DISPOSITIONAL OPTIMISM AND HEART SURGERY: PROSPECTIVE ASSOCIATIONS WITH QUALITY OF LIFE

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ABSTRACT OF THE THESIS

Dispositional Optimism and Heart Surgery:

Prospective Associations with Quality of Life

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Coronary artery bypass graft (CABG) surgery is a commonly performed treatment for coronary artery disease that reduces cardiac symptoms and improves quality of life (QOL) in many patients. While heart surgery typically improves cardiovascular function it does not always improve patients' QOL. One aspect of poor QOL, high levels of depressive symptoms, is also an important psychological predictor of recurrent cardiac episodes. Accordingly, this study examined psychological factors influencing post-surgical depression and other QOL measures. It evaluated the role of dispositional optimism in predicting post-surgical QOL and the processes by which the two are related. A total of 570 heart surgery patients were included in the study. Based on previous theory and research, Hypothesis 1 predicted a positive linear association between pre-surgical dispositional optimism and post-surgical QOL and Hypothesis 2 predicted a quadratic association such that moderate optimism would be more strongly associated with positive outcomes than high or low optimism. As cardiac symptom improvement is expected after CABG, distress was expected to occur if expectations were not met. Accordingly, Hypothesis 3 predicted that highly optimistic patients whose cardiac symptoms did not significantly improve after surgery would experience significant

distress. Hypothesis 4 predicted that self-care self-efficacy, expected consequences, perceived social support, and coping responses would mediate the optimism-QOL association. These variables have separately been shown to be associated with optimism and health outcomes in other studies. The results showed a positive linear association between optimism and 3-month depression. There were no other significant linear or quadratic associations between dispositional optimism and 3-month post-surgical QOL. Change in cardiac symptoms did not moderate the association between optimism and post-surgical distress. Lastly, there were several significant indirect effects between dispositional optimism and 6-month QOL. Significant mediators included: perceived social support, self-care self-efficacy, expected consequences, positive reinterpretation coping, and meaning-focused coping. These analyses address theoretically important questions and the results have implications for research involving interventions to improve outcomes following cardiac surgery.

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Introduction

Overview

Approximately 125 million Americans were living with a chronic illness in 2000 (Wu & Green, 2000). By 2009, this number had risen to 145 million, nearly half of the United States population (Anderson, 2010). The impact of chronic disease on individuals and families directly creates a huge economic burden. The chronically ill often have difficulty paying for their health care and out-of-pocket health care spending increases with the number of illnesses (Anderson, 2010). As of 2009, 85% of health care expenditures in the United States went to chronic health conditions (Anderson, 2010). Chronic illness is also a leading cause of lost productivity, creating an added, indirect economic cost to the nation (Collins et al., 2005).

Chronic illness and its treatment affect physical, emotional, and social functioning and well-being, thereby undermining quality of life (QOL; McDowell, Newell, & McDowell, 2006). Diminished QOL has gained recognition as an important health outcome in its own right, in addition to the more traditional focus of health sciences on morbidity and mortality. Moreover, poor QOL may lead to negative medical outcomes through effects on behaviors such as medication adherence that can contribute to effective disease management (Bernstein, Kleinman, Barker, Revicki, & Green, 2002; Rodis & Kibbe, 2010).

Among the determinants of QOL in patients with chronic disease are health-related personality factors. While many researchers have examined the predictive utility of personality for QOL, these studies have been limited in at least two respects. One limitation is that the typical focus on linear relationships may have left undetected

curvilinear effects of personality on outcomes. Another is that, for the most part, these studies have not been guided by theory concerning the psychological processes that influence cognitive, affective, and behavioral responses to chronic disease and its treatment. In the present study I modeled both linear and quadratic effects of a much-studied personality factor, dispositional optimism, in relation to QOL. I also tested hypotheses derived from theory concerning psychological processes that may explain the effects of optimism on outcomes.

This study concerns the role of dispositional optimism in the QOL of patients who undergo heart surgery. Coronary artery bypass grafting (CABG) is a surgical procedure undergone by many Americans every year in order to alleviate chest pain resulting from coronary artery disease (CAD) and to improve QOL. According to the National Hospital Discharge Survey (2012), approximately 400,000 bypass procedures were conducted in 2010. Other common forms of cardiac surgery involve repair or replacement of heart valves. While in many cases heart surgery is more effective than medical therapies (e.g., medications with or without health behavior change; Rihal, Raco, Gersh, & Yusuf, 2003), CABG and valve surgery are not always successful in improving patients' QOL (Chocron et al., 1996; Steine, Laerum, Eritsland, & Arnesen, 1996). Important factors contributing to QOL and hence the overall long-term success of CABG surgery include psychosocial factors such as dispositional optimism.

This study used data from a larger project examining QOL outcomes in patients undergoing open-heart surgical procedures, including CABG and valve repair/replacement (Contrada et al., 2006; Contrada et al., 2008; Contrada, Goyal, Cather, Rafalson, Idler, & Krause, 2004; Goyal, Idler, Krause, & Contrada, 2005; Idler,

Boulifard, & Contrada, 2012). Following a review of the empirical literature and a description of relevant process theory, I will describe a study that examined the functional form of the association linking dispositional optimism to several aspects of patients' QOL after undergoing CABG. Additionally, this study investigated the processes by which dispositional optimism might influence these post-surgical outcomes.

Curvilinear Effects of Dispositional Optimism

One premise of this thesis is that, by contrast with the usual focus solely on linear effects of personality relationships (Grant & Schwartz, 2011), there are reasons to expect that moderate rather than extreme levels of traits such as optimism may be the most health promoting, leading to the prediction of curvilinear effects. This is consistent with several studies that have found that high levels of dispositional optimism are associated with poorer outcomes than moderate optimism, rather than with ever-increasing positive effects (Grant et al., 2011; Haaga & Stewart, 1992; Milam, Richardson, Marks, Kemper, & Mccutchan, 2004; Ridder, Schreurs, & Bensing, 2000). The usual focus on linearity may gloss over such effects and misrepresent the relationship between optimism and QOL.

There may be psychometric reasons for curvilinear effects. As optimism scores become more extreme in either direction, they may be more likely to reflect random measurement error or systematic sources of variance that do not reflect true optimism. In either case, it might be expected that there will be diminishing positive effects of optimism, and diminishing negative effects of pessimism, with scores that are furthest from the population mean (Cohen, Cohen, West, & Aiken, 2013). In addition, there may be more substantive bases for expecting curvilinear effects. For example, whereas

extreme responding on psychological measures has been attributed to a response bias, it also has been hypothesized that it reflects an underlying disposition involving a need for certainty (Hamilton, 1968) which may not have the same correlates as optimism. Accordingly, both linear and curvilinear effects of optimism were examined in this study (Hypotheses 1 and 2, respectively). Specific psychological explanations for a possible quadratic effect of optimism on outcomes will be discussed further following consideration of a general theoretical model.

General Model

One pathway through which personality influences health outcomes is through its relationship with the cognitive, affective, and behavioral processes activated by the perceptions and experience of chronic illness and its treatment. A general conceptual model for the study of these phenomena is depicted in Figure 1. At its core is a framework for conceptualizing the processes by which individuals interpret and respond to health threats leading to changes in health. The model also specifies the role of personality factors. There are four major processes, represented in the figure as movement from top to bottom: health threat, stressor processing, psychological responses, and outcome evaluation. There is also a feedback loop by which the evaluation of outcomes of the psychological responses influences the previous three steps. This portion of the model integrates theory by Leventhal (Leventhal et al., 1997) and Lazarus (Lazarus & Folkman, 1984), among others. More enduring personal and contextual factors, including but not limited to personality attributes such as dispositional optimism, are assumed to influence health in chronic illness through their effects on the aforementioned processes. These factors are represented by the circle on the right side of

the figure and the pathways through which they influence one or more component processes.

The process begins with the emergence of observable manifestations of a chronic health problem. Underlying disease processes that progress silently for decades, or that develop more quickly, produce symptoms, objective signs, and functional impairments. For example, CAD may progress silently over the course of years or decades before manifesting in the experience of cardiac symptoms. Personality factors have been implicated in the initiation, progression, and clinical manifestation of chronic disease through their pathogenic physiological effects and their impact on health-promoting and health-damaging behaviors. However, the present study focuses on the person in whom chronic disease has already developed.

The next step is the psychological processing of disease-related cues. Processing of health threats has been described in terms of two constructs, cognitive appraisal and problem representation. The process of appraisal is central to the theory of psychological stress formulated by Lazarus (Lazarus et al., 1984). Appraisal involves the cognitive discrimination and evaluation of events or conditions with respect to their relevance for physical and psychological well-being. Primary appraisal involves the evaluation of actual or potential harm or loss, whereas secondary appraisal consists of an evaluation of cognitive and behavioral options for managing health threats and their subjective impact. These appraisals determine if an event will be experienced as threatening (or stressful). The process of problem representation is described in the common sense model of illness cognition proposed by Leventhal (Leventhal et al., 1997). Here, perceived health threats are interpreted through the formation of a mental structure comprising perceived features

of the threat. These include symptoms and diagnostic labels that identify the threat, its perceived causes, consequences, and likely time course, and available means of curing or controlling the problem.

Processes of cognitive appraisal and problem representation initiate and guide psychological responses, that is, cognitive, affective, and behavioral responses to the perceived health threat. These responses include coping, that is, cognitive or behavioral activities that are conscious, deliberate, and effortful and aimed at managing the health threat itself or its effects on the individual (Lazarus et al., 1984). Other psychological responses to health threats are not fully conscious and may be automatic and effortless. An example of a coping response is if an individual intentionally changes his or her diet after being diagnosed with CAD. Conversely, a more automatic response would be if an individual comes to take medication habitually in the morning as a part of his or her daily routine. Both coping and automatic responses play a significant role in determining the outcome of health threats including effects on QOL and other surgical outcomes. It is at the stressor processing and psychological response steps that most research has conceptualized the influence of personality.

After responding to the health threat individuals evaluate the outcomes resulting from their cognitive, affective, and behavioral responses and update their perception of the health threat. These evaluations then feed back into the prior steps. Individuals' interpretations of these outcomes may operate as feedback that alters their cognitive appraisals and modifies their illness representations (Leventhal et al., 2012; Scheier, Carver, & Armstrong, 2012). For example the feedback may result in increases or decreases in the perceived severity of the health threat, changes in coping and other

responses, and broad psychological changes in self-perception (e.g., changes in self-concept and identity, becoming helpless, or gaining a sense of purpose). By comparison with stressor processing and psychological response, less research has been based on the premise that psychosocial factors such as personality attributes may influence evaluations of the effectiveness of the earlier steps.

In this study I focused on dispositional optimism as a personality factor that influences and shapes the processes outlined above as reflected in specific process variables that fit within the general model and may be particularly relevant to understanding surgical outcomes in CABG patients. Optimism and these process variables influence multiple components of the model, as will be discussed. I will first discuss how optimism influences QOL in chronically ill patients and then discuss how this may be conceptualized using the general model described above.

Dispositional Optimism, Psychological Processes, and Health Outcomes

Dispositional optimism may be defined as the extent to which people consistently have positive expectations for their future. Dispositional optimism is a general outlook and set of expectations that are thought to come into play in a variety of situations, especially those for which the person does not hold more specific expectations. Research suggests that dispositional optimism has significant effects on the long-term QOL of the chronically ill (Carver et al., 1993; Carver, Scheier, & Segerstrom, 2010; Ebrecht, Hextall, Kirtley, Taylor, Dyson, & Weinman, 2004). The first hypothesis I tested is that dispositional optimism is positively and prospectively associated with QOL following heart surgery.

Previous findings indicate a positive linear association between optimism and QOL in the chronically ill. Specifically, various studies have found this association in individuals undergoing CABG (Fitzgerald, Tennen, Affleck, & Pransky, 1993; Mahler & Kulik, 2000; Scheier et al., 1989), in patients with ovarian cancer (De Moor, De Moor, Basen-Engquist, Kudelka, Bevers, & Cohen, 2006), and in patients with upper aerodigestive tract cancer (Allison, Guichard, & Gilain, 2000). A meta-analysis by Rasmussen, Scheier, and Greenhouse (2009) found that, in the chronically ill, dispositional optimism significantly predicted various aspects of QOL including better physical functioning, less pain, and fewer physical symptoms. It was also a significant predictor of health outcomes such as mortality and cardiovascular outcomes.

That the research outlined above found positive linear associations between dispositional optimism and QOL does not mean that curvilinear effects were not present in the data. Moreover, a number of studies have found curvilinear relationships between optimism and other health outcomes that might be expected to impact QOL (Grant et al., 2011; Milam et al., 2004; Ridder et al., 2000; Segerstrom, 2001). Specifically, these studies reported that, compared with high or low optimism, a moderate amount of dispositional optimism was associated with more effective coping with multiple sclerosis and Parkinson's disease (Ridder et al., 2000), slower HIV disease progression (Milam et al., 2004), and better immunological responses in response to stress (Segerstrom, 2001). These findings provide suggestive evidence that very high optimism may have negative health consequences, perhaps including effects on QOL. Based on these findings, a second hypothesis I tested is that heart surgery patients with moderate levels of

dispositional optimism will tend to have more positive health outcomes after surgery than patients with lower or higher levels of optimism.

In addition to the operation of response biases and styles discussed earlier, one possible substantive explanation for why very high optimism might be associated with negative health effects is that being highly optimistic may lead individuals to be overconfident in their ability to cope with the aftermath of surgery. For example, following surgery, patients may need assistance with activities of daily living, such as eating, bathing, and taking medication. However, people who are very optimistic and therefore have high expectations for their recovery may be more likely to believe inaccurately that they will be able to complete these tasks without help, perhaps delaying their requests for assistance. Excessive optimism may have negative health consequences as a result of individuals not taking the appropriate action. This and other psychological processes that may account for effects of optimism on health outcomes are discussed next.

An individual who is very optimistic regarding his or her post-surgical recovery may experience a significant amount of distress if his or her expectations are not met. A primary reason to undergo CABG is to alleviate cardiac symptoms such as chest pain. So a patient with high expectations for improvement would likely expect significantly reduced cardiac symptoms post-surgery. If the symptoms do not improve sufficiently it may be that the patient will experience distress due to his or her expectations being disconfirmed. Thus, it is possible that patients who are optimistic and whose symptoms do not improve significantly may experience more distress than patients who are less optimistic. For example, one study found that cancer patients undergoing radiation

therapy that expected, but did not achieve, remission tended to have poorer QOL than those patients whose expectations were met (Koller et al., 2000). As such, a third hypothesis I tested is that heart surgery patients who are optimistic pre-surgery and experience high levels of symptoms post-surgery will experience more distress than would otherwise be expected.

We have some description of the relationships linking dispositional optimism to QOL in chronically ill patients. Nonetheless, additional descriptive research and work that probes explanatory pathways are needed in order to formulate a more complete picture of how optimism is associated with QOL and post-surgical outcomes. A comprehensive understanding of the factors influencing post-surgical health is an important step towards developing interventions to improve these outcomes.

Dispositional optimism may play a part in determining QOL due to its relationship with other process variables implied by the general conceptual model shown in Figure 1. For example, optimism may affect the manner in which individuals interpret and respond to health threats which, in turn, may influence aspects of health-related QOL. One such process variable is self-care self-efficacy (SE; Bandura, 1977), which can be seen as part of Leventhal's control/cure construct and a component of the overall problem representation (Leventhal et al., 1997). SE is the confidence of a person in his or her ability to perform behaviors necessary to bring about desired health outcomes. For example, SE may refer to an individual's confidence in being able to complete physical therapy, to make heart-healthy lifestyle changes, and to adhere to treatment regimens (Strecher, DeVellis, Becker, & Rosenstock, 1986). SE was positively associated with QOL and mood for patients recovering after a stroke (Robinson-Smith et al., 2000) and

coping with cancer (Cunningham, Lockwood, & Cunningham, 1991). Additionally, SE in achieving a desired health outcome (e.g. confidence in being able to reduce physical pain and continue with his or her hobbies) in asthma, diabetes, and heart failure patients was found to predict QOL and psychological well-being (Kuijer & De Ridder, 2003). Research suggests that optimism is positively associated with SE for coping with the specific demands related to hurricane recovery (e.g., threat of looting and monitoring emotional reactions; Benight, Swift, Sanger, Smith, & Zeppelin, 1999). Some research suggests that self-efficacy can mediate the association between optimism and distress (Benight et al., 1999). As noted earlier, optimism may influence SE such that very high optimism may be associated with excessive SE, for example a highly optimistic heart surgery patient may make the appraisal that he or she can complete tasks without assistance or at an unrealistically rapid pace. This appraisal may constitute overconfidence which can cause persistence at failing strategies (e.g. unhelpful coping responses) and less time and energy spent learning and planning (Grant et al., 2011). Unrealistic recovery expectations and inadequate preparation may in turn have negative health consequences. So, it may be that very high optimism will predict relatively poor QOL as a result of someone having high levels of SE.

Leventhal's consequences construct, which is another aspect of problem representations, also has an important role in the interpretation of health threats (Leventhal et al., 1997). In the present context, the consequences construct refers to an individual's beliefs regarding the expected impact of a health threat on overall quality of life or functional capability (Hagger & Orbell, 2003). There is some overlap between the consequences and control/cure constructs. The belief that a health threat is to some

extent controllable implies that its consequences are less severe than if it is seen as uncontrollable. I will be referring to this construct as "expected consequences". A meta-analysis by Hagger and Orbell (2003) found that individuals who perceived their illness to have more serious consequences tended to have overall poorer QOL, including worse physical functioning and more psychological distress. Dispositional optimism may influence expected consequences in that optimistic individuals will tend to expect better outcomes (Segerstrom, Taylor, Kemeny, & Fahey, 1998; Taylor, Kemeny, Aspinwall, Schneider, Rodriguez, & Herbert, 1992). Individuals who expect very positive outcomes, in turn, may experience distress if their expectations are not met. So, it may be that very high optimism will predict relatively poor QOL as a result of an individual's high expectations. In addition to optimism, the third hypothesis included expected consequences as a predictor.

Perceived social support (PSS) has a significant effect on QOL in people with chronic illness and also may be influenced by dispositional optimism. It may be defined as the perception that one is cared for, that support is available from others, and that one is part of a close network of family and friends. Research has illustrated that PSS has a number of effects related to QOL. In a sample of individuals with HIV, satisfaction with the level of PSS they were receiving was related to significantly better QOL (Swindells et al., 1999). Low PSS can be associated with poorer life satisfaction and greater depressive symptoms (Newsom & Schulz, 1996). PSS partly influences health due to the manner in which it impacts factors in the general model. For example, the perception of social support can influence the appraisal of potential threats (Thoits, 2011; Wethington & Kessler, 1986). PSS may also influence coping, for example, through informational

support (Thoits, 2011). This form of support occurs when information or advice are provided to help a person solve a problem. Optimism and PSS may be reciprocally related in that an individual's interpersonal approach will shape the social environments he or she encounters. One's affect is typically reciprocated by interaction partners (Smith & MacKenzie, 2006). Warm, optimistic individuals will tend to evoke positive responses from others, perhaps garnering more support. Research in breast cancer patients (Trunzo & Pinto, 2003), patients undergoing cardiac rehabilitation (Shen, McCreary, & Myers, 2004), and college freshman (Brissette, Scheier, & Carver, 2002) has found that PSS can mediate the association between optimism and distress.

In addition to SE, expected consequences, and PSS, dispositional optimism is associated with health due to the manner in which it influences coping responses. One relevant coping response is known as meaning-making. Meaning-making is when an individual attempts to cope with a stressful event by searching for the meaning and purpose of the event (Park & Folkman, 1997). Meaning-making has been studied in cancer patients in whom it is believed to be important for psychological well-being (Lepore, 2001; Moadel et al., 1999). Additionally, an intervention designed to increase the use of meaning-making strategies in cancer patients found that patients in the experimental group had significantly greater self-esteem post-intervention (Lee, Robin Cohen, Edgar, Laizner, & Gagnon, 2006). In a sample of people caring for adults with mental illness, meaning-focused strategies were associated with positive affect (Mackay & Pakenham, 2012). Dispositional optimism is positively associated with engaged coping, of which meaning-making may be considered an example (Nes & Segerstrom,

2006). Engaged coping is a form of coping in which the goal is to manage the internal or external demands of a stressor (Nes & Segerstrom, 2006).

Another relevant coping response is positive reinterpretation. Positive reinterpretation is a strategy used to regulate emotions by a) recognizing a negative situation and reinterpreting it in order to reduce the situation's perceived severity, or b) exchanging a negative attitude for a more positive attitude (Ray, McRae, Ochsner, & Gross, 2010). A study by Moskowitz, Hult, Bussolari, and Acree (2009) found that people with HIV who used positive reinterpretation coping reported having greater QOL than those who did not. Another study found that the use of positive reinterpretation coping was associated with positive affect and greater perceived health in women with early-stage breast cancer (Sears, Stanton, & Danoff-Burg, 2003). There is considerable evidence to suggest that dispositional optimism is positively associated with positive reinterpretation (Chang, 1998; Fontaine, Manstead, & Wagner, 1993; Scheier, Weintraub, & Carver, 1986). Like meaning-making, positive reinterpretation may be considered to be a form of engaged coping (Nes & Segerstrom, 2006). Two studies, one in patients with breast cancer (Carver et al., 1993) and one examining adjustment to college (Brissette et al., 2002), found that positive reinterpretation mediated the association between optimism and less distress.

There is theory and research to suggest that the reported positive linear association between dispositional optimism and QOL is due to the effects of optimism on process variables such as SE, expected consequences, PSS, and coping. If there is a curvilinear relationship between optimism and QOL it, too, may be a result of optimism's effect on these process variables. Consequently, the fourth hypothesis I tested is that the

association between dispositional optimism and QOL is mediated by SE, expected consequences, PSS, and coping responses.

Purposes and Hypotheses

This study was based on data from a research project examining QOL outcomes in patients about to undergo heart surgery (Contrada et al., 2008; Contrada et al., 2004). While the theory discussed in the introduction could lead to a number of different predictions, most of them are beyond the scope of this thesis. In this thesis I tested the four interrelated hypotheses that were noted above. These hypotheses and their theoretical and empirical bases are restated below. While the primary focus of these hypotheses is QOL, in secondary analyses these hypotheses were also directed at rehospitalization.

H1: *I expect pre-surgical dispositional optimism to show a positive, linear, and prospective association with post-surgical QOL*. Optimistic expectations are thought to promote positive health outcomes through processes involving a more positive appraisal of health threats and more engaged coping responses to those threats. Previous findings have tended to support this premise with some consistency across a variety of patient populations.

H2: *Further examination will indicate a curvilinear (quadratic) association between dispositional optimism and post-surgical health outcomes such that moderate levels of optimism will be more strongly associated with positive post-surgical QOL than either lower or higher levels of optimism.* Very high optimism may be harmful if it leads highly optimistic individuals to be overconfident in their coping ability. Several studies in other patient populations have found that very high optimism may have negative health

consequences. Curvilinear effects of optimism on outcomes also might reflect psychometric factors, including random and systematic sources of error in optimism scores.

H3: *The association between pre-surgical expectations (dispositional optimism and expected consequences) will be diminished and possibly reversed for patients with high pre-surgical expectations whose post-surgical symptoms are relatively high compared with their symptoms pre-surgery*. An individual with high expectations for post-surgical recovery may experience a significant amount of distress if expectations are not met. Some research suggests that patients' positive expectations failing to meet reality may negatively affect post-surgical QOL.

H4: *The association between dispositional optimism and post-surgical health outcomes will be mediated by SE, expected consequences, PSS, and coping responses*. Research suggests that dispositional optimism is related to these process variables. Previous findings also support the importance of these variables when coping with stressors such as health threats. A few studies have examined the role of positive reinterpretation (Brissette et al., 2002; Carver et al., 1993), PSS (Brissette et al., 2002; Shen et al., 2004; Trunzo & Pinto, 2003), and SE (Benight et al., 1999) in mediating the association between optimism and distress. Overall, however, few studies have examined the role these variables play in explaining the beneficial effects of optimism, and those studies that did had different target populations and outcomes.

Methods

Participants

Participants in the source study were 570 patients who underwent open heart surgery, CABG and/or heart valve replacement or repair between October 2000 and October 2003. The study took place in an ethnically diverse area of the northeastern United States. Elective surgery patients were initially approached during an outpatient consultation visit and interviewed during preadmission testing. Urgent and emergent patients were recruited following hospital admission and were interviewed bedside. In order to participate in the study patients must have been able to speak English and they had to be alert and capable of participation.

A total of 1,078 patients were approached and 677 agreed to participate. Pre-surgical interviews could not be arranged with 101 of the patients who agreed to participate, leaving a sample of 576 patients. Of these 576 participants 6 did not undergo cardiac surgery, leaving a final sample of 570. Data on participants' demographic and medical characteristics are presented in Table 1. As described below, two imputation methods were used to address missing data in this sample. This being the case, when variables have missing data two tables are provided. However, demographic characteristics are reported in a single table (Table 1) as there was minimal missing data for these variables and imputing values did not change the results. There were 416 men (73%) and 154 women (27%) aged 28 to 89 (M = 65.29, SD = 11.64). The sample was predominantly white (n = 501) and married (n = 407). They reported an average of 13.44 years of education (SD = 2.98). Individuals were excluded from participating if they did not speak English or if they had difficulties that would interfere with the interview process.

Procedure

The study was conducted at a major medical center with a high volume of surgeries. Psychosocial interviews were conducted approximately five days prior to surgery and 3 months, 6 months, and 12 months post-surgery. In instances in which the surgery was elective, patients were recruited and interviewed when they came to the hospital for preadmission testing. In urgent and emergent cases, recruitment and interviewing took place at bedside after admission. The study was described as an investigation of the social and psychological features of undergoing heart surgery. Recruitment staff described the study, obtained informed consent, and conducted the interviews.

Measures

Dispositional optimism. Dispositional optimism was assessed using the Life Orientation Test-Revised (LOT-R; Scheier, Carver, and Bridges, 1994), a measure of generalized expectancies for positive outcomes. Research suggests that the LOT-R possesses good internal consistency, good test-retest reliability, and acceptable predictive and discriminant validity (Scheier et al., 1994). Cronbach's alpha calculated for this study was .82.

Self-care self-efficacy. An SE measure was developed for the original study. This measure comprised two main subscales: internal state (3 items) and expected difficulty regarding physical recovery following surgery (4 items). Internal state refers to patients' confidence in being able to deal with the pain, discomfort, and disruption that are associated with heart surgery. The expected difficulty regarding physical recovery is related to patients' confidence regarding the ease at which they expect to recover their physical health following surgery. For example it includes confidence about being able

to perform necessary exercises and get out of bed. Cronbach's alpha for the internal state scale was .77 and for the physical recovery scale was .78.

Social support. PSS was measured using 9 items from the 12-item Multidimensional Scale of Perceived Social Support (Contrada et al., 2008; Zimet, Dahlem, Zimet, & Farley, 1988) which has been used successfully in heart patient populations (Blumenthal, Burg, Barefoot, Williams, & Zimet, 1987). The Multidimensional Scale of Perceived Social Support's total score, which reflects the degree to which respondents believe that support is available from friends and family, was used in this study. This measure has high internal consistency, good reliability, and good validity (Canty-Mitchell & Zimet, 2000). Cronbach's alpha was .86.

Expected consequences. A measure of expected consequences was developed for the original study. The measure comprised four questions. The questions ask patients whether they believe surgery will be successful, whether they will quickly recover from the surgery, whether they expect their life to improve after surgery, and whether they believe that they will be free from heart problems in the future. Cronbach's alpha was .76.

Positive reinterpretation coping. A measure of positive reinterpretation, comprising three items, was developed for the original study. The questions ask whether patients have been trying to focus on the benefits of undergoing surgery, whether they have been making an effort to think about surgery in the best possible way, and whether they believe they have learned something valuable from having heart surgery. Cronbach's alpha was .78.

Meaning-focused coping. A measure of meaning-focused coping was developed for the original study. This measure comprised three questions. The questions ask whether patients have spent time understanding why they were undergoing surgery, whether they have thought about the different possible reasons why they need to face surgery, and whether they have spoken with others to help understand the meaning of their experience with heart surgery. Cronbach's alpha was .73.

Cardiac symptoms. The cardiac symptoms angina and dyspnea were assessed using the Rose questionnaires (Rose & Blackburn, 1968). Angina refers to chest pain and dyspnea refers to shortness of breath. These symptoms often occur due to lack of blood flow to the heart muscle. Both symptoms are common in patients with CAD and their elimination is a common reason for performing CABG. To validate the Rose angina questionnaire studies have used expert clinical diagnosis (Heyden et al., 1971; Rose, 1962), electrocardiography findings (Cook, Shaper, & MacFarlane, 1989; Wilcosky, Harris, & Weissfeld, 1987), and coronary angiography (Erikssen, Forfang, & Storstein, 1977). Results indicate high specificity (80–95%) and variable sensitivity (19–83%; Fischbacher, Bhopal, Unwin, White, & Alberti, 2001). A study by Arnold, Spertus, Jones, Xiao, and Cohen, (2009) showed that that the Rose dyspnea questionnaire had good discriminant validity, was reliable, and exhibited significant reduction in dyspnea after patients underwent a successful revascularization.

Quality of life. QOL was measured using several scales from the Medical Outcomes Study (MOS) Patient Questionnaire (Stewart and Ware, 1992). The scales included in this study were those for physical functioning (10 items) and anxiety (4

items). Cronbach's alpha calculated on this sample for the physical functioning scale was .92 and for the anxiety scale was .86.

Depression. Depressive symptoms are also a component of QOL but given their particular importance in cardiac patient populations depression symptoms were measured with the Center for Epidemiologic Studies – Depression scale (CES-D), a commonly used instrument that provides a more thorough assessment of depressive symptoms than is typically provided in conventional QOL instruments (Radloff & Teri, 1986). The CES-D is typically composed of 20 items divided into four subscales assessing positive affect (4 items), depressed affect (7 items), somatic symptoms of depression (7 items), and interpersonal feelings (2 items). In addition to a total score for the CES-D each of the subscales yield a score. A confirmatory factor analysis conducted by Contrada, Boulifard, Idler, Krause, and Labouvie (2006) rejected the inclusion of the interpersonal feelings subscale in the CES-D. As a result I chose to exclude this subscale from the analyses and instead focus on the 18 items in the other three subscales. Cronbach's alpha calculated on this sample for the 18-item CES-D score was .89, for the positive affect scale was .70, for the depressive affect scale was .84, and for the somatic symptoms scale was .80.

Surgical health outcomes. Several surgical outcomes were assessed including length of stay in the hospital (LOS), complications in the aftermath of the surgery, and rehospitalization. LOS was measured as the number of days between surgery and discharge. Complications was a count of whether the following occurred post-surgery: reoperation for bleeding, reoperation for valve repair, other cardiac reoperation, noncardiac reoperation, renal failure/dialysis, pneumonia, permanent stroke, transient

stroke, deep sternal wound infection, peri-operative myocardial infarction, prolonged ventilation, complication of anticoagulation therapy, urinary tract infection, cardiac arrest, gastrointestinal complication, septicemia, tamponade, heart block, multiple system failure, ischemic limb, pulmonary embolism, and thoratomy. Finally, rehospitalization was defined as a patient reporting having been hospitalized for any reason between the surgery and each post-surgical interview. Rehospitalization was assessed at each follow-up interview.

Biomedical risk factors. Biomedical data were gathered on preoperative, intraoperative, and postoperative treatments, procedures, and test results as obtained from hospital medical charts. These individual variables were combined into an index of biomedical risk factors. This index indicated the presence or absence of 19 pre-surgical conditions and treatments. Additional detail may be found in Contrada et al. (2008). Among these variables are a number of chronic conditions including, but not limited to, hypertension, history of myocardial infarction, heart failure, stroke, diabetes, and cerebrovascular disease.

Data Analytic Strategy

Prior to testing the hypotheses, missing data patterns were analyzed and addressed using multiple imputation (MI) and the expectation maximization (EM) algorithm. MI was implemented in the dataset prior to testing the first three hypotheses. However, MI does not readily allow for complex mediation analyses. That being the case an alternative method, EM, was separately used to address missing data for the fourth hypothesis. Both MI and EM impute raw data and yield less biased parameter estimates than case deletion or mean imputation (Enders, 2010). An additional advantage is that

MI and EM assume data are missing at random (MAR) rather than missing completely at random. Missing completely at random is a more strict assumption necessary for unbiased results when using case deletion or mean imputation (Enders, 2010). Data for variable Y are MAR when the missingness is related to a measured variable, but not to the values of variable Y itself (Enders, 2010). There is no statistical test to determine whether data are MAR. However, even if the MAR assumption is not fully met, including all complete and incomplete cases in the analyses typically yields less biased parameter estimates than analyses that include only cases with complete data (Schafer & Graham, 2002). For additional detail on MI and EM please see the Appendix.

Imputing values for non-normally distributed continuous variables under a normal model can lead to bias. That being the case, predictor, moderator, mediator, and outcome variables were assessed for skew and kurtosis based on the criteria reported in Kline (2005). These criteria are that a skew statistic greater than 3 indicates significant skew and a kurtosis statistic greater than 10 indicates significant kurtosis. Using these criteria none of the variables exhibited significant skew or kurtosis

The first three hypotheses were tested using predictors measured at baseline and QOL and depression measured at the 3-month follow-up. The moderator in the third hypothesis, change in cardiac symptoms, was assessed as the difference between symptoms measured at baseline and at the 3-month follow-up. The 3-month follow-up was chosen for these hypotheses because this is a critical period of the post-surgical recovery ("What To Expect After," 2012). The mediation hypothesis was tested using the predictor as measured at baseline, mediators measured at 3 months, and QOL and depression measured at 6 months.

To test mediation effects I chose to use the PROCESS macro made available by Hayes (2013). The PROCESS macro was used instead of the Sobel test (Sobel, 1982) or the procedure described by Baron and Kenny (1986) because it provides greater statistical power than these options and does not make distributional assumptions. This macro uses an ordinary least squares framework for estimating direct and indirect effects in multiple mediator models. PROCESS uses bootstrapping to create confidence intervals and to assess the statistical significance of mediation effects. Bootstrapping is a method of resampling which treats your sample as a population and samples from it. It calculates a statistic (e.g. beta) on each of these new "samples", creating a distribution for the statistic. A confidence interval is then calculated on this distribution. Bootstrapping yields a non-symmetric confidence interval and does not make distributional assumptions. This is important because the sampling distribution of a mediation effect is often non-normal (Shrout & Bolger, 2002). Using a symmetric confidence interval with non-symmetric data will bias the results towards the null hypothesis (Shrout & Bolger, 2002). A 95% confidence interval gives the probability that upon resampling 95% of the intervals we obtain will contain the true population parameter.

Results

A number of variables were included as statistical controls for the analyses. Age, gender, marital status, ethnicity, years of education, baseline measure of outcomes, LOS, number of medical complications, and the biomedical index were controlled for in all analyses. The outcomes for all hypotheses were: physical functioning, anxiety, overall depression, and rehospitalization.

Sample Characteristics

Descriptive statistics for the measures used in the analyses are displayed in Tables 2-3. Descriptive statistics are reported separately for the MI and EM datasets because the two techniques impute slightly different values. These tables also contain slightly different variables due to the different hypotheses the datasets were used to test.

To evaluate the representativeness of the sample a previous study also using the current dataset (Contrada et al., 2008) compared these demographic data to those of Shroyer et al. (2003), whose data were derived from a Society for Thoracic Surgery (STS) database. This database comprised standardized measures of biomedical variables collected from 503,478 CABG procedures from 497 participating centers around the United States. Mean age for the STS sample was 64.9 years (*SD* = 10.7), the majority were male (70.9%), and White (86.8%), and the mean postoperative LOS was 6.9 days (*SD* = 7.0). These values are similar to the corresponding characteristics displayed in Table 1.

At baseline there were 570 participants. At the 3-month follow-up attrition brought this down to 370 participants, whereas at 6 months there were 409 participants. Participants were lost to post-surgical follow-up either because they could not be reached by phone or they were unwilling to participate at that time. Participants who did and did not complete the 6-month follow-up were compared on baseline characteristics (Contrada et al., 2006). Those who did not complete the 6-month follow-up were slightly less depressed at baseline, less likely to be married, less well educated, and more likely to have a history of congestive heart failure and of prior MI (Contrada et al., 2006). Completion of the 6-month follow-up was not related to age, gender, ethnicity,

hypertension, ejection fraction, body surface area, diabetes, or prior heart surgery (Contrada et al., 2006).

Bivariate Correlations

Intercorrelations for the variables included in the analyses are displayed in Tables 4 and 5. The correlations in Table 4 are from the MI dataset and are between the primary variables used in the analyses of Hypotheses 1-3. These correlations ranged from -.004 – .426, the former occurring between baseline optimism and 3-month rehospitalization and the latter between 3-month anxiety and 3-month depression. The correlations in Table 5 are from the EM dataset and are between the primary variables used in the analysis of Hypothesis 4. These correlations ranged from .020 – .693, the former occurring between 3-month positive reinterpretation and 6-month rehospitalization and the latter between 6-month anxiety and 6-month depression. Thus, in both the MI and EM datasets, the largest correlations were between depression and anxiety. In both datasets few variables were significantly associated with rehospitalization. Optimism was associated with a greater number of health outcomes at 6 months than at 3 months.

Hypotheses 1 and 2: Linear and Quadratic effects of Optimism on QOL

To test the hypotheses of a linear and quadratic association between optimism and QOL and depression at 3 months, I conducted hierarchical regression analysis. In the first step I included the control variables, in the second step I included the linear optimism term, and in the third step I included the quadratic optimism term. Optimism was centered prior to the regression analyses. As a measure of effect size I used the squared semi-partial correlation (sr^2) which is the percent of variance in the dependent variable uniquely accounted for by the predictor. The only control variables to

significantly predict the 3-month outcomes were the baseline measures of outcomes. This was true for every outcome: physical functioning (b = .118, sr^2 = .023, p = .005), anxiety (b = .259, sr^2 = .074, p < .001), and total depression (b = .307, sr^2 = .125, p < .001). Results addressing Hypotheses 1 and 2 indicated only a statistically significant linear association between optimism and 3-month depression (b = -1.418; sr^2 = .013; p = .011). This result is illustrated in Figure 2. There were no other statistically significant associations for the first two hypotheses. Thus, optimism showed a significant linear relationship with depression, but not with anxiety, physical functioning or rehospitalization, and there were no quadratic relationships linking optimism to any of the 3-month outcomes.

Hypothesis 3: Moderating Effect of Post-Surgical Symptoms

Using hierarchical regression I tested the hypothesis that the slope representing the association between optimism and QOL would vary depending on the level of post-surgical cardiac symptoms. The slope was expected to be positive for patients with low-moderate cardiac symptoms and less positive, or negative, for patients with high levels of cardiac symptoms. This hypothesis was modeled as an optimism X cardiac symptoms interaction.

In the first step of the regression model I included the control variables, the baseline cardiac symptom, and the baseline pre-surgical expectation. In the second step I included the quadratic terms of cardiac symptoms and pre-surgical expectations. It is important to control for the quadratic terms of the predictor and moderator. Otherwise, a significant moderation effect could reflect a correlated quadratic effect (Ganzach, 1997). This can occur if the predictor (X) and moderator (M) are highly correlated. As the

correlation between X and M increases, so too does the correlation between XM and X^2. This results in an overlap in the explained variance of XM and X^2. Thus, a statistically significant quadratic effect (X^2) can appear to be a significant moderation effect (XM). In the third step I added the interaction between baseline expectations and baseline cardiac symptoms. I chose to include this interaction in order to partial out the initial symptom interaction term from the post-surgical interaction. If the third step is significant it suggests that the role of expectations in predicting distress is influenced by initial cardiac symptom severity. In the fourth step I included the interaction between baseline expectations and 3-month cardiac symptoms. If the fourth step is significant it suggests that the role of expectations in predicting distress is influenced by post-surgical cardiac symptom severity. Additionally, because the initial symptoms are already in the model, the fourth step also captures the change in symptoms from pre- to post-surgery. Optimism, expected consequences, angina, and dyspnea were centered prior to analysis.

The only control variables to significantly predict the 3-month outcomes were the baseline outcomes (see the previous section for statistics describing this association). There were no statistically significant interactions between pre-surgical expectations and change in cardiac symptoms. Additionally, there were no significant interactions between pre-surgical expectations and baseline cardiac symptoms. To ensure the results were not due to the method of assessing change in cardiac symptoms, the hypothesis was also tested with an interaction between a cardiac symptoms change score and pre-surgical expectations. This analysis yielded the same results.

Hypothesis 4: Mediators of the Effects of Optimism on Outcomes

Mediation effects were assessed using the PROCESS macro provided by Andrew Hayes (Hayes, 2013). The independent variable was measured at pre-surgical baseline, the mediators on average three months after surgery, and the outcomes on average six months after surgery. The mediators were assessed simultaneously (i.e., multiple mediator model), and the same control variables (age, gender, marital status, ethnicity, years of education, the baseline measure of outcomes, LOS, number of medical complications, and the biomedical index) were included in each step of the mediation analysis. All continuous measures are scaled such that a higher score indicates more of the measured attribute. All results are unstandardized.[1] The total effect of the independent variable on the dependent variable, referred to as *c*, is the regression coefficient for the association between the independent and dependent variables prior to the inclusion of any mediators. The indirect effect was assessed as *ab*, the product of the *a* (independent variable to mediator) and *b* (mediator to dependent variable) regression coefficients. Therefore, *ab* represents the indirect effect of the independent variable on the dependent variable that is transmitted by the mediator. The significance of *ab* was assessed using bias-corrected 95% confidence intervals (CI) based on 10,000 bootstrapped samples.[2] The CI is considered statistically significant if it does not contain zero. The mediation results may be found in Tables 6-9 and the statistically significant indirect paths are illustrated in Figures 5-8.

[1] Hayes' (2013) explanation for only providing unstandardized results is that standardization changes one arbitrary measurement scale into another arbitrary scale and that standardized effects are scaled in terms of variability in the sample and as a result are not comparable across studies.

[2] A bias-corrected CI is a CI whose endpoints are adjusted as a function of the proportion of the bootstrapped *ab* values that are less than *ab* (Hayes, 2013).

There was a significant overall effect of optimism on 6-month physical function (c = 0.062, p = .008). There were four statistically significant indirect effects for optimism predicting physical function. As can be seen in Table 6 and Figure 5, part of the association between optimism and physical function occurred indirectly through internal state SE (ab = 0.019, CI = 0.003, 0.041), expected consequences (ab = 0.029, CI = 0.012, 0.052), positive reinterpretation (ab = 0.023, CI = 0.007, 0.047), and meaning-focused coping (ab = 0.005, CI = 0.0001 , 0.016). SE regarding post-surgical physical recovery and PSS were not significant mediators.

The results revealed a significant overall effect of optimism on 6-month anxiety (c = -0.217, p < .001), as shown in Figure 3. As can be seen in Table 7 and Figure 6, part of the association between optimism and anxiety occurred indirectly through internal state SE (ab = -0.037, CI = -0.080, -0.009) and PSS (ab = -0.027, CI = -0.064, -0.006). SE regarding post-surgical physical recovery, expected consequences, positive reinterpretation, and meaning-focused coping were not significant mediators.

There was no significant overall effect of optimism on 6-month rehospitalization. It should be noted that the lack of a significant overall effect does not mean that there are no indirect effects (Hayes, 2009). Indirect effects can occur without a significant total effect, for example, when two or more indirect effects exist and operate in opposite directions (Hayes, 2009). There were, however, significant indirect effects (Table 8 and Figure 4) occurring through SE regarding post-surgical physical recovery (ab = -0.014, CI = -0.031, -0.003) and expected consequences (ab = 0.020, CI = 0.002, 0.041). Internal state SE, PSS, positive reinterpretation, and meaning-focused coping were not significant mediators.

As illustrated in Figure 4, there was a statistically significant overall effect of optimism on overall depressive symptoms (c = -2.661, p < .001). In addition there was a statistically significant indirect effect through PSS (ab = -0.172, CI = -0.457, -0.021). Significant indirect effects did not occur through internal state SE, SE regarding post-surgical physical recovery, expected consequences, positive reinterpretation, or meaning-focused coping. These results may be found in Table 9 and Figure 8.

Discussion

The results support some, but not all, of the hypotheses that guided this study. There was mixed evidence for a linear association between optimism and post-surgical health. Optimism had a linear relationship with 3-month depression, but showed neither a linear nor quadratic relationship with any other outcome at the 3-month follow-up (Hypotheses 1 and 2). However, within the mediation analyses there were significant linear associations between pre-surgical optimism and 6-month post-surgical physical function, anxiety, and depression, such that optimistic patients experienced a greater reduction in these symptoms than their less optimistic counterparts (Hypothesis 1). Change in cardiac symptoms did not significantly moderate the association between optimism and post-surgical distress at 3 months (Hypothesis 3). Finally, the results support the importance of process variables in explaining the association between optimism and health outcomes 6-months after surgery (Hypothesis 4). This association was mediated by self-care self-efficacy, perceived social support, expected consequences, and coping responses.

Linear Effects of Optimism on QOL

Previous research has suggested an association between dispositional optimism and a variety of health outcomes. The analyses reported here found only one small association between optimism and 3-month post-surgical health outcomes, overall depression. However, more associations were significant at 6 months, including physical function, depression, and anxiety. This suggests that in some instances the association between optimism and health may take some time to become apparent. Consistent with this possibility, a study examining CABG patients found that higher pessimism predicted greater pain 6 and 12 months after surgery, but not at earlier times (Mahler & Kulik, 2000). Other research on CABG patients also has found statistically significant associations between optimism and health outcomes 6 months after surgery (Scheier et al., 1989, Scheier et al., 1999). Conversely, one study found that optimism was associated with distress 3 months, 6 months, and 12 months after breast cancer surgery (Carver et al., 1993). Thus, there is suggestive evidence that the association between optimism and health may depend on time. However, given the mixed findings from past studies this is far from certain and additional research is needed to answer this question.

Since process variables must in some sense play a role in explaining the association between optimism and health, it is likely that the differing results at the 3-month versus 6-month follow-up is due to the process variables. One possible explanation for the differing results is that optimists and pessimists have similar levels of process variables soon after surgery. For example, optimists tend to perceive more social support than pessimists (Brissette et al., 2002; Shen et al., 2004). Due to the difficult nature of the surgery, a pessimist's support network may still come to support the patient enough such that he or she gains benefits (e.g. less distress). However, this individual's

personality style may lead to withdrawal of support. Since social support is such an important part of reducing distress, if optimists and pessimists perceive similar levels of social support soon after surgery they may not significantly differ on depression and anxiety.

The apparent time-dependent nature of the association between optimism and post-surgical QOL might also occur for methodological reasons. The missing data at 3-month and 6-month follow-up were addressed using two different techniques. While the two techniques have similarities they have different approaches to missing data that result in slightly different imputed data. The differing association between optimism and post-surgical QOL at 3-months versus 6-months could be a result of these differences.

Past research has been mixed on the question of whether the association between optimism and post-surgical health changes over time. The current results support the idea that optimism has a greater influence on post-surgical health later in the recovery process. The changing role of optimism in the different stages of recovery may help us uncover previously unknown ways in which process variables influence post-surgical health. This is potentially significant since process variables such as self-efficacy and expected consequences are typically more readily changed than optimism, making them more tractable targets for interventions.

Quadratic Effects of Optimism on QOL

The second hypothesis, which was not confirmed, predicted that moderate optimism would be more strongly associated with positive health outcomes than high or low optimism. Previous studies finding non-linear associations between optimism and outcomes were different from the current study in that they included participants from

different populations and studied different health-related outcomes (Milam et al., 2004; Ridder et al., 2000; Segerstrom, 2001). The prediction in this study was based on the premise that high optimism would be harmful if it led highly optimistic individuals to be overconfident in their coping ability. There are a few possible explanations for why this prediction was not supported in these analyses. It may be because overconfidence does not have a serious negative impact on the post-surgical recovery, because any negative effects are outweighed by the benefits of optimism, or because very high optimism does not translate into overconfidence. Conversely, it is also possible that the null hypothesis is actually false but was not rejected for methodological reasons. For example, it may simply be that few participants in this study were sufficiently optimistic to become overconfident. In this case results from a sample of more optimistic participants might support the hypothesis. The likelihood of this explanation is difficult to gauge because it is not clear what level of optimism should cause overconfidence in coping ability.

Research on the health effects of optimism has focused almost solely on linear relationships. Few studies report the results of non-linear analyses. This is a potentially significant gap in the literature. While some research suggests that moderate optimism may lead to better outcomes in some circumstances, it is still unclear in what situations this will occur. It may be that future studies will determine that non-linear effects of optimism are uncommon. However, it will not be known until this possibility is explored in a broader range of samples with a variety of different outcomes. Having an accurate understanding of the association is necessary in order to create effective interventions. For example, if there is a non-linear association then an intervention designed to increase optimism may have negative side effects for some patients.

Cardiac Symptoms and Expectations Interaction

Change in cardiac symptoms did not significantly moderate the association between pre-surgical expectations and post-surgical distress. This finding contrasts with some research illustrating the potential harm of unmet expectations (Koller et al., 2000). An important difference between the current study and research finding the predicted moderation effect was that this study did not explicitly assess the fulfillment of expectations. The use of cardiac symptom change as a proxy is imperfect as it does not provide direct insight into the perceived fulfillment of participants' expectations.

As with the previous hypothesis, there are several possible explanations for why the third hypothesis was not supported. One possibility is that the hypothesis is true but was non-significant due to methodological factors. For example, this might occur if symptom change was not an accurate proxy for perceived expectation fulfillment or if few patients in our sample had significantly unrealistic expectations. In any of these cases participants would not be distressed due to unmet expectations. A sample with more optimistic expectations or worse cardiac symptom change might yield results supporting the hypothesis. The plausibility of this explanation is difficult to determine since the hypothesis depends on participants having sufficiently high expectations and sufficiently poor symptom change. It is not clear how extreme these need to be in order to result in the predicted distress. The other possibility is that the null hypothesis is correct. If the null were true it might be that while improving cardiac symptoms is a primary goal of many CABG procedures it is not the sole goal. CABG improves blood flow to the heart which improves cardiac symptoms such as angina and reduces the likelihood of a heart attack. Patients whose cardiac symptoms do not improve as desired

may change the criteria by which they evaluate their health status such that they focus more on the objective improvement in heart health and reduction in the likelihood of a heart attack. Past research suggests that this type of selective evaluation is common (Taylor, 1983).

While it is clear that expectations influence QOL, less research has been done examining the effect of unmet expectations in determining health. This is a notable gap with potential implications for interventions. Future research determining that unmet expectations are harmful should emphasize the importance of having realistic expectations. This could have implications for medical professionals in that it highlights the importance of ensuring individuals undergoing medical procedures have realistic expectations. Patient education is a possible low-cost intervention that could beneficially influence expectations.

Indirect Effect of Optimism on QOL

Results indicated that optimism had significant indirect effects on post-surgical QOL through SE, PSS, expected consequences, and coping responses. The importance of the process variables differed depending on the outcome, and the outcomes have varying numbers of significant indirect effects. A critical examination of the results appears to suggest that PSS is an especially important mediator of the association between optimism and distress. The greatest number of mediators were significant for explaining the association between optimism and physical functioning.

These results shed light on, and illustrate the importance of, the processes by which optimism is related to post-surgical health. Previous research showed that these process variables are important when coping with stressors. In addition several studies

have indicated the importance of PSS (Brissette et al., 2002; Shen et al., 2004; Trunzo & Pinto, 2003) and SE (Benight et al., 1999) in explaining the association between optimism and distress. To my knowledge, however, this was the first study examining the mediating role of these variables in post-surgical recovery. This is important as the process variables examined in this study are all potentially malleable, making them potential targets for an intervention. For example, SE is an important determinant of post-surgical anxiety. An intervention intended to increase SE might reduce the likelihood of patients experiencing anxiety after their procedure.

Limitations

This study has limitations that should be acknowledged. One limitation is that while the study sample was in many ways similar to a large multisite sample (Contrada et al., 2008), it was not nationally representative. For example, there was low representation of ethnic minorities. This potentially limits the generalizability of the results. Failure to be nationally representative, however, is typical in most clinical research. On the other hand, a strength of this study is the inclusion of urgent/emergent status patients in addition to elective surgery and the use of few exclusion criteria. Much of the existing literature only includes patients undergoing elective surgery and uses stricter exclusion criteria.

A second limitation is that while a large number of covariates were included in analyses, it is possible that unmeasured variables influenced the findings. For example, given the overlap between personality traits an unmeasured personality trait such as neuroticism (Scheier et al., 1994) may have influenced the reported associations. This limitation exists in all correlational studies. A third limitation is the use of self-report

measures, the limitations of which are well known (e.g. social desirability). Self-report measures were used as the variables of interest could not be assessed through other methods. In addition, the participants' subjective well-being, which necessarily must be gathered with self-report, was the primary outcome of interest.

A fourth limitation was the attrition at follow-up. Attrition may lead to biased results if participants drop out in a systematic way. The use of MI and EM largely addresses this limitation, making it a much less severe problem than might otherwise be expected (Enders, 2010). While not perfect, these techniques are superior to the alternatives. The accuracy of point estimates in MI may also be increased by using a greater number of imputations. The thirty imputations used in these analyses are based on the recommendations of Graham et al. (2007). A greater number of imputations may lead to additional computation time but otherwise will have no negative consequences.

Conclusion

Even with the limitations described above, these analyses address important and theoretically interesting questions and the results have implications for future research and may influence interventions. Few studies examine the possibility of non-linear associations, a gap in the literature that needs to be filled in order to make certain we have an accurate understanding of the association between optimism and health. Perhaps most importantly, however, researchers need to map the pathways through which optimism influences QOL as these pathways may lead to interventions which in turn may lead to improved post-surgical health. Further research is needed to examine the importance of time and unmet expectations in determining the association between optimism and health.

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Appendix

MI is an iterative technique that imputes values for missing data by calculating regression equations between variables based on the participants with complete data (Enders, 2010). These regression equations were based on the variables included in the primary analyses in addition to auxiliary variables. An auxiliary variable is a variable that is not part of the research questions but is a potential correlate of missingness or a correlate of the missing variable. Including auxiliary variables in the MI analysis can mitigate bias, increase power, and increase the accuracy of MI by recapturing some of the lost information in the missing variable (Collins, Schafer, & Kam, 2001). Including auxiliary variables is nearly always beneficial and there appears to be no downside to making liberal use of such variables (Collins et al., 2001). For example, consider a hypothetical dataset with two variables (A and B), both of which have missing data. Using the data from participants with values for both A and B we can run regression analyses to estimate the association between the two variables. We then use that information to calculate predicted values for the missing data. Each predicted value score is augmented with a normally distributed residual term to create variability in the imputed data.

This process is repeated to create multiple imputed datasets. The multiple imputed datasets are then analyzed using standard procedures for complete data. Point estimates of model parameters are calculated by taking the arithmetic mean of the point estimates calculated on each dataset (Enders, 2010). For example, the beta coefficient of a regression analysis is calculated on each imputed dataset. These coefficients, which differ between datasets, are averaged by taking their mean. This averaged coefficient is

the final result. Increasing the number of imputed datasets increases the accuracy of the point estimates when the percentage of missing data is high (Graham, Olchowski, & Gilreath, 2007). After considering recommendations by Graham et al. (2007), MI was used to create thirty imputed datasets.

As described in Enders (2010), EM is a two-step iterative process that consists of an E step and an M step. EM starts with an initial estimate of the means and variances of each variable and the covariances between them. The E step then uses this information to build a set of regression equations to predict and fill in the missing values in a similar manner as that described for MI. For example, these equations are also based on participants with complete data on the relevant variables. The M step then generates updated estimates of the means, variances, and covariances based on the now complete dataset. The subsequent E step carries forward these means, variances, and covariances to build a new set of regression equations. These equations are used to predict the missing values from the original data set. The next M step re-estimates the means, variances, and covariances. This process continues until the means, variances, and covariances no longer change between consecutive M steps (Enders, 2010). It should be noted that auxiliary variables may also be included in EM, and were in the present study, in order to take advantage of benefits mentioned above.

Table 1
Demographic and Biomedical Characteristics

Variables	Number	Percent	Mean	SD	Min	Max
Age			65.29	11.64	28	89
Gender						
Female	154	27.0				
Male	416	73.0				
Marital status						
Married	407	71.4				
Unmarried	163	28.6				
Race/Ethnicity						
White	501	87.9				
Black	26	4.6				
Hispanic	12	2.1				
Asian	31	5.4				
Years of education			13.44	2.98	0	22
Biomedical index[a]			4.35	1.99	0	11
Complications[b]			0.44	1.13	0	8
Length of hospital stay (days)			8.67	10.21	1	155

Note. There was minimal missing data for these variables and imputing values did not change the demographic or biomedical characteristics.
[a] Sum of all dichotomous biomedical predictors (see text for details).
[b] Count of all complications.

Table 2
Descriptive Statistics for the Multiple Imputation Dataset

Variables	Mean	SD	Min	Max	Range
Expectations (baseline)					
Dispositional optimism	3.72	0.65	1.44	5.00	1-5
Expected consequences	4.36	0.60	1.00	5.00	1-5
Cardiac symptoms					
Angina (baseline) [a]	0.47	0.75	0.00	2.00	0-2
Angina (3-month) [a]	0.47	0.69	0.00	2.00	0-2
Dyspnea (baseline)	1.54	1.48	0.00	4.00	0-4
Dyspnea (3-month)	1.12	1.40	0.00	4.00	0-4
Rehospitalization (3-month) [b]	1.68	0.46	1.00	2.00	1-2
Physical function					1-3
Baseline	2.18	0.58	1.00	3.00	
3-month	2.61	0.44	1.00	3.00	
Anxiety					1-6
Baseline	2.53	1.03	1.00	5.52	
3-month	2.09	0.93	1.00	5.25	
Total CES-D [c]					0-54
Baseline	11.19	8.96	0.00	48.00	
3-month	7.88	7.40	0.00	54.00	

Note. Continuous measures are scaled such that a higher score is more of that construct. Mean scores are reported for continuous variables except for overall depression symptoms for which Center of Epidemiologic Studies–Depression (CES-D) total scores are reported.
[a] 0 is no angina, 1 and 2 are angina, with 2 being more severe.
[b] 1 = rehospitalized and 2 = not rehospitalized.
[c] The total CES-D score is a sum of the 18 items.

Table 3
Descriptive Statistics for the Expectation Maximization Dataset

Variables	Mean	SD	Min	Max	Range
Expectations (baseline)					
Dispositional optimism	3.72	0.64	1.44	5.00	1-5
Mediators (3-months)					
Perceived social support	5.79	1.10	1.00	7.00	1-7
Expected consequences	3.88	0.61	1.33	5.00	1-5
SE – internal state	4.59	0.51	1.67	5.00	1-5
SE – physical recovery	4.45	0.55	1.00	5.00	1-5
Positive reinterpretation	3.98	0.64	1.00	5.00	1-5
Meaning-focused coping	2.05	0.78	1.00	5.00	1-5
Rehospitalization (6-months) [a]	1.22	0.37	1.00	2.00	1-2
Physical function					1-3
Baseline	2.18	0.58	1.00	3.00	
6-month	2.66	0.39	1.00	3.00	
Anxiety					1-6
Baseline	2.53	1.02	1.00	5.50	
6-month	2.06	0.87	1.00	6.00	
Total CES-D [b]					0-54
Baseline	11.18	8.96	0.00	48.00	
6-month	6.78	6.91	0.00	41.00	

Note. Continuous measures are scaled such that a higher score is more of that construct. The SE mediators are self-care self-efficacy.
[a] 1 = not rehospitalized and 2 = rehospitalized.
[b] The total CES-D score is a sum of the 18 items.

Table 4

Correlations among selected variables in the Multiple Imputation Dataset

Variable	1	2	3	4	5	6	7	8	9	10
1. Dispositional optimism	-	.407**	-.024	-.071	-.111*	-.061	.009	-.122*	-.287**	-.004
2. Expected consequences		-	.054	-.041	-.090*	-.106	.108	-.145**	-.234**	-.022
3. Baseline angina [a]			-	.058	.210**	.041	-.005	-.030	.049	.040
4. 3-month angina [a]				-	.039	.420	-.123*	.061	.125	-.187
5. Baseline dyspnea					-	.127*	-.165**	.030	.092	-.023
6. 3-month dyspnea						-	-.230**	.065	.149*	-.143
7. Physical functioning							-	-.213**	-.243**	.107
8. Anxiety								-	.426**	-.028
9. Total depression									-	-.068
10. Rehospitalization [b]										-

Note. Continuous measures are scaled such that a higher score is more of that construct. Dispositional optimism and expected consequences are from baseline and physical functioning, anxiety, depression, and rehospitalization are from the 3-month follow-up.

*Correlation is significant at $p < .05$. **Correlation is significant at $p < .001$.

[a] 0 is no angina, 1and 2 are angina, with 2 being more severe.

[b] 1 = rehospitalized and 2 = not rehospitalized.

Table 5

Correlations among selected variables in the Expectation Maximization Dataset

Variable	1	2	3	4	5	6	7	8	9	10	11
1. Dispositional optimism	-	.362**	.281**	.185**	.256**	.341**	-.141**	.194**	-.309**	-.441**	.063
2. Expected consequences		-	.334**	.409**	.165**	.288**	-.123*	.277**	-.283**	-.325**	.051
3. Internal state (SE)			-	.597**	.202**	.302**	-.245**	.321**	-.402**	-.446**	-.058
4. Physical recovery (SE)				-	.266**	.322**	-.219**	.326**	-.416**	-.454**	-.065
5. Perceived social support					-	.251**	-.102*	.206**	-.280**	-.330**	.085*
6. Positive reinterpretation coping						-	.082	.290**	-.234**	-.286**	.020
7. Meaning-focused coping							-	-.139**	.227**	.211**	-.037
8. Physical functioning								-	-.414**	-.417**	-.178**
9. Anxiety									-	.693**	.065
10. Total depression										-	.078
11. Rehospitalization [a]											-

Note. Continuous measures are scaled such that a higher score is more of that construct. The SE variables are self-care self-efficacy. Expected consequences, internal state SE, physical recovery SE, perceived social support, positive reinterpretation coping, and meaning-focused coping were assessed at the 3-month follow-up. Physical functioning, anxiety, depression, and rehospitalization are from the 6-month follow-up.

*Correlation is significant at $p < .05$. **Correlation is significant at $p < .001$.

[a] 1 = not rehospitalized and 2 = rehospitalized

Table 6

Bootstrap analysis of statistical significance of indirect effects between optimism and physical functioning

Independent variable	Mediator variable	Dependent variable	c	c'	*ab*	SE of *ab*	95% CI for *ab* [lower, upper]	P_M
Optimism	SE physical recovery	Physical function	0.062*	-0.026	0.005	0.005	-0.003, 0.017	0.074
Optimism	SE internal state	Physical function	0.062*	-0.026	0.019*	0.009	0.003, 0.041	0.312
Optimism	Perceived social support	Physical function	0.062*	-0.026	0.006	0.006	-0.003, 0.019	0.094
Optimism	Expected consequences	Physical function	0.062*	-0.026	0.029*	0.010	0.012, 0.052	0.483
Optimism	Positive reinterpretation	Physical function	0.062*	-0.026	0.023*	0.010	0.007, 0.047	0.378
Optimism	Meaning-focused coping	Physical function	0.062*	-0.026	0.005*	0.004	0.000, 0.016	0.083

Note. The independent variable was measured at baseline, the mediators at 3-month follow-up, and the outcome at 6-month follow-up. Each analysis included the control variables. All continuous measures are scaled such that a higher score is more of that construct. All results are unstandardized. c is the regression coefficient for the total effect (direct + indirect) of the independent variable on the dependent variable. c' is the regression coefficient for the direct effect. *ab* is the product of the *a* (independent variable to mediator) and *b* (mediator to dependent variable) regression coefficients and represents the indirect effect. SE of *ab* is the standard error for the *ab* product. A 95% confidence interval (CI) gives the probability that, upon resampling, 95% of the intervals we receive will contain the true population value of *ab*. The indirect effect is statistically significant if the confidence interval does not contain zero. P_M is a measure of effect size and represents the percent of the total effect that goes through the mediator. The mediators were included simultaneously. The SE mediators are self-care self-efficacy. Numbers below 0.000 are written as 0.000.

* $p < 0.05$

Table 7

Bootstrap analysis of statistical significance of indirect effects between optimism and anxiety

Independent variable	Mediator variable	Dependent variable	c	c'	*ab*	SE of *ab*	95% CI for *ab* [lower, upper]	P_M
Optimism	SE physical recovery	Anxiety	-0.217*	-0.076	-0.011	0.009	-0.040, 0.001	0.052
Optimism	SE internal state	Anxiety	-0.217*	-0.076	-0.037*	0.017	-0.080, -0.009	0.171
Optimism	Perceived social support	Anxiety	-0.217*	-0.076	-0.027*	0.015	-0.064, -0.006	0.125
Optimism	Expected consequences	Anxiety	-0.217*	-0.076	-0.030	0.024	-0.081, 0.013	0.140
Optimism	Positive reinterpretation	Anxiety	-0.217*	-0.076	-0.030	0.022	-0.077, 0.008	0.140
Optimism	Meaning-focused coping	Anxiety	-0.217*	-0.076	-0.005	0.007	-0.026, 0.002	0.024

Note. The independent variable was measured at baseline, the mediators at 3-month follow-up, and the outcome at 6-month follow-up. Each analysis included the control variables. All continuous measures are scaled such that a higher score is more of that construct. All results are unstandardized. c is the regression coefficient for the total effect (direct + indirect) of the independent variable on the dependent variable. c' is the regression coefficient for the direct effect. *ab* is the product of the *a* (independent variable to mediator) and *b* (mediator to dependent variable) regression coefficients and represents the indirect effect. SE of *ab* is the standard error for the *ab* product. A 95% confidence interval (CI) gives the probability that, upon resampling, 95% of the intervals we receive will contain the true population value of *ab*. The indirect effect is statistically significant if the confidence interval does not contain zero. P_M is a measure of effect size and represents the percent of the total effect that goes through the mediator. The mediators were included simultaneously. The SE mediators are self-care self-efficacy.

* $p < 0.05$

Table 8

Bootstrap analysis of statistical significance of indirect effects between optimism and rehospitalization

Independent variable	Mediator variable	Dependent variable	c	c'	*ab*	SE of *ab*	95% CI for *ab* [lower, upper]	P_M
Optimism	SE physical recovery	Rehospitalization	0.035	0.012	-0.014*	0.007	-0.031, -0.003	-0.400[a]
Optimism	SE internal state	Rehospitalization	0.035	0.012	0.002	0.009	-0.015, 0.019	0.069
Optimism	Perceived social support	Rehospitalization	0.035	0.012	0.007	0.007	-0.007, 0.022	0.192
Optimism	Expected consequences	Rehospitalization	0.035	0.012	0.020*	0.009	0.002, 0.041	0.580
Optimism	Positive reinterpretation	Rehospitalization	0.035	0.012	0.004	0.010	-0.015, 0.025	0.123
Optimism	Meaning-focused coping	Rehospitalization	0.035	0.012	0.003	0.004	-0.003, 0.012	0.081

Note. The independent variable was measured at baseline, the mediators at 3-month follow-up, and the outcome at 6-month follow-up. Each analysis included the control variables. All continuous measures are scaled such that a higher score is more of that construct. All results are unstandardized. c is the regression coefficient for the total effect (direct + indirect) of the independent variable on the dependent variable. c' is the regression coefficient for the direct effect. *ab* is the product of the *a* (independent variable to mediator) and *b* (mediator to dependent variable) regression coefficients and represents the indirect effect. SE of *ab* is the standard error for the *ab* product. The indirect effect is statistically significant if the confidence interval does not contain zero. P_M is a measure of effect size and represents the percent of the total effect that goes through the mediator. The mediators were included simultaneously. The SE mediators are self-care self-efficacy.

* $p < 0.05$

[a] P_M will be negative when the total effect (*c*) and indirect effect (*ab*) have opposite signs.

Table 9

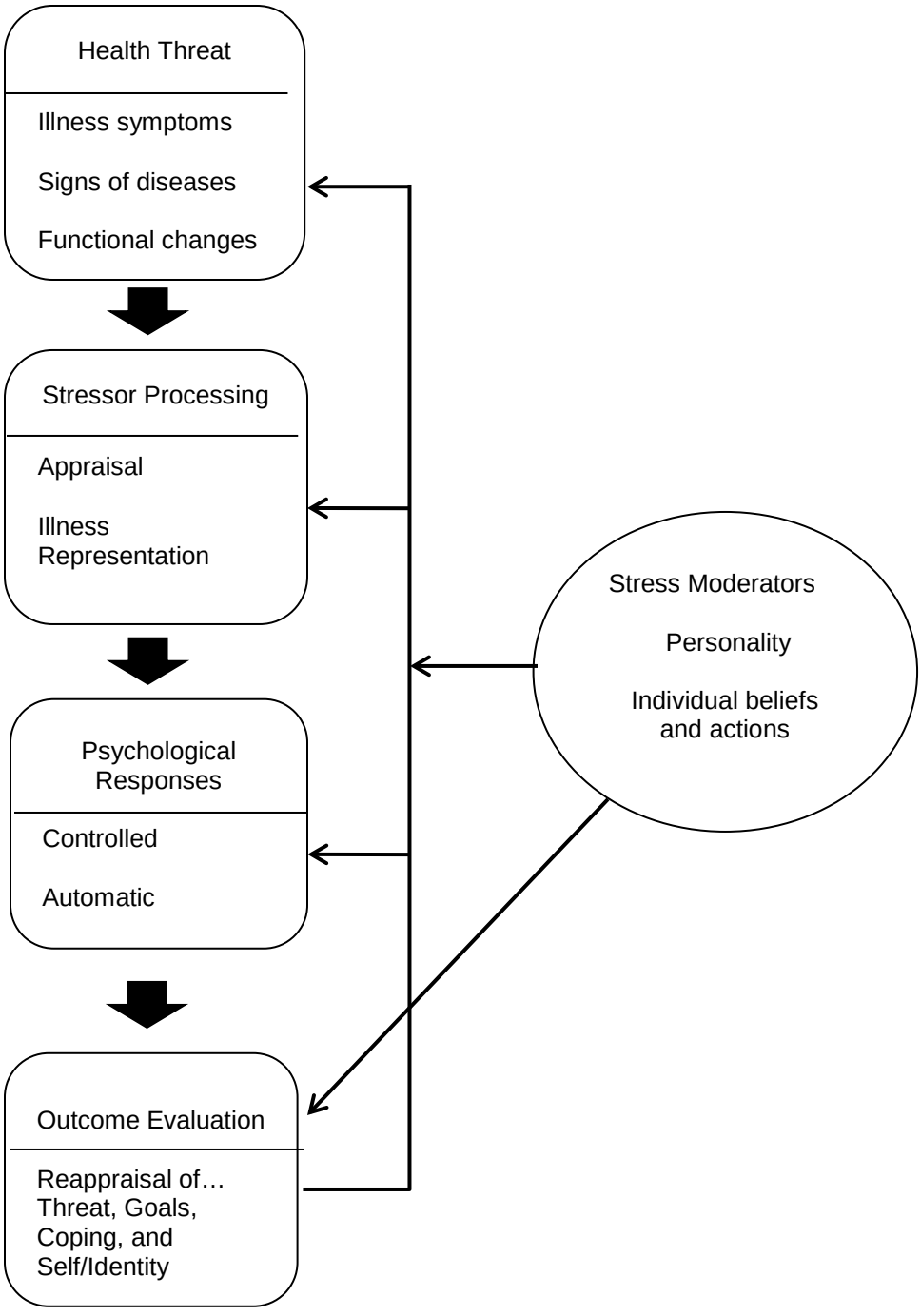
Bootstrap analysis of statistical significance of indirect effects between optimism and overall depression

Independent variable	Mediator variable	Dependent variable	c	c'	*ab*	SE of *ab*	95% CI for *ab* [lower, upper]	P_M
Optimism	SE physical recovery	Overall depression	-2.661*	-2.008*	-0.026	0.111	-0.255, 0.188	0.009
Optimism	SE internal state	Overall depression	-2.661*	-2.008*	-0.109	0.083	-0.350, 0.001	0.041
Optimism	Perceived social support	Overall depression	-2.661*	-2.008*	-0.172*	0.107	-0.457, -0.021	0.065
Optimism	Expected consequences	Overall depression	-2.661*	-2.008*	-0.174	0.159	-0.513, 0.115	0.065
Optimism	Positive reinterpretation	Overall depression	-2.661*	-2.008*	-0.173	0.152	-0.508, 0.090	0.065
Optimism	Meaning-focused coping	Overall depression	-2.661*	-2.008*	-0.000	0.029	-0.072, 0.058	0.0001

Note. The independent variable was measured at baseline, the mediators at 3-month follow-up, and the outcome at 6-month follow-up. Each analysis included the control variables. All continuous measures are scaled such that a higher score is more of that construct. All results are unstandardized. c is the regression coefficient for the total effect (direct + indirect) of the independent variable on the dependent variable. c' is the regression coefficient for the direct effect. *ab* is the product of the *a* (independent variable to mediator) and *b* (mediator to dependent variable) regression coefficients and represents the indirect effect. SE of *ab* is the standard error for the *ab* product. A 95% confidence interval (CI) gives the probability that, upon resampling, 95% of the intervals we receive will contain the true population value of *ab*. The indirect effect is statistically significant if the confidence interval does not contain zero. P_M is a measure of effect size and represents the percent of the total effect that goes through the mediator. The mediators were included simultaneously. The SE mediators are self-care self-efficacy. Numbers below 0.000 are written as 0.000.

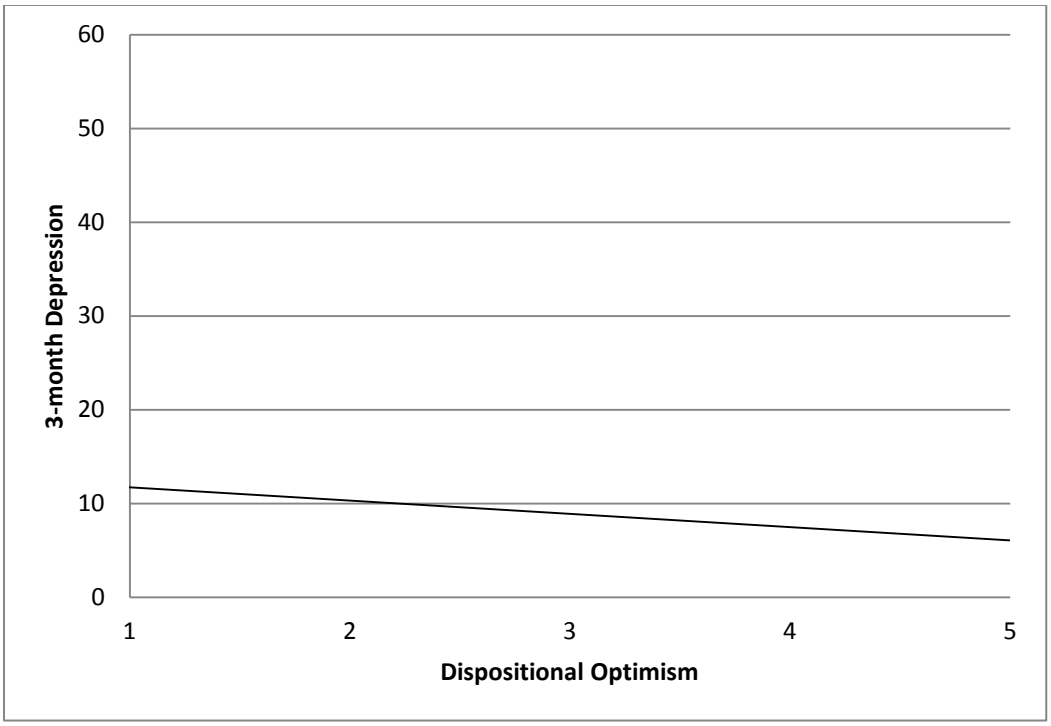
* $p < 0.05$

Figure 1
General Model



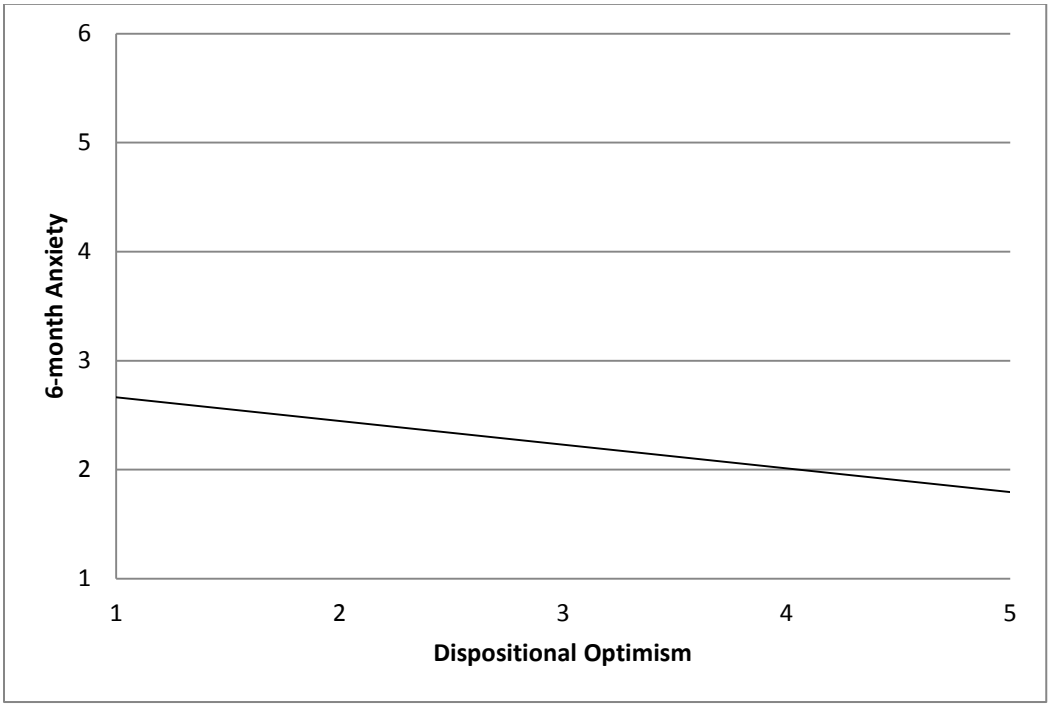
Note. Model of the process by which individuals interpret and cope with health threats and the factors influencing this process. The process is influenced by many external factors including, but not limited to, personality and individual beliefs and actions. The pathways displayed in this figure are not comprehensive and do not represent all possible relationships between the steps.

Figure 2
Regression plot of optimism predicting 3-month depression



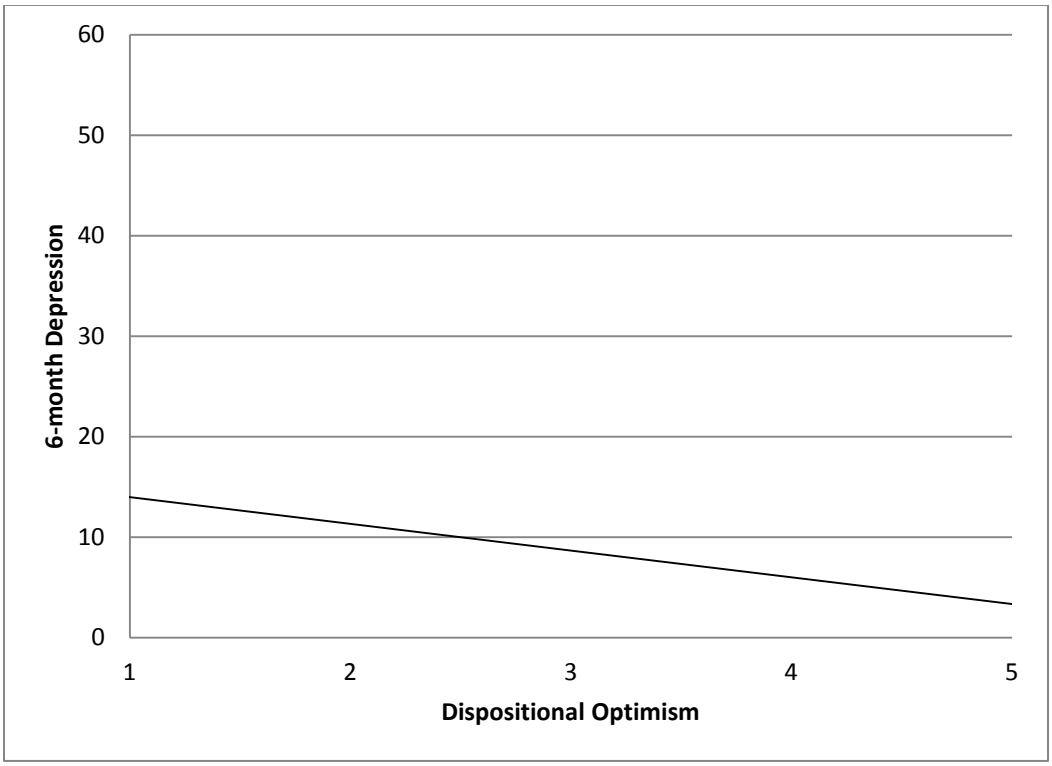
Note. Regression plot of baseline dispositional optimism predicting 3-month depression, adjusted for the control variables. The X-axis is the mean optimism score and the Y-axis is the total depression score. Neither score is centered. Predicted values of 3-month depression are plotted for participants scoring 1 standard deviation below and above the mean for baseline optimism. The control variables were set at their means. See the text for a complete list of control variables. The plot is based on unstandardized regression coefficients. A CES-D score of 16 is a commonly used cutoff in studies of psychiatric patients. A score below 16 suggests that no significant depressive symptomatology is present (Radloff, 1977).

Figure 3
Regression plot of optimism predicting 6-month anxiety



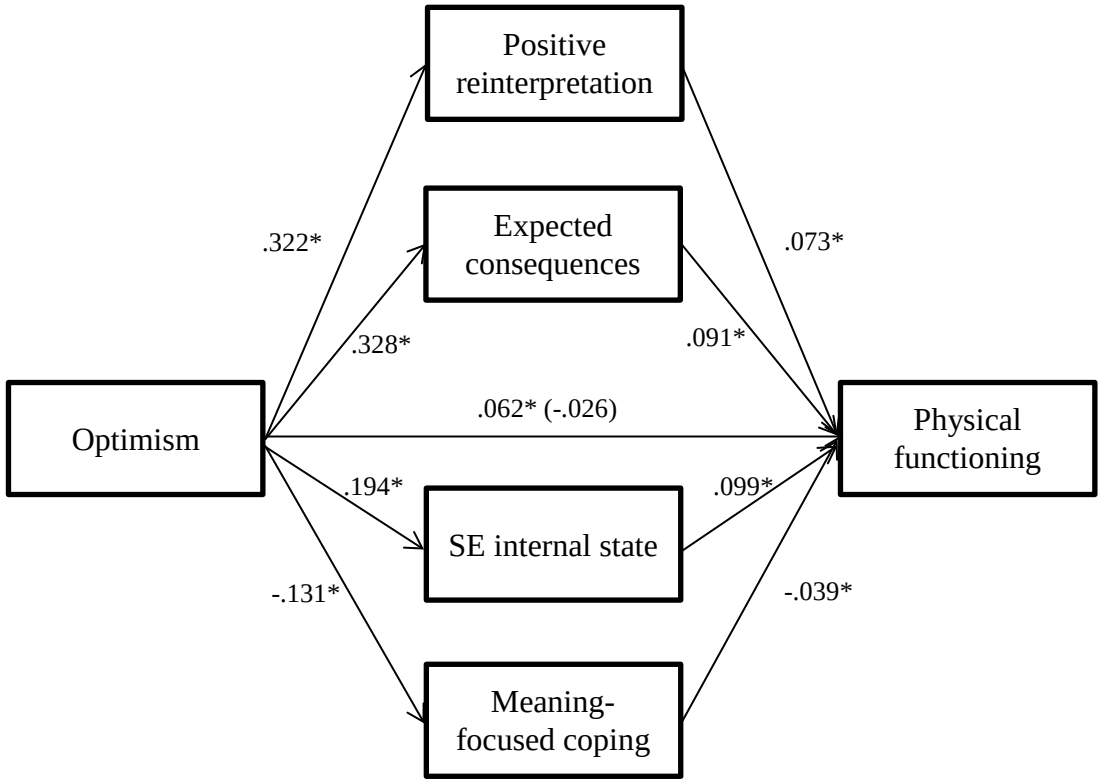
Note. Regression plot of baseline dispositional optimism predicting 6-month anxiety, adjusted for the control variables. The X-axis is the mean optimism score and the Y-axis is the mean anxiety score. Neither score is centered. Predicted values of 3-month anxiety are plotted for participants scoring 1 standard deviation below and above the mean for baseline optimism. The control variables were set at their means. See the text for a complete list of control variables. The plot is based on unstandardized regression coefficients.

Figure 4
Regression plot of optimism predicting 6-month depression



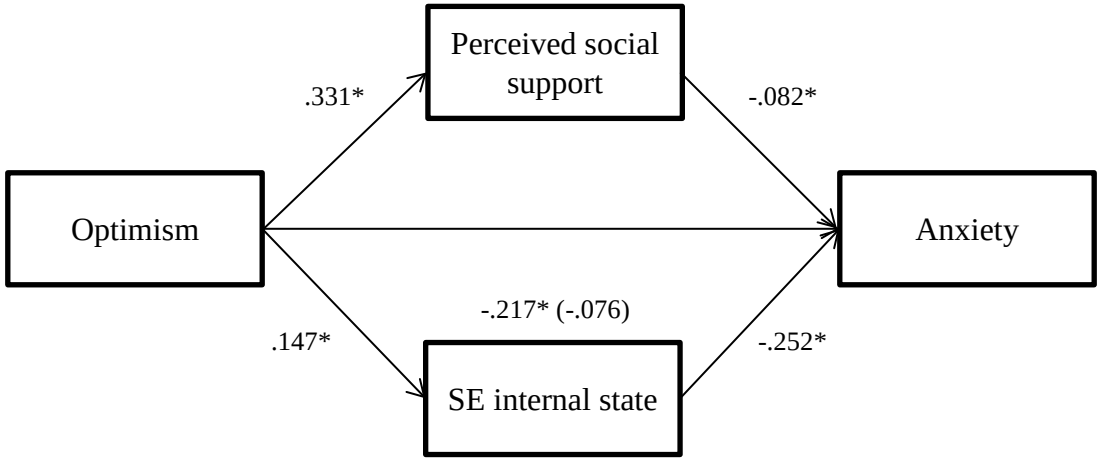
Note. Regression plot of baseline dispositional optimism predicting 6-month depression, adjusted for the control variables. The X-axis is the mean optimism score and the Y-axis is the total depression score. Neither score is centered. Predicted values of 6-month depression are plotted for participants scoring 1 standard deviation below and above the mean for baseline optimism. The control variables were set at their means. See the text for a complete list of control variables. The plot is based on unstandardized regression coefficients. A CES-D score of 16 is a commonly used cutoff in studies of psychiatric patients. A score below 16 suggests that no significant depressive symptomatology is present (Radloff, 1977).

Figure 5
Mediation analysis of optimism predicting physical functioning



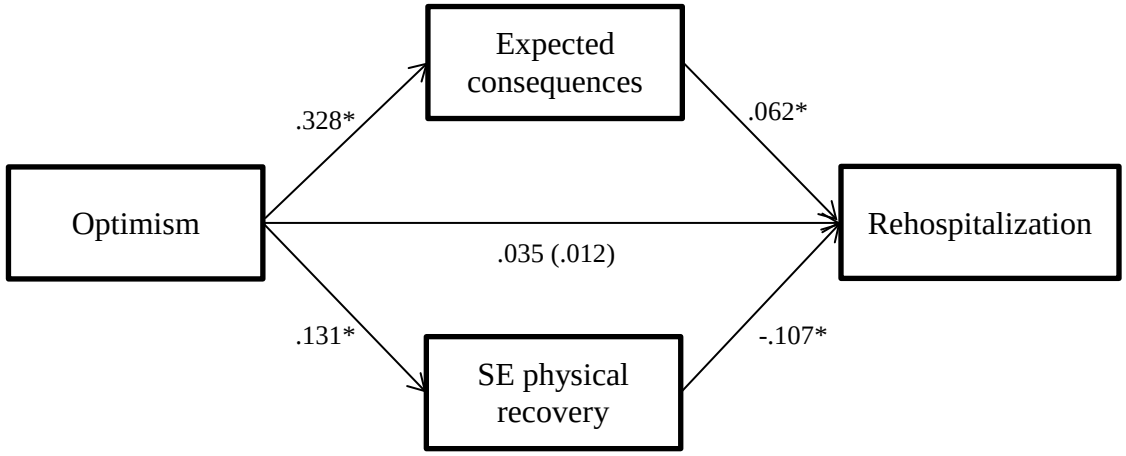
Note. All paths are unstandardized. The path from optimism to physical functioning outside the parentheses is the total effect and the effect within the parentheses is the direct effect. The independent variable was measured five days before surgery, the mediators three months after surgery, and the outcome six months after surgery. In each analysis I controlled for age, gender, marital status, ethnicity, years of education, the baseline outcome, length of stay in the hospital, number of medical complications, and the biomedical index. All continuous measures are scaled such that a higher score is more of that construct. All results are unstandardized. The SE mediators are self-care self-efficacy.
* $p < 0.05$

Figure 6
Mediation analysis of optimism predicting anxiety



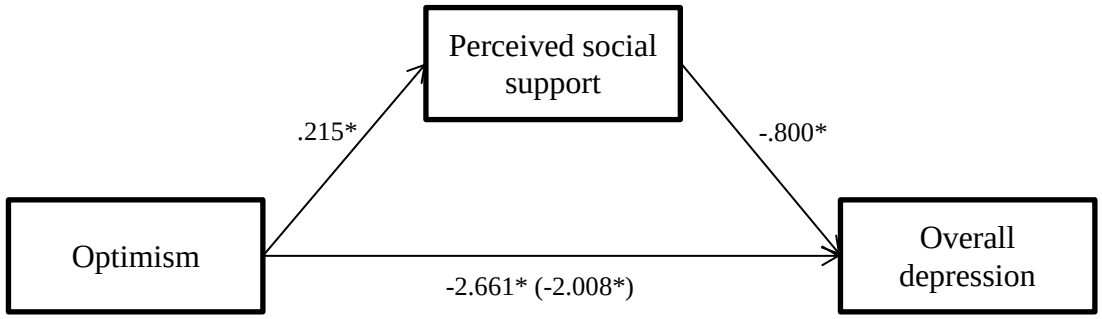
Note: All paths are unstandardized. The path from optimism to anxiety outside the parentheses is the total effect and the effect within the parentheses is the direct effect. The independent variable was measured five days before surgery, the mediators three months after surgery, and the outcome six months after surgery. In each analysis I controlled for age, gender, marital status, ethnicity, years of education, the baseline outcome, length of stay in the hospital, number of medical complications, and the biomedical index. All continuous measures are scaled such that a higher score is more of that construct. All results are unstandardized. The SE mediators are self-care self-efficacy.
* $p < 0.05$

Figure 7
Mediation analysis of optimism predicting rehospitalization



Note. All paths are unstandardized. The path from optimism to rehospitalization outside the parentheses is the total effect and the effect within the parentheses is the direct effect. The independent variable was measured five days before surgery, the mediators three months after surgery, and the outcome six months after surgery. In each analysis I controlled for age, gender, marital status, ethnicity, years of education, the baseline outcome, length of stay in the hospital, number of medical complications, and the biomedical index. All continuous measures and rehospitalization are scaled such that a higher score is more of that construct. All results are unstandardized. The SE mediators are self-care self-efficacy.
* $p < 0.05$

Figure 8
Mediation analysis of optimism predicting overall depression



Note. All paths are unstandardized. The path from optimism to overall depression outside the parentheses is the total effect and the effect within the parentheses is the direct effect. The independent variable was measured five days before surgery, the mediators three months after surgery, and the outcome six months after surgery. In each analysis I controlled for age, gender, marital status, ethnicity, years of education, the baseline outcome, length of stay in the hospital, number of medical complications, and the biomedical index. All continuous measures are scaled such that a higher score is more of that construct. All results are unstandardized.
* $p < 0.05$