 and  $n = 1,000$ ) are presented in Tables 11 to 16 (Appendix M, supplemental materials).  
21 As expected, 95% confidence intervals about the parameter estimates were progressively  
22 wider with decreasing sample size. This meant that the confidence intervals for the smaller  
23 parameter estimates were more likely to encompass zero as a possible value. The attenuation  
24 effect notwithstanding, non-trivial parameter estimates remained statistically significant  
25 according to adopted criteria even in models tested with the smallest sample size. These

1 findings corroborate the imperative of a focus on effect size rather than statistical significance  
2 alone when interpreting results from path analyses based on correlations from a meta-  
3 analysis. Overall, the sensitivity analyses did not alter our interpretation of the pattern of  
4 main effects among model constructs.

### 5 **Sensitivity Analyses of Model Effects**

6       Although the moderator analysis demonstrated few statistically significant differences  
7 in the individual averaged corrected correlations across moderator groups, we conducted  
8 sensitivity analyses to test whether the pattern of effects among constructs in our proposed  
9 process model was dependent on levels of the study design, illness type, medically-explained  
10 vs. medically-unexplained symptoms, and methodological quality moderators<sup>13,14</sup>. Given we  
11 found that the model including direct and indirect effects of illness representations on  
12 outcomes (Model 2) was superior for each outcome variable in full sample analyses, a key  
13 purpose of our sensitivity analyses was to test whether this was the case in the moderator  
14 groups. We also tested whether the pattern of effects in the proposed models differed across  
15 moderator groups by conducting a set of multi-group path analyses of the models  
16 constraining each path to be invariant across levels of the moderator using a set of equality  
17 constraints. Models were estimated using the averaged corrected correlation matrices as input  
18 for the path analyses for each moderator group<sup>15</sup>. Goodness-of-fit estimates for the single  
19 sample and multi-group path analyses of both models for each outcome variable and at all

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<sup>13</sup>We did not conduct sensitivity analyses for the time from diagnosis moderator due to large numbers of correlations missing in the matrices for the recently diagnosed moderator group. For example, for correlations among the coping and outcome constructs there was only sufficient data to compute two of the thirty six possible correlations for the recently diagnosed (RD) moderator group.

<sup>14</sup>Scores on the methodological quality checklist did not result in substantive variation in the magnitude of the corrected correlations across studies. This was the case for the analyses coded according to checklist score tertiles and a cut-off score of six. Both coding methods revealed extremely similar patterns of effects, although there were many instances where an effect size could not be computed due to insufficient studies for the analysis based on tertiles. We opted to use the coding based on the cut-off scores in subsequent sensitivity analyses to maximize the sample size at each level of the moderator.

<sup>15</sup>Some of the effects in the moderator groups were tested by fewer than two studies so an averaged corrected effect size could not be computed (see Table 6, Appendix K, supplemental materials). These effects were substituted by the equivalent correlation from the full sample analysis to generate the complete correlation matrix required to run the path analyses.

1 levels of each moderator are presented in Tables 17 to 20 (Appendix N, supplemental  
2 materials). For the single-sample analyses, lower AIC values were observed for Model 2  
3 relative to Model 1 within each moderator group in all analyses corroborating the observed  
4 superiority in fit of this model in the full sample analysis. In addition, CFI values for Model 1  
5 were below acceptable cutoff criteria, indicating substantive misspecification as a result of  
6 omitting the direct effects. For the multi-group models, the indirect effects only model  
7 (Model 1) exhibited fit statistics which fell short of accepted criteria for a well-fitting model  
8 in virtually every case. Conversely, goodness-of-fit indexes for Model 2 exceeded adopted  
9 criteria for good fit, and were superior to Model 1, in all analyses. These data not only  
10 provided additional confirmatory evidence for the superiority of Model 2, but also indicated  
11 that constraining model parameters to equality across moderator levels resulted in very little  
12 misspecification. This suggested that the proposed pattern of effects among the illness  
13 representation, coping, and outcome constructs in Model 2 provided a robust representation  
14 of observed relations among these constructs in the meta-analyzed data. Consistent with the  
15 moderator analysis of the correlations, these analyses indicate that the pattern of effects  
16 among the constructs in the models did not vary substantially across levels of the moderator.

## 17 **Discussion**

18 Our primary goal in the current analysis was to test a process model in which effects  
19 of illness representation dimensions on outcomes in patients with chronic illnesses or  
20 conditions were mediated by coping procedures as specified by Leventhal et al.'s (1980)  
21 common-sense model of self-regulation. We expect our analysis to contribute to a better  
22 understanding of the illness process by (a) demonstrating the unique effects of illness  
23 representation and coping variables on illness outcomes in a comprehensive, fully-inclusive  
24 model accounting for all dimensions of the common-sense model; (b) confirming the  
25 sufficiency of the process model in which coping strategies account for the effects of illness

1 representations on illness outcomes; (c) providing information on the specific indirect  
2 pathways by which illness representations relate to illness outcomes through coping  
3 procedures; and (d) assessing the impact of candidate moderator variables on relations among  
4 the common-sense model constructs. Our analysis informs theory development by testing the  
5 sufficiency of the process model, a central but often neglected premise of the common-sense  
6 model. It also has potential implications beyond the model as relations between beliefs about  
7 threat, emotional distress and coping are key tenets of other theories of stress and coping  
8 (e.g., Lazarus & Folkman, 1984). In the next sections we discuss the findings and  
9 implications of the present analysis in each area of contribution.

#### 10 **Sufficiency of the Model**

11         The present research is the first to produce a full meta-analytic inter-correlation  
12 matrix among the representation, coping, and outcome variables across studies adopting the  
13 common-sense model. Not only did this permit us to ascertain the unique effects of  
14 representation and coping dimensions on illness outcomes in multivariate analyses, but to  
15 also test the proposed process model based on cumulative evidence from multiple studies.

16         Examining the unique effects in the current analysis, a key finding was that the  
17 process model that assumed coping fully mediated effects of illness representations on  
18 outcomes was not sufficient, and direct representation-outcome relations were present. This  
19 suggests that the coping procedures did not fully explain the effects of illness representations  
20 on outcomes. This finding is unique because previous meta-analyses were not able to test the  
21 sufficiency of the model. However, given that we found total indirect effects of the illness  
22 representation dimensions constructs on illness outcomes through coping means that the  
23 mediation hypothesis should not be rejected; instead both direct and indirect effects exist. Our  
24 findings suggest that coping partially accounts for the effects of cognitive and emotional

1 representation dimensions on outcomes in chronic illness, but the representations also have  
2 unique effects on outcomes independent of the coping constructs included in these studies.

3         The total effects from the models enabled identification of the representation  
4 dimensions that, overall, contribute most to explaining variance in illness outcomes. The  
5 consequences and identity dimensions emerged as consistent positive predictors of  
6 maladaptive outcomes, that is, outcomes related to increased illness progression, greater  
7 distress, and poorer well-being, and perceived control as a positive predictor of adaptive  
8 outcomes such as better functioning and well-being, and reduced distress and disease  
9 progression. Individuals interpreting their illness as having less impact on their life,  
10 attributing fewer symptoms to the illness, and perceiving the illness as under control and  
11 treatable are likely to experience less distress, better functioning and well-being, and reduced  
12 disease state. In addition, emotional representations had a strong positive total effect on  
13 distress, a strong negative effect on well-being, and weaker negative effects on physical and  
14 role functioning. Individuals who are able to downplay their emotional response to the illness  
15 are less likely to experience deleterious emotional outcomes and more likely to report better  
16 psychological well-being. By comparison, effects of emotional representations on functioning  
17 and illness progression were weaker, suggesting that reduced emotional representations may  
18 not have a strong effect on outcomes related to adaptive function and illness recovery. These  
19 findings illustrate the overall unique effects of the cognitive and emotional illness  
20 representation dimensions on outcomes based on the current sample of studies.

21         One explanation for the insufficiency of the full mediation model is that the coping  
22 measures in the included studies may not have been optimally effective in testing mediation.  
23 Many studies in the present sample adopted coping measures that tap generalized coping  
24 procedures rather than illness- or behavior-specific measures that precisely capture means to  
25 cope with the illness. The use of generalized measures is likely to result in weaker relations

1 of the coping measures with illness representations and outcomes, a problem that has been  
2 noted elsewhere (e.g., Hagger & Orbell, 2003; Heijmans, 1999). Generalized measures are  
3 unlikely to capture all possible coping procedures relevant to the illness. One solution  
4 employed in the current analysis was to specify a separate problem-focused specific coping  
5 category, which encompassed illness-specific coping procedures. Illness-specific coping  
6 strategies were expected to have closer correspondence with the representation and outcome  
7 measures. However, few studies in the current sample included such measures and the  
8 measures inevitably captured only one specific coping strategy when a range of specific  
9 strategies may have been relevant. There is, therefore, scope to improve prediction in tests of  
10 the common-sense model by moving away from generic coping scales and adopting coping  
11 measures specific to the target illness.

12         An alternative interpretation for the insufficiency of the model is that the coping  
13 constructs included in the current sample of studies did not adequately explain relations  
14 between illness representations and outcomes. Other coping strategies or unmeasured  
15 extraneous variables may have served to mediate the direct effects of representations on  
16 outcomes. For example, research has identified ‘all or nothing’ coping procedures in which  
17 patients with chronic illness follow cycles of full engagement in a behavioral coping strategy  
18 to manage their illness followed by complete disengagement. This pattern was not accounted  
19 for in the current model as it has only been tested in a few studies (e.g., Chilcot & Moss-  
20 Morris, 2013; Moss-Morris et al., 2011). Such patterns are likely to be adopted by patients  
21 who are high on certain traits, such as perfectionism, and prone to distress (c.f., Limburg,  
22 Watson, Hagger, & Egan, 2016). Coping in the common-sense model may, therefore, only  
23 account for some of the effects on illness beliefs on outcomes in chronic illness. Finally, the  
24 direct effects may reflect effects of representations on outcomes that are independent of  
25 consciously-accessible coping strategies. Representations of the illness may be implicitly

1 linked with typically-adopted coping strategies in memory (Henderson et al., 2009; Orbell et  
2 al., 2015). The strategies may become salient when the illness 'schema' is activated and serve  
3 to mediate effects of representations on subsequent illness outcomes beyond the individual's  
4 awareness.

### 5 **The Function of Coping in the Process Model**

6         The total indirect effects of the cognitive and emotional representation dimensions on  
7 illness outcomes were consistent with the general expected pattern of effects in many cases.  
8 However, our current analysis also revealed some important effects which were not evident  
9 on inspection of the total indirect or total effects of the illness representation constructs on  
10 outcomes. For example, zero-order correlations from the current and previous meta-analyses  
11 (Dempster et al., 2015; Hagger & Orbell, 2003; Mc Sharry et al., 2011) have revealed  
12 consistent positive relations between the consequences dimension and maladaptive outcomes  
13 (increased disease state and distress) and negative relations with adaptive outcomes (greater  
14 well-being, better functioning). In contrast, the total indirect effects from our analysis  
15 revealed null or relatively small effects of this construct on outcomes. Furthermore,  
16 examination of the specific indirect effects revealed patterns of effect for illness  
17 representation dimensions on outcomes that could not be ascertained from the total indirect  
18 effects alone. Prominent among these were the specific indirect effects for the perceived  
19 consequences dimension which had consistent negative effects on adaptive outcomes through  
20 avoidance, and positive effects on adaptive outcomes through problem-focused coping. The  
21 presence of both positive and negative specific indirect effects of approximately equal  
22 magnitude equated to a zero total indirect effect for consequences on all but one of the illness  
23 outcomes in the current analysis. Evaluating the effects of consequences on outcomes  
24 through coping based on the total indirect effects alone would lead to an erroneous  
25 conclusion that representing the illness as having serious consequences has no indirect effect



1 on outcomes. The specific effects reveal otherwise and indicate that illness consequences can  
2 lead to individuals selecting coping strategies that lead to both adaptive and maladaptive  
3 outcomes.

4         The presence of effects of illness representation dimensions on both adaptive and  
5 maladaptive outcomes mediated by coping has important ramifications for theory. These  
6 findings suggest a pattern of effects among constructs in the common-sense model that is  
7 more complex than that found in previous research syntheses. Much of the research on the  
8 common-sense model has consistently demonstrated that beliefs indicating increased threat,  
9 i.e. viewing an illness as having serious consequences, highly symptomatic, and chronic, will  
10 lead to emotion-focused coping strategies and poorer outcomes including greater disease  
11 progression, lower functioning and well-being, and greater distress (e.g., Dempster et al.,  
12 2015; Hagger & Orbell, 2003; Mc Sharry et al., 2011). However, these findings have been  
13 exclusively derived from zero-order correlations among constructs and regression models  
14 examining effects of representation dimensions on outcomes in the absence of other  
15 representation dimensions and coping strategies. The current analysis indicates that these  
16 overall patterns, and corresponding conclusions, may be misleading because bivariate  
17 analyses do not test the multiple pathways by which representation dimensions relate to  
18 outcomes through coping strategies.

19         We have demonstrated that the overall effects of representations on outcomes  
20 comprise sets of specific indirect effects that are opposite in sign (i.e., positive and negative).  
21 These patterns are, in fact, consistent with theory, but have seldom been shown empirically.  
22 For example, while zero-order correlations indicate largely negative effects of consequences  
23 on functioning and well-being, and positive effects on distress, the emergent pattern of  
24 indirect effects from the mediation model indicates that consequences was positively related  
25 to functioning and well-being through problem-focused coping. These findings are consistent

1 with Leventhal et al.'s (1980) original proposal that beliefs indicating elevated seriousness of  
2 the illness will motivate individuals to search for coping strategies to manage the illness and  
3 down-regulate the felt dissonance between health state and beliefs. There are also similar  
4 specific indirect effects for timeline which show positive effects on functioning and well-  
5 being, and negative effects on disease state, through problem-focused coping, while zero-  
6 order correlations indicate the opposite. Although rare, previous research has also found  
7 negative mediated effects of consequences on disease state and distress through problem-  
8 focused coping and self-nurturing coping procedures (Benyamini et al., 2004; Brewer et al.,  
9 2002). Current findings indicate that representation dimensions relate to multiple coping  
10 strategies which have both positive and negative effects on outcomes related to illness  
11 recovery. This pattern suggests that representation dimensions might motivate adoption of  
12 different coping strategies under different circumstances. Identifying the circumstances that  
13 determine the specific pattern of effects is, therefore, critical for the accurate prediction of  
14 coping responses and concomitant outcomes.

### 15 **Role of Context and Moderators in the Process Model**

16 High levels of heterogeneity were observed in the majority of the effect sizes in the  
17 current analysis. This means that after correcting for methodological artifacts there was still  
18 substantive variation in the size of the relations among the common-sense model constructs  
19 across studies. Given that these effect sizes were used as input for our meta-analytic path  
20 analysis of the process model, results must be interpreted in light of the potential of the  
21 coefficients involved in the analysis to vary and for that variability to affect the strength of  
22 the effects in the process model. The effects reported in the process model, to some extent,  
23 reflect a generalized, 'ideal' case of relations in chronic illness, which may be indicative of  
24 potential pathways that may operate in the model, but the pathways would be dependent on

1 extraneous moderating variables that determine whether the pathway will be present or  
2 absent. A search for moderators was, therefore, warranted.

3         We contended, consistent with theory and previous research on the common-sense  
4 model (Horne & Weinman, 2002; Leventhal et al., 1980; Moss-Morris et al., 2011), that  
5 contextual factors will moderate effects within the common-sense model. The factors may  
6 assist in resolving the high heterogeneity observed in the zero-order correlations among  
7 model constructs and explaining the patterns of effects in the process model. We tested the  
8 effects of contextual factors (illness type), illness characteristics (medically-explained and  
9 medically-unexplained symptoms), illness stage, and methodological artifacts (study design,  
10 methodological quality) as moderators. Contrary to expectations, our analysis did not reveal  
11 consistent moderation effects or lead to a resolution of the high levels of heterogeneity  
12 observed in relations among model constructs. Furthermore, moderator analysis reproducing  
13 our models in each moderator group corroborated the consistency of the stipulated pattern of  
14 effects across levels of the moderator. Results indicated that the model that specified both  
15 direct and indirect effects of representation dimensions on outcomes (Model 2) exhibited  
16 superior fit to the indirect effects only model (Model 1) in all moderator groups. In addition,  
17 constraining the paths in Model 2 to be equal across levels of the moderator resulted in well-  
18 fitting models with few misspecifications in every case.

19         It is important to note that our moderator analyses were limited due to substantial  
20 heterogeneity remaining in the effect sizes within moderator groups, as well as the small  
21 sample sizes in many of the moderator groups. For example, studies on cancer and CVD  
22 included a number of different variants of the illness that likely introduced additional within-  
23 group heterogeneity. More primary research is needed that systematically tests the proposed  
24 mediation effects in the process model in the presence and absence of the moderators.  
25 Resolving the unique moderating effects of these characteristics may require systematic

1 comparisons of the direct and indirect effects of illness representation dimensions on  
2 outcomes through coping at different levels of the moderator. For example, primary research  
3 examining the moderating effect of illness type would necessitate testing relations among  
4 process model constructs using appropriate measures in patients of two illnesses, preferably  
5 matching samples and taking measures at a similar time from diagnosis, or, at the very least,  
6 controlling for these factors. Similar procedures could be adopted in the design of studies  
7 testing the moderating effects of illnesses with medically-explained or medically-unexplained  
8 symptoms or a definitive treatment protocol. Tests of the moderating effects of personality  
9 and dispositional factors such as optimism and perfectionism would also require systematic  
10 treatment and controls, and preferably confining analyses to particular illness types or  
11 controlling for their effects.

12 Tests of the moderating effects of illness stage on model pathways could also be  
13 conducted in a similar way. Data on illness representations captured in very close proximity  
14 to actual diagnosis, coupled with matched group or, preferably, longitudinal comparison data  
15 on coping and outcomes for the same illness, would be invaluable in providing an indication  
16 as to how links between illness representations, coping procedure selection, and illness  
17 progression and other outcomes change over time. Although challenging to collect, such data  
18 may assist in providing empirical support for the dynamic processes proposed in the  
19 common-sense model (Leventhal et al., 1980; Leventhal et al., 2016). We call for the  
20 development of well-designed studies that systematically test moderator effects in the  
21 common-sense model and move the field beyond the static, correlational designs that  
22 predominate in the literature to date. Such research should test the effects of moderators in  
23 the model and explain changes in relations among representation, coping, and outcome  
24 constructs over time. The research will provide better evidence for the processes by which  
25 beliefs about illnesses affect coping strategies and outcomes in chronic disease.

## 1 **Implications for Practice**

2           The identification of specific indirect effects in the current analysis has implications  
3 for the application of the common sense model in practice. Behavioral interventions should  
4 not only target change in certain illness representation dimensions linked to adaptive  
5 outcomes (e.g., halting or reversing disease progression, improving functioning, promoting  
6 well-being, and allaying distress), but also target the coping strategies that these  
7 representations activate. In some cases, targeting change in a given representation dimension  
8 would be an appropriate strategy if the dimension was consistently related to adaptive  
9 outcomes through the model pathways. For example, the control representation dimension  
10 has consistent effects, both direct and indirect, on adaptive illness outcomes. Promoting  
11 positive change in this dimension, therefore, would likely lead to adaptive outcomes and it  
12 should be labelled as a priority target for intervention. However, in some cases targeting  
13 intervention efforts on a particular representation dimension may have effects on adaptive  
14 and maladaptive outcomes. For example, providing messages that highlight the serious  
15 consequences of an illness to patients may lead to adaptive outcomes by prompting adoption  
16 of problem-focused coping strategies, but may, in turn, lead to maladaptive outcomes like  
17 distress and disease progression through avoidance. A solution might be to adopt strategies  
18 that link the representation with the desired coping strategy. The common-sense model  
19 implies that coping strategies may be stored schematically alongside representation  
20 dimensions (Leventhal et al., 2016), and there is research suggesting that activating the  
21 representation leads to a concomitant activation of the coping strategy (Henderson et al.,  
22 2009). Active reinforcement of this link in interventions may, therefore, lead illness sufferers  
23 to associate their beliefs about the illness with an appropriate coping strategy. Returning to  
24 the example of the consequences dimension, raising patients' awareness of the serious  
25 consequences of the illness and simultaneously suggesting an illness-relevant problem-

1 focused strategy that will assist in managing the threat may increase the likelihood of  
2 promoting adaptive outcomes.

3         Similarly, accounting for the contextual factors that affect the indirect effects in the  
4 process model is a critical consideration when developing interventions to change beliefs and  
5 affect subsequent change in illness outcomes. For example, patients with illnesses that have  
6 clear treatment protocols and high levels of objective control may benefit from  
7 communications highlighting the consequences of the illness and the consequences of not  
8 complying with treatment. In contrast, patients with illnesses that have uncontrollable or  
9 uncertain outcomes may not benefit from problem-focused coping efforts that are unlikely to  
10 be effective, so focusing on representations such as reducing emotional representations to  
11 promote emotion-focused coping may be a more realistic and beneficial coping strategy to  
12 manage threat. So while current findings may provide guidance for interventions, it is  
13 important to consider such suggestions in light of the heterogeneity of the effects identified  
14 and the likely context-dependency of the indirect effects. Primary research to confirm the  
15 moderators of the indirect effects would be important additions to the formative literature to  
16 provide stronger evidence on which to base recommendations for practice.

### 17 **Revising the Common-Sense Model**

18         Our meta-analytic test of the process model has been instrumental in identifying the  
19 prominence of particular illness representation dimensions in predicting illness outcomes  
20 directly and indirectly through coping strategies. For some representation dimensions, the  
21 indirect effects exhibited a consistent pattern corroborating findings from previous meta-  
22 analyses and primary research. An example of such a pattern was the positive indirect effects  
23 of control beliefs on adaptive outcomes (e.g., better functioning and well-being) through  
24 problem-focused-coping. However, there were also representation dimensions which had  
25 both positive and negative indirect effects on outcomes. Prominent among these were

1 positive and negative indirect effects of perceived consequences on adaptive outcomes  
2 mediated by problem-focused coping and avoidance, respectively. The presence of these  
3 paths prompts suggestions that the processes reflected in the different pathways may be  
4 dependent on contextual factors that moderate their effects. Similarly, research has identified  
5 the potential of other variables in the common-sense model, including beliefs about coping  
6 behaviors and beliefs about treatment, in accounting for variance in coping and outcomes  
7 alongside cognitive and emotional representations (e.g., French, Wade, & Farmer, 2013;  
8 Hagger, Hardcastle, et al., 2016; Orbell, Hagger, Brown, & Tidy, 2006). These findings,  
9 together with extant theory, have provided the impetus to propose a revised common-sense  
10 process model that incorporates the moderation processes and additional constructs derived  
11 from theory and previous research. Next, we outline the conceptual bases, operationalization,  
12 and specific examples of our revised model.

13         Based on theory and research on the proposed effects of socio-contextual and self-  
14 systems on model relations (Martin et al., 2003; Moss-Morris et al., 2011; Petrie & Weinman,  
15 2012), we propose three key moderators of representation effects on outcomes: illness  
16 characteristics (e.g., illness type and severity, whether the illness is symptomatic or  
17 asymptomatic, and whether the illness has medically-explained or medically-unexplained  
18 symptoms), personality and individual differences (e.g., optimism, perfectionism), and  
19 emotional representations. The proposed moderating effects are illustrated in Figure 3, which  
20 outlines the generalized version of the revised model. The basic mediation effects of the  
21 process model tested in the current meta-analysis are depicted in the central section of Figure  
22 3. In the revised model, these mediated pathways are proposed to be moderated by three sets  
23 of factors, represented in the diagram by the effects of illness type, dispositions, and  
24 emotional representations on the mediated pathways (see broken lines in Figure 3). In its  
25 generalized form, the model indicates the potential for upward and downward moderating

1 effects on the mediated pathways involving representation dimensions, coping strategies, and  
2 outcomes (Figure 3). The revised model extends previous theory by providing a formal  
3 operationalization of Leventhal et al.'s (1992; 1980) proposal that socio-cultural and self-  
4 system constructs will impact on relations between illness representations, coping strategies,  
5 and outcomes (see upper section of Figure 1).

6 We provide specific examples of the moderation effects and illustrate them in Figures  
7 4 and 5<sup>16</sup>. The moderating effect of an illness characteristic, the extent to which the illness is  
8 treatable, on model pathways is presented in Figure 4. Illnesses and conditions that are  
9 unlikely to respond to treatment (e.g., chronic pain) may mean that problem-focused coping  
10 efforts will be viewed as less effective, while emotional focused-coping such as venting or  
11 even avoidance may be more appropriate. Lower illness treatability may, therefore, moderate  
12 the effects of threat and control representations on outcomes (e.g., functioning) through  
13 problem-focused coping downwards, and effects of threat representations on outcomes (e.g.,  
14 distress, disease state) through emotion-focused coping upwards.

15 The moderating effect of emotional representations on model relations is presented in  
16 Figure 5. Viewing an illness as highly emotionally distressing may lead individuals to  
17 prioritize the selection of emotion-focused coping strategies aimed at managing the increased  
18 distress over more problem-focused strategies. Emotional representations are, therefore,  
19 depicted as moderating the positive effects of perceived consequences on increased disease  
20 state and distress through emotion-focused coping upward, and the positive effects of threat  
21 and control perceptions on better functioning and reduced disease state downwards. These  
22 moderation effects were implied by Leventhal et al. in the initial specification of the  
23 common-sense model, suggesting that emotional representations have both independent and

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<sup>16</sup>Constructs in Figures 4 and 5 are represented such that larger scores represent higher levels of the construct. For example, high levels of identity, consequences, and timeline cognitive illness representations reflect greater threat perceptions, high levels of functioning and well-being indicate adaptive outcomes, and high levels of distress and disease state indicate maladaptive outcomes.



1 interactive effects on coping and outcomes (see Leventhal et al., 1992; Martin et al., 2003),  
2 and were depicted as bidirectional arrows between representation, coping, and outcome  
3 dimensions in schematics of the model (see Figure 1). However, these effects have, to date,  
4 not been formally operationalized or tested empirically. This aspect of the revised process  
5 model extends Leventhal et al.'s original proposals by identifying and operationalizing  
6 specific, testable hypotheses regarding the potential moderation of mediated pathways.  
7 Empirical verification of these pathways should be considered a priority for future research.

8         In addition to incorporating moderating factors, our revised common-sense process  
9 model also incorporates the independent effects of beliefs with respect to engaging in specific  
10 coping behaviors and beliefs about treatment. The inclusion of these beliefs follows theory  
11 and research that has focused on integrating the common-sense model with other social  
12 cognitive approaches to understanding coping and illness outcomes. For example, behavioral  
13 coping with an illness can be conceptualized as a function of beliefs about the illness (e.g.,  
14 threat perceptions, perceived control, and emotional responses), as indicated in the common-  
15 sense model. It can also be conceived as a function of beliefs about engaging in the coping  
16 behavior itself, such beliefs that the behavior will result in desired outcomes (attitudes),  
17 beliefs in personal capacity to perform the behavior (self-efficacy), and beliefs in capacity to  
18 cope with difficulties or setbacks in managing the illness (coping self-efficacy), as indicated  
19 in social cognitive approaches to behavior (e.g., Bandura, 1977; Fishbein & Ajzen, 2009;  
20 Schwarzer, 2008). The modifications provide a more comprehensive perspective on the  
21 factors that are related to problem-focused coping responses to manage illness. For example,  
22 an asthmatic patient's decision to engage in a problem-focused coping procedure to manage  
23 attacks (e.g., prophylactic use of an inhaler) is not only likely to be a response to beliefs that  
24 an attack is sufficiently serious but controllable, but also beliefs that the inhaler will be  
25 effective and that they can use it appropriately. The parallel influence of cognitive illness

1 representations and social cognitive beliefs on illness outcomes through problem-focused  
2 coping strategies is illustrated in Figure 3. Studies incorporating both sets of beliefs in tests of  
3 the common-sense model have indicated that social cognitive beliefs tend to have stronger  
4 effects and usually attenuate or extinguish the effects of cognitive representations (e.g.,  
5 French et al., 2013; Hagger, Hardcastle, et al., 2016; Orbell et al., 2006).

6 Leventhal et al. (1992; 2016) have also suggested that beliefs about treatment,  
7 including its efficacy and perceived side effects, would affect selection of, and adherence to,  
8 treatment. Treatment can refer to numerous problem-focused coping behaviors including  
9 medication adherence and behaviors aimed at rehabilitation, recovery, and prevention of  
10 relapse (e.g., physical activity in patients with cardiovascular disease or osteoarthritis).  
11 Beliefs relating to treatment behaviors engagement can be accounted for in tests of the  
12 common sense model by incorporating constructs from social cognitive theories (e.g.,  
13 attitudes, self-efficacy). However, there has also been interest in isolating patients' beliefs  
14 about medication as a specific form of treatment (Horne, 1997). Horne et al. (1999) contend  
15 that medication adherence (e.g., taking anti-hypertension tablets to manage blood pressure) is  
16 a function of specific beliefs about the effectiveness (e.g., taking tablets reduces blood  
17 pressure at the next test) and drawbacks (e.g., debilitating side-effects of taking the tablets) of  
18 medication. Research on beliefs about medication identified that patients held general beliefs  
19 about the harmfulness and overuse of medication, and specific beliefs about the necessity of  
20 the medication and concerns over its use. In the revised model, medication beliefs are  
21 expected to explain unique variance in specific coping behaviors (i.e., medication adherence)  
22 alongside illness representations and beliefs about other coping behaviors (Figure 3).

23 A growing body of research has incorporated measures of illness representations  
24 alongside measures of medication beliefs (e.g., BMQ; Horne et al., 1999) in an extended  
25 model of illness self-regulation (see Horne & Weinman, 2002) and examined their

1 independent effects on medication adherence, including a number of the studies included in  
2 the present analysis ( $n = 18$ ; Table 3, Appendix E, supplemental materials). Results have  
3 indicated that individuals with strong beliefs in the necessity of their medication and fewer  
4 concerns over its use tend to have better medication adherence independent of illness  
5 perceptions (e.g., Byrne, Walsh, & Murphy, 2005; Horne & Weinman, 2002; Nicklas,  
6 Dunbar, & Wild, 2010). The unique effects of beliefs about medication identified in this  
7 research highlights the importance of including treatment beliefs in the revised common-  
8 sense process model.

9         A specific example illustrating the effects of additional beliefs in the revised  
10 common-sense model is presented in Figure 6. In this model, problem-focused coping  
11 procedures are depicted as a response to illness beliefs, consistent with the original model.  
12 Coping is also viewed as a response to beliefs about the coping response itself derived from  
13 social cognitive theories (e.g., attitudes, self-efficacy, coping self-efficacy). Intentions are  
14 also included as a mediator of the effects of illness and behavioral beliefs on coping  
15 procedures to reflect the effort and motivation toward the coping response. The relative  
16 contribution of each belief set advances theory by illustrating the specific pathways that  
17 influence patients' decisions on the adoption of coping procedures. Testing these pathways  
18 empirically within the revised model may provide formative evidence to assist in the  
19 identification of the beliefs that should be targeted in interventions to promote participation in  
20 appropriate coping strategies (Hagger, Hardcastle, et al., 2016; Orbell et al., 2006). The  
21 model also provides the opportunity to explore potential interactions between the sets of  
22 beliefs. Given research indicating that individuals are more likely to engage in health  
23 behaviors in response to a perceived threat when motivation and self-efficacy are high (e.g.,  
24 Peters, Ruiter, & Kok, 2013), we have indicated that threat perceptions may moderate the  
25 effect of intentions on problem-focused coping (see broken line in Figure 6).

1           We also incorporate action planning as an important component of the process  
2 preceding the adoption of coping procedures. Leventhal et al. identified action plans as  
3 critical to the implementation of coping strategies to manage illness outcomes. The plans  
4 identify the specific coping response (e.g., taking an insulin injection), the context in which it  
5 will be performed (e.g., in the morning 15 minutes before breakfast), and expectations of the  
6 outcomes of the response (e.g., appropriately-managed blood glucose levels). In the model,  
7 action plans are depicted as generated by representations of the illness threat and beliefs  
8 about the behavior. Furthermore, action plans form a ‘bridge’ between intentions and the  
9 enactment of the coping procedure, as illustrated by the mediation of the effect of intentions  
10 on coping by action plans in Figure 6. Formation of action plans has been shown to be pivotal  
11 for illness management by assisting individuals in the efficient enactment of an appropriate,  
12 effective coping response to a threat representation (Leventhal et al., 2016). The concept of  
13 action plans has also been adopted and applied as an important intervention technique in the  
14 promotion of health behavior in multiple contexts (e.g., Hagger, Luszczynska, et al., 2016;  
15 Orbell, Hodgkins, & Sheeran, 1997; Schwarzer, 2008). Action plans provide opportunities to  
16 intervene and promote better adherence to health behaviors. Whereas some patients with  
17 chronic illnesses form action plans independently, others need assistance from health  
18 professionals. Assisting patients in developing appropriate skills to generate their own action  
19 plans may provide important means to enhance coping self-regulation.

20           It is important to note that the proposed effects in our revised common-sense process  
21 model are speculative, based on a combination of the findings of the current research, theory,  
22 and evidence from primary research to provide potential explanations for effects identified in  
23 the current analysis. We expect the revised model to provide a starting point for future  
24 research examining the processes by which representations impact outcomes in the common-  
25 sense model and we have provided examples of some key hypotheses that might be tested.

1 Such research will assist in further advancing the common-sense model and the processes  
2 involved in coping with chronic illness.

### 3 **Strengths, Limitations and Recommendations**

4         The current analysis has numerous strengths. It is the first test of the sufficiency of a  
5 process model, based on the common-sense model of self-regulation, in which coping  
6 responses mediate the effects of illness representations on illness outcomes across research in  
7 chronic illness using a quantitative cumulative synthesis. No previous research has tested a  
8 comprehensive model that accounts for multiple representation, coping, and outcome  
9 constructs simultaneously. Our data set comprising studies from multiple chronic illnesses  
10 allowed us to test the sufficiency of a full mediation model, in which coping strategies fully  
11 accounted for effects of representation dimensions on outcomes, compared to an alternative  
12 in which both direct and indirect effects were specified (viz. Bagozzi, 1981; Hagger, Chan, et  
13 al., 2016). In addition, our research also permitted tests of the unique effects of illness  
14 representation dimensions on coping strategies and illness outcomes that may contribute to  
15 explaining coping selection and outcomes and the selection of potential targets for behavioral  
16 interventions. A further strength of the current analysis is our systematic classification and  
17 coding of measures of illness representation, coping, and outcome across research adopting  
18 the common-sense model in chronic illness. The theory-based classification was also  
19 essential to minimize potential shared variance between constructs attributable to conceptual  
20 overlap. Building on a previous coding scheme developed by Hagger and Orbell (2003), we  
21 developed a set of definitions of constructs and used expert raters to develop sets of  
22 independent illness representation, coping, and outcome categories which accounted for all  
23 measures adopted in studies eligible for inclusion in the current analysis. We have provided  
24 this coding scheme in the online supplemental materials (see Appendixes F, G, and H,

1 supplemental materials) so that researchers may locate future analyses within the current one,  
2 and to assist researchers in categorizing coping and outcome measures.

3         A key limitation of the present analysis is that the vast majority of included studies  
4 were correlational in design, those adopting experimental or intervention designs numbered  
5 relatively few by comparison. This has also been noted in previous reviews on research  
6 adopting the common-sense model (Hagger & Orbell, 2003; Leventhal et al., 2016). Not only  
7 does the preponderance of correlational designs limit the extent to which causal effects can be  
8 inferred, it also neglects the proposed dynamic nature of the model in which experience with  
9 coping strategies and changes in symptoms provide feedback for the individual to modify his  
10 or her beliefs and subsequent coping procedures. While the introduction of a time lag  
11 between representation and coping or outcome measures in research on the common-sense  
12 model may provide some indication of proposed direction, the resulting data will be static,  
13 and will not account for change over time.

14         Given the heavy dependence on correlational data, causation in the process model is  
15 inferred from theory rather than data. While analytic methods such as the path analyses used  
16 in the present study imply directional relations, alternative models which specify other  
17 directional relations among the variables could be estimated and would be plausible from a  
18 statistical and empirical perspective, even if they were not consistent with theory. The  
19 correlational nature of the data may account for some of the patterns of effects among model  
20 variables identified in the current analysis and in previous research. For example, similar to  
21 other meta-analyses, we found negative effects of perceived consequences on problem-  
22 focused coping and adaptive outcomes, when a theory-based expectation was that such  
23 beliefs would serve as a stimulus for problem-focused action focused on treatment to manage  
24 the threat. Given the correlational data on which this finding is based, one interpretation  
25 would be that the beliefs about consequences is a result of adherence such that success with

1 problem-focused-coping behaviors may have led to better illness outcome and hence fewer  
2 perceived consequences. The correlational data does not account for such dynamic processes  
3 and cross-lagged panel designs in which previous experience with coping and past behavior  
4 are modelled along with illness representations may provide a solution.

5 Findings from our current analysis should be interpreted with these limitations in  
6 mind, and the current test does not provide strong evidence to support the directional nature  
7 of the causal structure proposed in the process model. We advocate the adoption of  
8 longitudinal studies adopting cross-lagged panel designs, preferably in close proximity to first  
9 diagnosis, so that change in the representation, coping, and outcome constructs over time can  
10 be modelled. Such analyses would better capture dynamic effects in the model proposed in its  
11 original operationalization (Leventhal & Cleary, 1980; Martin et al., 2003). Similarly,  
12 randomized controlled intervention designs and experimental studies in which illness beliefs  
13 are manipulated and effects on subsequent coping behaviors and illness outcomes over time  
14 should also be conducted. Such data would shed light on the causal and dynamic effects in  
15 the model. To date, there have been few studies that have adopted experimental and  
16 intervention designs that involve manipulation of common-sense model constructs and  
17 examination of their effects on outcomes (e.g., Evans & Norman, 2009; Jonsbu, Martinsen,  
18 Morken, Moum, & Dammen, 2013; Petrie, Cameron, Ellis, Buick, & Weinman, 2002). We  
19 recognize the challenges inherent in collecting such data, but the contribution would be  
20 substantive given the dearth of research testing causal and dynamic effects in the common-  
21 sense model.

## 22 **Conclusion**

23 Our meta-analysis of the common-sense model of self-regulation advances previous  
24 research by simultaneously testing the mechanisms by which illness representations relate to  
25 outcomes mediated by coping strategies based on Leventhal et al.'s (1980) predictions.

1 Overall, we rejected a full mediation model in favor of a model that included both direct and  
2 indirect effects of representation dimensions on illness outcomes through coping strategies.  
3 We also identified specific mediated pathways which demonstrated that illness  
4 representations that signal a health threat, such as perceived consequences, were related to  
5 both adaptive and maladaptive outcomes through specific coping strategies. Identification of  
6 these specific pathways is important for a full understanding of model effects and conclusions  
7 based on zero-order relations or overall pathways could be misleading. Our tests of effects of  
8 key moderators revealed few moderation effects and did not resolve the heterogeneity  
9 identified in the effect sizes across studies on the model. Many of the studies in the current  
10 analysis adopted self-report measures and correlational designs, and we call for research  
11 adopting stronger designs, particularly intervention and experimental research, and research  
12 using objective measures of specific, behavioral, problem-focused coping strategies and  
13 illness outcomes. The research would be extremely informative in resolving some of the  
14 relatively untested processes in the common-sense model, such as the dynamic process by  
15 which patients' lay representations of illness relate to coping strategy selection, and,  
16 subsequently, coping appraisals. We have also proposed a revised common-sense process  
17 model that we hope will catalyze primary research testing the effects of moderators, beliefs  
18 about coping, and treatment beliefs on coping behavior selection and illness outcomes. We  
19 expect findings from the current analysis and revised model will stimulate future research and  
20 theory development to advance knowledge on the processes by which illness beliefs affect  
21 coping and outcomes in chronic disease.

22



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Figure 1. Schematic representation of common-sense model of illness representations based on Leventhal et al.'s (1992) illustration. The coping strategy and illness outcome categories are based on the classification procedure used in the present study developed by Hagger and Orbell (2003).

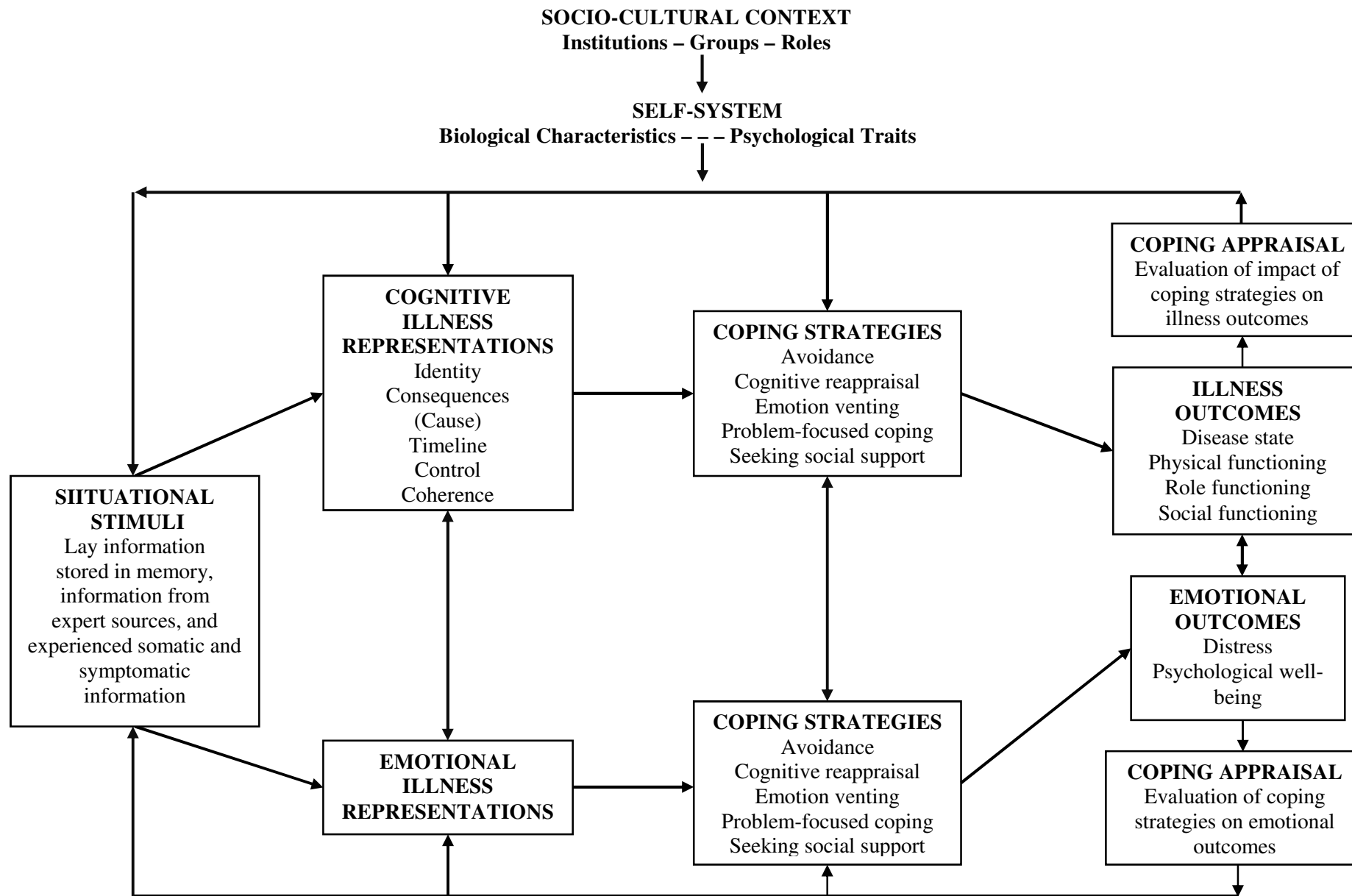




Figure 2. Basic process model derived from the common-sense model.

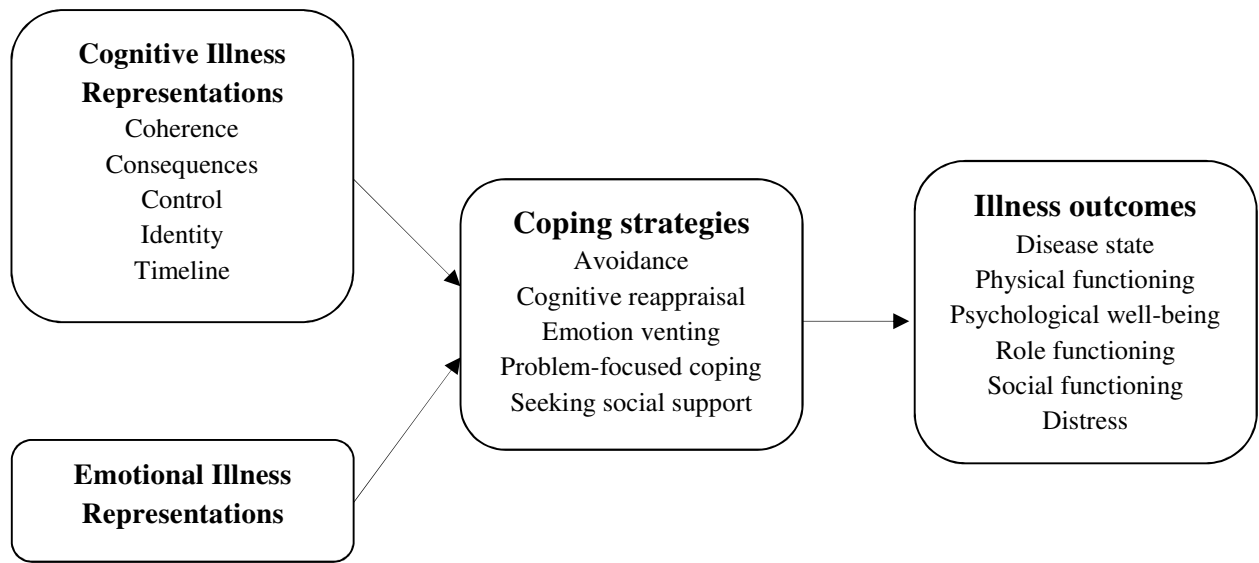


Figure 3. Path diagram of generalized effects in the revised common-sense process model. Solid lines represent hypothesized effects of beliefs on coping strategies and effects of coping strategies on illness outcomes, and broken lines represent moderating effects. Direct effects of cognitive and emotional representations on illness outcomes omitted for clarity.

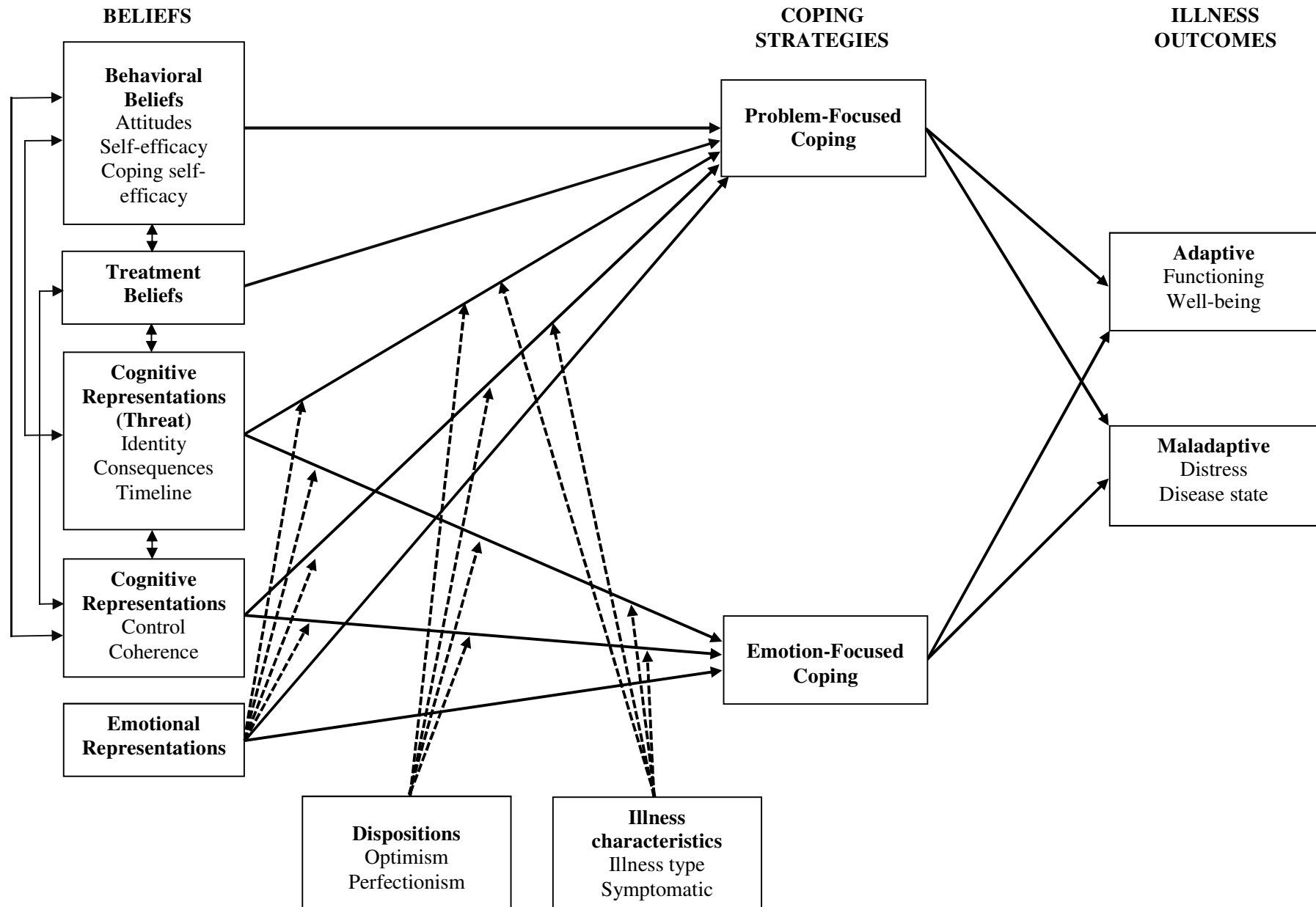


Figure 4. Path diagram of moderating effects of illness treatability (higher scores represent greater treatability) on mediated relations of perceived consequences and control on illness outcomes mediated by problem- and emotion-focused coping strategies in the revised common-sense process model. Solid lines represent hypothesized effects of representations on coping strategies and effects of coping strategies on illness outcomes, and broken lines represent moderating effects. Direct effects of cognitive and emotional representations on illness outcomes omitted for clarity.

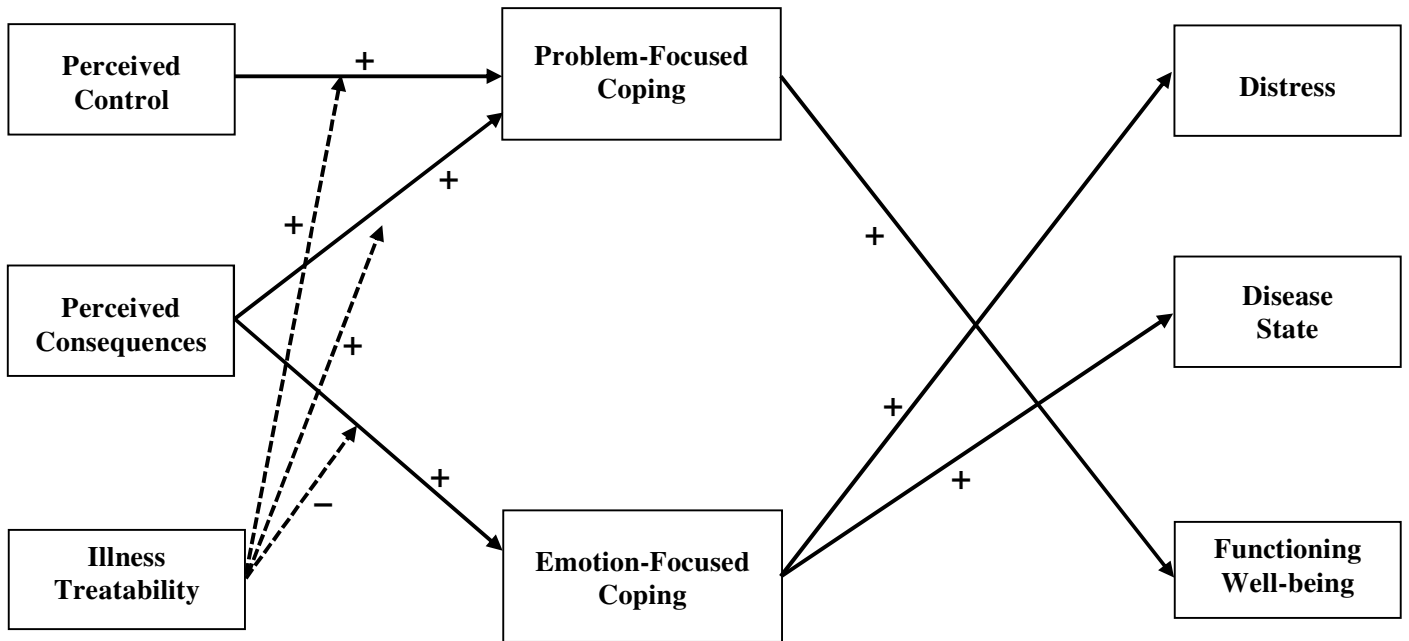
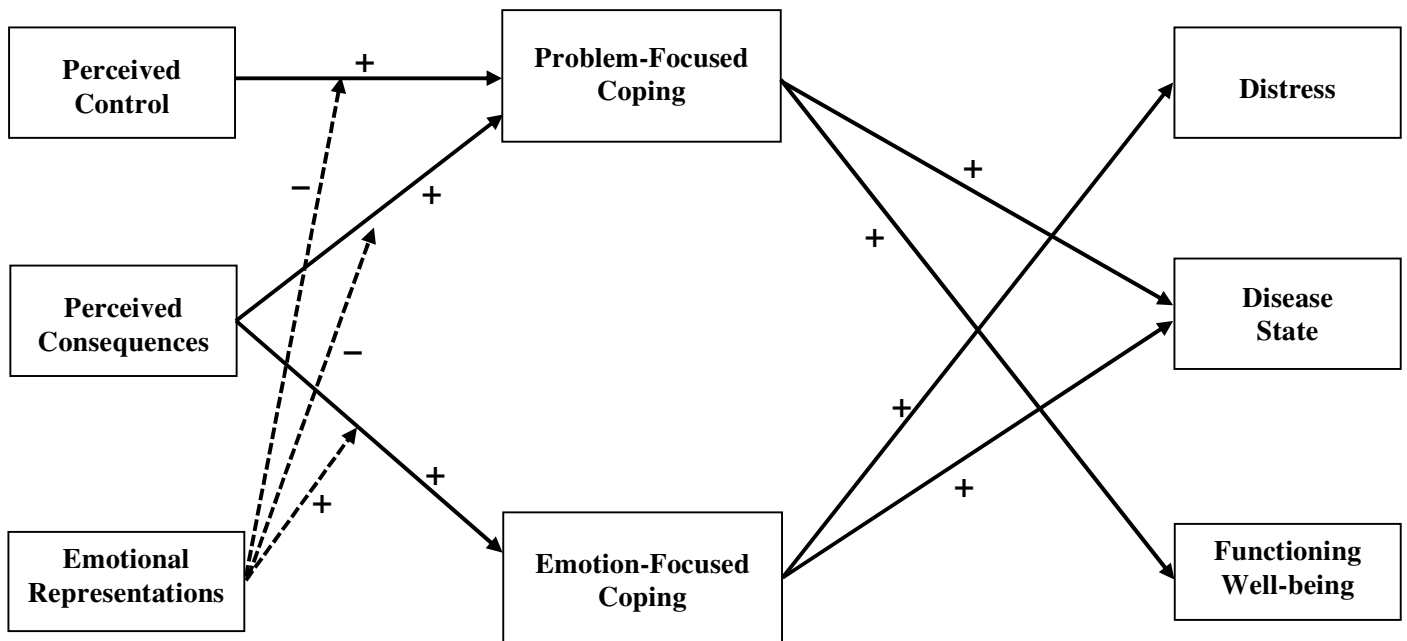


Figure 5. Path diagram of moderating effects of emotional representations (higher scores represent greater emotional responses) on mediated relations of perceived consequences and control on illness outcomes mediated by problem- and emotion-focused coping strategies in the revised common-sense process model. Solid lines represent hypothesized effects of representations on coping strategies and effects of coping strategies on illness outcomes, and broken lines represent moderating effects. Direct effects of cognitive and emotional representations on illness outcomes omitted for clarity.



*Figure 6.* Path diagram showing independent effects of beliefs about coping behavior, derived from social cognitive theories (Bandura, 1977; Fishbein & Ajzen, 2009), and beliefs about illness and action plans, derived from the common-sense model (Leventhal et al., 1980; Leventhal et al., 2016) on problem-focused coping behaviors in the revised common-sense process model. Direct effects of cognitive and emotional representations on illness outcomes omitted for clarity. The proposed model is a generalized one with constructs comprising multiple dimensions of constructs (e.g., behavioral beliefs, cognitive representations) that may have effects on outcomes with different signs.

