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

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Abstract

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

Keywords: Illness perceptions; illness cognition; coping procedures; parallel-processing model; chronic illness

Public Significance Statement

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

[1]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).

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

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

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

A Process Model of 'Common-Sense' Illness Representations

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

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

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

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

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

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

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

The Present Review

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

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

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

[2]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).

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

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

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

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

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

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

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

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

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

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

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

Method

Literature Search and Inclusion Criteria

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

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

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

Included Studies and Characteristics

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

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

Classification of Illness Representations

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

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

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

[3]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.

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

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

Classification of Coping Strategies

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

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

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

Classification of Illness Outcomes

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

Meta-Analytic Strategy

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

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

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

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

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

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

Moderator Coding and Analyses

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

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

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

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

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

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

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

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

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

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

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

[7]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.

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

Testing the Process Model

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

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

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

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

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

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

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

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

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

Results

Corrected correlations

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

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

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

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

Moderator Analyses

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

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

Path Analyses of the Process Model

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

[9]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.

[10]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, & Gölz, 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.

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

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

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

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

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

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

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

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

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

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

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

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

[11]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.

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

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

[12]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 25th percentile.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Sensitivity Analyses of Model Effects

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

[13]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.

[14]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.

[15]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.

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

Discussion

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

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

Sufficiency of the Model

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

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

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

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

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

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

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

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

The Function of Coping in the Process Model

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

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

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

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

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

Role of Context and Moderators in the Process Model

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

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

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

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

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

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

Implications for Practice

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

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

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

Revising the Common-Sense Model

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

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

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

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

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

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

[16]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-bring indicate adaptive outcomes, and high levels of distress and disease state indicate maladaptive outcomes.

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

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

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

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

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

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

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

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

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

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

Strengths, Limitations and Recommendations

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

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

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

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

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

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

Conclusion

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

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

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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).

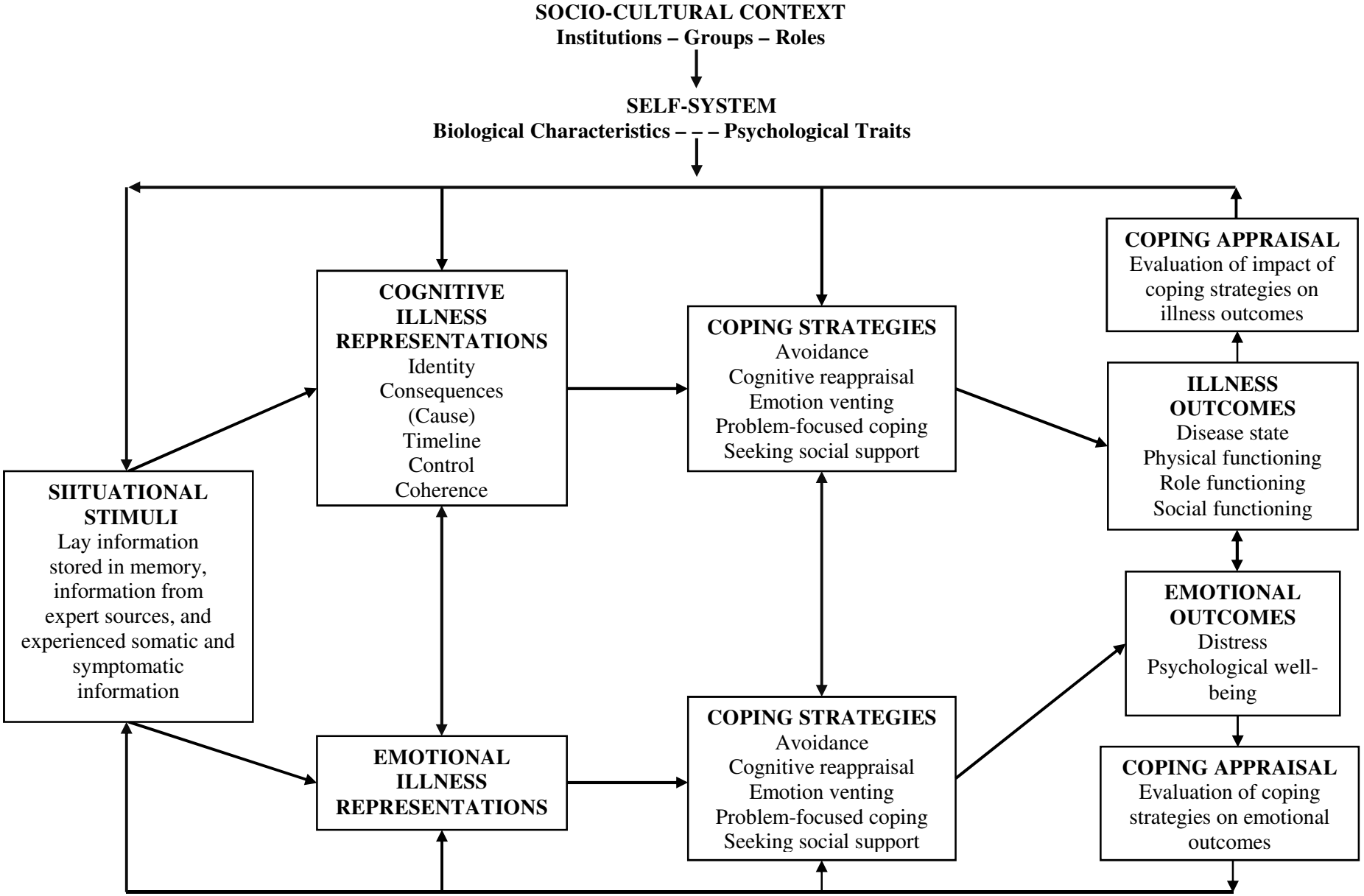

Figure 2. Basic process model derived from the common-sense model.

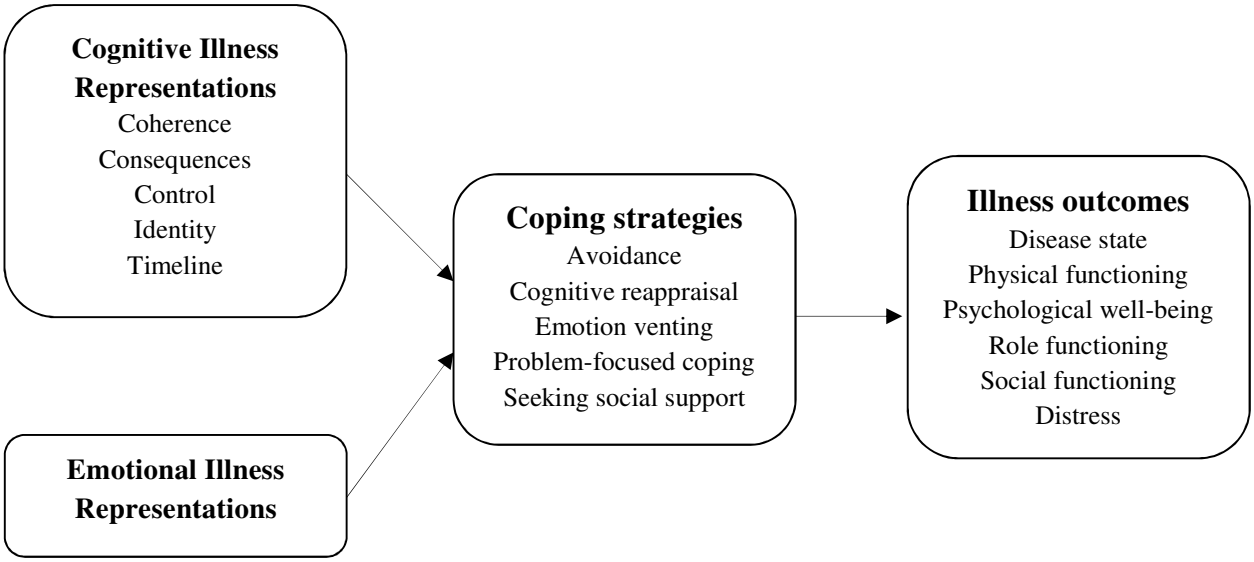

Figure 3. Path diagram of generalized effects in the revised common-sense process model. Solid lines represent hypothesized effects of beliefs on coping strategies and effects of coping strategies on illness outcomes, and broken lines represent moderating effects. Direct effects of cognitive and emotional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

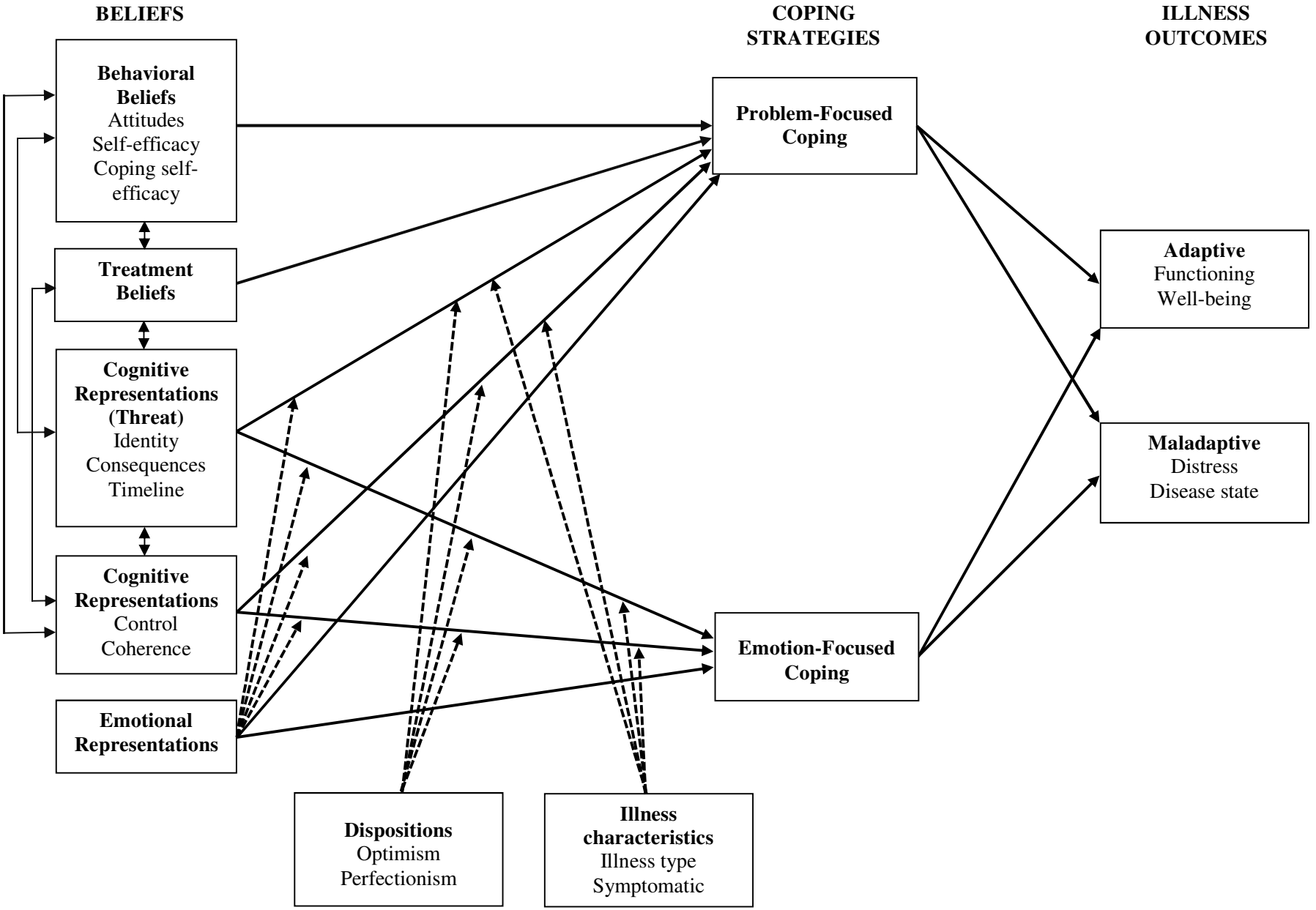

Figure 4. Path diagram of moderating effects of illness treatability (higher scores represent greater treatability) on mediated relations of perceived consequences and control on illness outcomes mediated by problem- and emotion-focused coping strategies in the revised common-sense process model. Solid 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.

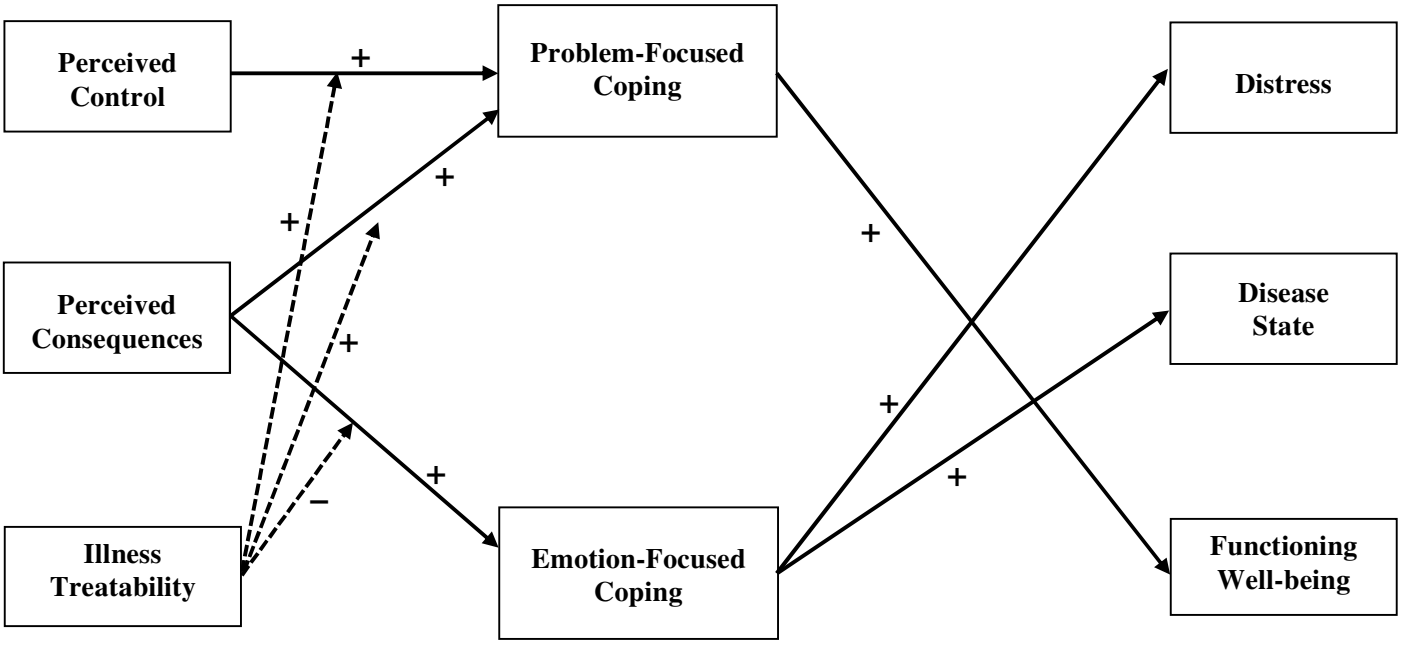

Figure 5. Path diagram of moderating effects of emotional representations (higher scores represent greater emotional responses) on mediated relations of perceived consequences and control on illness outcomes mediated by problem- and emotion-focused coping strategies in the revised common-sense process 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.

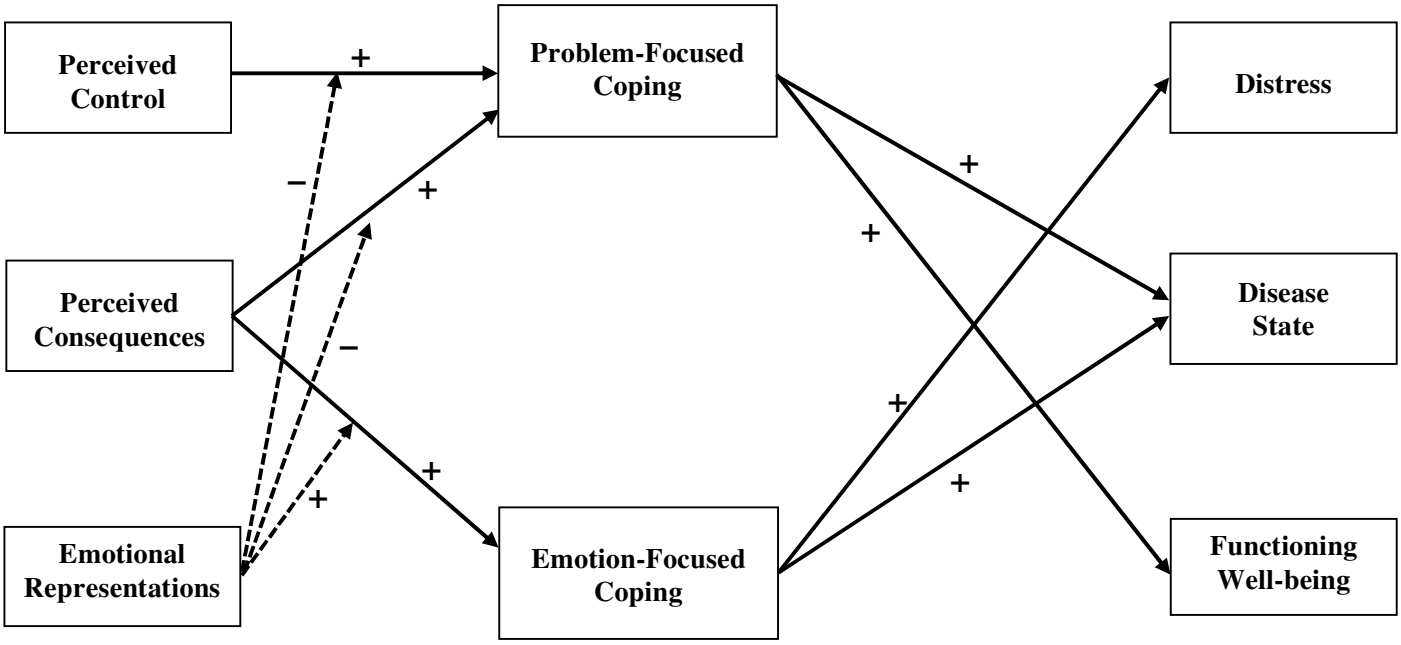

Figure 6. Path diagram showing independent effects of beliefs about coping behavior, derived from social cognitive theories (Bandura, 1977; Fishbein & Ajzen, 2009), and beliefs about illness and action plans, derived from the common-sense model (Leventhal et al., 1980; Leventhal et al., 2016) on problem-focused 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.