SYMPTOMS AS A MODERATOR OF THE RELATIONSHIP BETWEEN BELIEFS AND BEHAVIORS AMONG PATIENTS UNDERGOING CORONARY ARTERY BYPASS SURGERY

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ERIC B. HEKLER

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ABSTRACT OF THE DISSERTATION

Symptoms as a Moderator of the Relationship between Beliefs and Behaviors among Patients Undergoing Coronary Bypass Surgery

By ERIC B. HEKLER

Dissertation Director:

Richard J. Contrada, PhD

There is growing evidence suggesting health behaviors (e.g., physical activity, medications) significantly improve health outcomes and quality of life following coronary artery bypass graft (CABG) surgery. Despite the clear benefits of these behaviors, adherence is poor and interventions designed to promote them have yielded mixed results. This dissertation, guided by Leventhal's Commonsense Model of Self-Regulation (CSM) and Bandura's Social Cognitive Theory (SCT), was a descriptive study designed to identify beliefs that might predict adherence and serve as intervention targets.

Participants were 89 CABG (*M* age = 65.4, 73% male, 79.8% white) surgery patients who spoke English and were free of any neurological, cognitive, or medical condition that might influence their ability to complete the study. They were interviewed prior to surgery about their CSM and SCT beliefs and their health behaviors (i.e., physical activity, medication adherence) using structured interviews. All measures exhibited factor structures that fit with *a priori* expectations and had acceptable reliability (αs between .67 and .91). Demographic information was gathered during the structured interviews. Medical information was gathered from medical records and aggregated to create a single cardiac risk factor index.

Results suggested that personal control and emotional cause beliefs were positively associated with physical activity, whereas medical cause beliefs were inversely associated with physical activity. In addition, the relationship between symptoms and physical activity appeared to be statistically mediated by emotional cause beliefs. With regard to SCT beliefs, negative medication outcome expectancies (NMOE) was inversely associated with medication adherence, and the relationship between medication adherence self-efficacy and medication adherence was statistically mediated by NMOE. Examination of the possible moderating influence of symptoms on beliefs suggested that both self-efficacy and bed rest outcome expectancies were associated with physical activity if an individual was symptomatic but they were not associated with physical activity if an individual was asymptomatic. Overall, results suggest that integrating the CSM with SCT provides a useful conceptual framework for understanding medication adherence and physical activity. Future research is required to evaluate the prospective, predictive utility of this framework. In addition, interventions that are tailored to patients' symptom status seem worth pursuing.

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INTRODUCTION

Cardiovascular disease is the leading source of mortality in the U.S. and most other industrialized nations, killing nearly as many Americans as all other diseases combined (American Heart Association, 2006). Coronary heart disease (CHD) accounts for more than half of U.S. deaths that are due to cardiovascular causes (American Heart Association, 2006), and remains a significant cause of death despite an overall decline in CHD-related mortality.

Over the past twenty years, there have been major developments in the use of invasive diagnostic techniques and treatments for CHD such as coronary artery bypass graft (CABG) surgery. It is estimated that 467,000 CABG surgeries were performed in the U.S in 2003 (American Heart Association, 2006). CABG is effective for the relief of angina and improvement in quality of life for a wide range of patients and, in certain patient subgroups, it improves survival and reduces the incidence of nonfatal outcomes such as myocardial infarction, congestive heart failure, and hospitalization (Eagle et al., 2004). As a consequence of these technical advances, more Americans with high risk profiles can expect to undergo acute treatment for coronary disease and to survive and subsequently live a significant portion of their lifetimes with CHD. This trend is magnified by the aging of the population and increased use of invasive treatments in older individuals. These developments argue for efforts to optimize secondary prevention of CHD following such treatments and over the long-term to reverse the trend toward increasing rates of CHD-related hospitalization that has resulted from advances in acute treatment and reduced mortality.

Secondary Prevention of CHD Following CABG

Most risk factors responsible for the development and progression of CHD involve patient behavior. Guidelines for secondary prevention in CABG patients include exercise, medication (i.e., maintenance of target levels of plasma lipid fractions; antiplatelet therapy using aspirin to promote patency of vein grafts), and diet (Eagle et al., 2004). Also recommended in CABG patients and others with chronic CHD and/or acute coronary syndromes are smoking cessation and management of hypertension, where relevant, and efforts to manage stress via relaxation/rest (Eagle et al., 2004; Herlitz, 2004; Orth-Gomer et al., 2005). These strategies have demonstrable efficacy for reducing the risk of recurrent CHD and cardiovascular mortality (Eagle et al., 2004; Herlitz, 2004; Orth-Gomer et al., 2005).

The treatment gap

There is considerable evidence to suggest that the foregoing guidelines are not being followed. Estimates of patients that adhere to secondary preventative behaviors including exercise, diet, and smoking cessation range from 10% to 48% (Denton, Fonarow, LaBresh, & Trento, 2003) suggesting the need for interventions to improve adherence. Lipid-lowering medications are underutilized in a number of populations, as are drugs for controlling hypertension and arrhythmias (Foody et al., 2003). A significant proportion of CABG patients do not enroll in cardiac rehabilitation programs (Jackson, Leclerc, Erskine, & Linden, 2005). A lack of theory-driven research is likely limiting the efficacy of these interventions.

Theoretical Framework

The guiding theoretical framework for this dissertation draws from Leventhal's commonsense model of self-regulation (CSM) (Howard Leventhal, Nerenz, & Steele, 1984; Howard Leventhal et al., 1997; Howard Leventhal, Leventhal, & Cameron, 2001) and from Bandura's social cognitive theory (SCT) (Bandura, 2001). Central themes of the CSM are: 1) An individual with a medical illness is an active problem-solver who is constantly attempting to make sense of his illness with the goal of avoiding or controlling his illness and subsequent cognitive, emotional, and somatic responses; 2) The strategies that an individual uses to control his or her illness are based on commonsense beliefs about the illness and therefore do not necessarily conform with a biomedical appraisal of the problem; 3) Socio-cultural, other external factors (e.g., social support), and internal factors (e.g., symptoms, gender, depression) play an important role in shaping these commonsense beliefs (Howard Leventhal et al., 2001).

According to the CSM, these processes interact with underlying schemas to influence a patient's interpretation of objective health cues, level of functioning, symptoms, and use of heuristics to guide efforts at disease management. Objective health cues (e.g., blood pressure or glucose levels) and level of functioning (e.g., self-sufficiency) are important factors that a patient monitors to determine if he is "sick". In addition, patients monitor a variety of internal symptoms (e.g., chest pain, fatigue, low affect). These symptoms play a major role in influencing a patient's belief system. Schemas are underlying explanations of complex experiences and operate as guiding principles for illness beliefs. Schemas are beliefs that are rooted within cultural belief systems. For example, a schema of interest to this study is that "surgery is a cure." Another example of a schema is that "heart disease is a male problem." These popular conceptions of surgery and heart disease – along with a variety of other schemas – will influence a patient's beliefs about his/her illness. Heuristics are the rules that govern how a patient interprets these different sets of information (i.e., symptoms, level of functioning, objective health cues, schemas) and guide behavioral decisions. These heuristics are what ultimately influences goal-directed action plans (i.e., strategies a person develops to engage in a behavior to manage illness).

Social cognitive theory (SCT), on the other hand, focuses on predicting human behavior in general rather than dealing specifically with medical patients. Central to SCT is the assumption that human behavior is part of a "triadic reciprocal causation" loop between: 1) behavior; 2) personal factors (i.e., cognitive, affective, and biological events) and; 3) external environmental factors (e.g., social interactions) (Bandura, 1997). Furthermore, these bidirectional interactions will impact an individual's goals to engage or not engage in a behavior. A key personal factor is an individual's expectancies. These expectancies can be divided broadly into three domains: 1) situation-outcome expectancies (i.e., environmental events cause outcomes that are outside of an individual's control); 2) action-outcome expectancies (i.e., outcomes occur because of personal action) and; 3) perceived self-efficacy (i.e., a person's belief that he can engage in a specific action required to bring about a desired outcome) (Ralf Schwarzer, 2001). These processes function in a self-regulatory fashion whereby learning (i.e., operant, classical, and social) and the formation of goals and action plans play a fundamental role in the interaction of environment, behavior, and personal factors.

The CSM and SCT share many points in common. Both acknowledge the importance of pre-existing personal and external factors influencing behavior and beliefs. Both also assume that humans are self-regulatory beings with the capacity to change external and internal processes. In addition, both models emphasize the importance of setting goals and creating action plans to carry out goals. Finally, both suggest constructs likely to play an important role in self-regulated behavior.

The two models differ in several key ways as well. First, the CSM is focused specifically on commonsense beliefs about an illness and how these beliefs influence self-regulatory behaviors in medical patients. Social Cognitive Theory (SCT) on the other hand is focused on the determinants of behavior in general. As the CSM is designed to explain illness beliefs, it also suggests a differentiation between an individual's belief system and a more scientifically-based belief system regarding illness. Although this is not counter to SCT, it is not an explicit component of that model. The CSM offers several constructs regarding illness beliefs (i.e., control, consequences, timeline, and causes) that allow for a more subtle breakdown of what SCT would refer to as situation- or action-outcome expectancies. In addition, SCT emphasizes the interaction of environmental cues, cognitions, and behaviors but as it is a general model does not offer specific cues that an individual will monitor. The CSM implies specific constructs (i.e., objective health cues, level of functioning, and symptoms) that a patient will actively monitor to understand illness and behaviors.

By contrast, SCT offers a conceptualization of the interaction of behavior and environment along with key cognitive constructs that are only implicit in the CSM. Social cognitive theory developed from a behaviorist framework. As such, central to SCT is the importance that learning (i.e., classical, operant, and social) plays in the interaction of the environment and behavior. Beyond this, a key construct – if not the primary construct – of SCT is self-efficacy. Perceived self-efficacy (i.e., a person's belief that he can engage in a behavior) has been shown to consistently predict a variety of behaviors (Bandura, 1997). In addition, many studies have supported interventions to change maladaptive behaviors via self-efficacy (Bandura, 1997). A belief in self-efficacy is especially important in behaviors such as physical activity in which the task can be somewhat difficult to accomplish. Beyond self-efficacy, action-outcome expectancy is also an important construct in SCT. A person's belief about the positive and negative outcomes of a behavior has been shown to influence motivation to engage in the behavior (e.g., Bennett, Mayfield, Norman, Lowe, & Morgan, 1999; Williams, Anderson, & Winett, 2005).

The Commonsense model and health behaviors among cardiac patients

Research examining the relationship between commonsense beliefs and health behaviors among cardiac patients has generally focused on cardiac rehabilitation attendance. A recent meta-analysis of 8 studies (N=906) examined the combined effect sizes of factors that predict cardiac rehabilitation attendance (French, Cooper, & Weinman, 2006). Results overall suggest that identify (r = 0.123) cure/control (r = 0.111), consequences (r = 0.081), and coherence (r = 0.160) were positively associated with cardiac rehab attendance. These results lend support for the utility of examining illness representations among cardiac patients in general, albeit with small effect sizes.

Other studies have been done that examine the influence of CSM beliefs on a number of health behaviors including physical activity and medication adherence among patients with heart disease (Byrne, Walsh, & Murphy, 2005; Gump, Matthews, Scheier, Schulz, Bridges, & Magovern, 2001), or with risk factors for heart disease such as diabetes (Searle, Norman, Thompson, & Vedhara, 2007a, 2007b), hyperlipidemia (Brewer, Chapman, Brownlee, & Leventhal, 2002; Senior, Marteau, & Weinman, 2004), and hypertension (Hekler, Lambert, Leventhal, Leventhal, Jahn, & Contrada, 2008; Ross, Walker, & MacLeod, 2004). In addition, there has been one intervention study thus far that has attempted to influence illness beliefs among cardiac patients (Petrie, Cameron, Ellis, Buick, & Weinman, 2002). In general, results of these studies suggest that CSM beliefs are associated with health behaviors (Brewer et al., 2002; Gump et al., 2001; Hekler et al., 2008; Petrie et al., 2002; Ross et al., 2004; Searle et al., 2007a, 2007b; Senior et al., 2004) with one exception that is discussed in the section below regarding studies that combined CSM and SCT constructs (Byrne et al., 2005). In addition, the effect sizes are usually small to medium as was found when predicting cardiac rehabilitation attendance.

With regard to the intervention study, Petrie and colleagues (2002) conducted a randomized clinical trial designed to change illness beliefs following a myocardial infarction (MI). The intervention resulted in significant changes in beliefs about the chronicity of heart disease and personal control over heart disease that persisted to 3-months later. In addition, results suggested that 3 months after the intervention, the intervention group reported significantly less angina and a faster return to work. These results were later qualified by the influence of trait negative affectivity (L. D. Cameron, K. J. Petrie, C. J. Ellis, D. Buick, & J. A. Weinman, 2005b). Specifically, those high in trait negative affect and who were in the intervention group exhibited decreased worry about heart disease that persisted 6 months later but those individuals also exercised less and ate more fat relative to those with low negative affect or those in the control condition. Nonetheless, those individuals low in negative affect exhibited increased cardiac rehab attendance and lower disability at 3 months relative to their control group counterparts. These results emphasize the potential important influence trait negative affect may have on the relationship between illness beliefs and subsequent behaviors.

Gump and colleagues (2001) examined the relationship between preoperative CSM beliefs and post operative behaviors among CABG surgery patients. Results suggested that age significantly moderated the relationship between CSM beliefs and post operative behaviors. Specifically, cause beliefs about the influence of health-protective behaviors (e.g., healthy diet, exercise) predicted post operative changes in exercise. In addition, beliefs that heart disease was caused by health damaging behaviors (e.g., smoking, alcohol use) were predictive of post operative changes in smoking. Finally, it was found that age interacted with chronic timeline beliefs. Specifically, belief that heart disease was an acute condition resulted in reduction of health damaging behaviors only among the youngest age group (age 31-59).

Searle and colleagues (2007b) found that chronic timeline and personal control beliefs were cross-sectionally positively associated with physical activity whereas no CSM beliefs significantly predicted medication adherence. Searle et al. (2007a) also examined longitudinal associations, baseline and 12 months later, between CSM beliefs and medication adherence and physical activity. Results of regression analyses suggested that treatment control predicted medication adherence whereas no CSM belief was predictive of physical activity 12 months later.

Brewer and colleagues conducted a cross-sectional study examining the association between illness representations, medication adherence, and low density lipoprotein (LDL) cholesterol levels among patients with hypercholesterolemia (Brewer et al., 2002). Results suggested that consequences were associated with medication adherence and identity (i.e., belief that the disease is stable and asymptomatic), and that consequences were both associated with LDL cholesterol levels.

Hekler and colleagues examined illness beliefs and adherence to health behaviors among African Americans with hypertension (Hekler et al., 2008). Results of this study suggested that cause/control beliefs tended to cluster together into what was termed a medical belief model (i.e., hypertension is caused and controlled by factors generally accepted in the medical community such as exercise and diet), and a stress belief model (i.e., stress is the main factor that causes and thus should be controlled within hypertension), and indicated separable dimensions for identity, consequences, and timeline beliefs. It was found that the medical belief model was predictive of engagement in lifestyle behaviors (e.g., cut down salt, exercise), whereas the stress belief model was associated with engagement in stress management behaviors. In addition, the medical belief model was inversely associated with systolic blood pressure and this relationship was statistically mediated by engagement in lifestyle behaviors.

Ross and colleagues did a similar cross-sectional analysis of the relationship between both illness beliefs and beliefs about medications to predict medication adherence among patients with hypertension (Ross et al., 2004). Results suggested that personal control and a person's emotional response to hypertension (i.e., increase in emotions based on the presence of hypertension) were both inversely associated with medication adherence. The inverse association between personal control and medication adherence was unexpected but was explained as a potential problem of self-efficacy. Specifically, individuals that believe they have the ability to control their illness but lack the belief in their self-efficacy to engage in the tasks to remain healthy (e.g., diet, take medications) will be less likely to engage in the behavior. Although speculative, this line of reasoning highlights the potential importance of self-efficacy when predicting medication adherence, at least among hypertensive patients.

Social Cognitive Factors and health behaviors among cardiac patients

Extensive research has been done using both observational, correlational designs and interventions to examine the impact of social cognitive constructs, particularly self-efficacy, on physical activity among cardiac patients. A recent review suggested 41 observational studies conducted prior to March 2005 that examined the relationship between physical activity and self-efficacy among patients in cardiac rehabilitation (Woodgate & Brawley, 2008). As suggested by Bandura (1997), self-efficacy beliefs, by definition, should be focused on specific beliefs rather than a broader general self-efficacy belief. This is primarily because more specific belief systems offer more valuable insights into the key factors that promote physical activity and therefore are more readily translatable into interventions. In addition, they tend to be better predictors of specific behaviors. As such, the Woodgate and Brawley review found primarily two types of self-efficacy, self-regulatory self-efficacy (i.e., belief in ones ability to plan and regulate behaviors) and task specific self-efficacy (i.e., belief in the ability to perform specific behaviors like walking). Results of this study suggest that both task and self-regulatory self-efficacy are associated with physical activity in both symptomatic and healthy control groups. In addition, results further suggest that task self-efficacy and physical activity have a bidirectional relationship in that increases in physical activity appear to improve task self-efficacy beliefs but increases in self-efficacy beliefs also appear to improve physical activity (Woodgate & Brawley, 2008).

More recent work examining this bidirectional relationship appear to give more support to the notion that physical activity increases task self-efficacy with less evidence suggesting a reciprocal relationship whereby task self-efficacy promotes increased physical activity (Rejeski et al., 2008; Scholz, Sniehotta, Schuz, & Oeberst, 2007). In addition, although several interventions designed to promote self-efficacy have been linked with improved physical activity and health up to one year later, it is unclear if changes in task self-efficacy was the key mediating factor in maintenance of physical activity or if task self-efficacy simply improved as a byproduct of increased physical activity (Gary, 2006; Moore et al., 2006; Senuzun, Fadiloglu, Burke, & Payzin, 2006). Nonetheless, there is some evidence suggesting that self-efficacy beliefs influence maintenance of physical activity soon after stopping a cardiac rehab program (Joekes, van Elderen, & Schreurs, 2007) and up to 5 years after a physical activity intervention (McAuley, Morris, Motl, Hu, Konopack, & Elavsky, 2007). In addition, there is evidence to suggest that self-regulatory self-efficacy may play a more important role in directly mediating the relationship between task-self-efficacy and physical activity (Anderson, Wojcik, Winett, & Williams, 2006; Woodgate, Brawley, & Weston, 2005). In sum, although the model suggests a bidirectional relationship between task self-efficacy and health behaviors, the evidence strongly supports the assertion that self-efficacy is increased by behaviors but the evidence is not as strong but still supports the general idea that self-efficacy influences increased engagement in behaviors.

Other descriptive longitudinal studies, have examined the relationship between either task self-efficacy (labeled action self-efficacy by these authors) or recovery self-efficacy (i.e., I can be physically active despite setbacks such as increased symptoms) (R.

Schwarzer, 2008; R. Schwarzer, Luszczynska, Ziegelmann, Scholz, & Lippke, 2008). Results of these studies suggest that task self-efficacy, outcome expectancies and risk perception predicted intention to engage in physical activity two months after the initial baseline with task self-efficacy the strongest predictor. In addition, task self-efficacy predicted recovery self-efficacy 2 months later and intentions predicted planning. Planning and recovery self-efficacy were the two factors that predicted physical activity 4 months later.

Similar results were found by other authors as well (Luszczynska & Sutton, 2006). These authors distinguished between maintenance self-efficacy (i.e., belief in the ability to maintain physical activity) versus recovery self-efficacy. Participants were patients with a recent myocardial infarction (MI) interviewed soon after the MI and then two time points later. The authors divided the groups up between those that maintained physical activity levels following cardiac rehab versus those that relapsed to lower levels of physical activity. Results suggested that maintenance self-efficacy was associated with physical activity among those individuals that maintained their level of physical activity whereas recovery self-efficacy was positively associated with physical activity for those that relapsed.

In conclusion, research generally supports the notion that different forms of self-efficacy, particularly task, self-regulatory, and recovery self-efficacy are associated with physical activity. In addition, results suggest improvements of physical activity increase self-efficacy whereas there is some evidence to support the notion that task, recovery, and self-regulatory self-efficacy beliefs appear to increase maintenance of physical activity in the long-term.

Although outcome expectancies play a central role in SCT, less research has focused on it specifically compared to self-efficacy. Nonetheless, a recent review of the role outcome expectancies plays in predicting physical activity suggests mixed results. Specifically, positive outcome expectancies appears to more clearly predict physical activity compared to negative outcome expectancies (Williams et al., 2005). Barriers to treatment appear to play the strongest predictive role if negative outcome expectancies were divided.

To progress the examination of physical activity outcome expectancies, Williams and colleagues (2005) suggested the examination of both sedentary activity outcome expectancies and affective outcome expectancies for physical activity. Sedentary activity outcome expectancies, particularly for those patients with heart problems, are likely an interesting way of examining if patients are potentially afraid to engage in physical activity because of the risk of cardiac complications, such as a heart attack. As such, beliefs about the possible influences of sedentary activity or even bed rest may be an effective means of examining these beliefs. Further, work by Rothman (2000) suggests that affective expectations, particularly emotional satisfaction with a behavior, may play an important role in maintenance of health behaviors including physical activity. As such, affective outcome expectancies for physical activity will likely be important to examine.

The beliefs about medications questionnaire (BMQ) was originally designed by authors that customarily work from a CSM framework (Horne, Weinman, & Hankins, 1999). The measure includes four subscales with two focused on beliefs about specific medicines and two focused on more general beliefs about medications. For the purposes of this dissertation, the two specific subscales about medications will only be discussed. The two specific subscales were labeled beliefs about the necessity of medications and concerns about medications. These constructs are practically identical to what SCT would label positive and negative outcome expectancies. For the remainder of this paper, the BMQ subscale, necessity of medications will be referred to as positive medication outcome expectancies (PMOE) whereas the BMQ subscale, concerns about medications, will be referred to as negative medication outcome expectancies (NMOE). This relabeling was done primarily to emphasize that the scales could be used to assess the SCT construct of outcome expectancies despite the fact that is was also derived from the CSM. A review of the literature using the BMQ and other scales that assess medication outcome expectancies suggest that both PMOE and NMOE are associated with medication adherence (Bane, Hughes, & McElnay, 2006; Byrne et al., 2005; Horne & Weinman, 1999; Mann, Ponieman, Vilchez, Leventhal, & Halm, 2008; Ross et al., 2004).

The majority of research on the influence of medication adherence self-efficacy (MASE) and medication adherence has been done among patients with HIV. Nonetheless, there has recently been increased interested in MASE for other chronic illnesses such as hypertension (Ogedegbe, Mancuso, Allegrante, & Charlson, 2003; Ogedegbe et al., 2007). Preliminary results suggest that MASE was associated with improved hypertension control and therefore presumably medication adherence (Ogedegbe et al., 2003). The vast majority of other studies that examined medication adherence self-efficacy among patients other than those with HIV incorporated both CSM and SCT elements.

Empirical evidence linking the CSM and SCT

A growing number of studies have examined both CSM and SCT beliefs (Bean, Cundy, & Petrie, 2007; Byrne et al., 2005; Lau-Walker, 2004, 2006; Mann et al., 2008; Ross et al., 2004). Lau-Walker (2004) cross-sectionally examined the relationship between CSM and SCT in 250 patients with a recent MI or angina. Results of this study suggested a correlation between illness representations and self-efficacy such that greater perceived consequences of the illness were related to lower general self-efficacy, and a chronic perception of the illness was associated with reduced diet and exercise self-efficacy. Lau-Walker later examined the relationship between CSM beliefs and general, cardiac diet, and cardiac exercise self-efficacy prospectively among patients with a recent MI (Lau-Walker, 2006). Results replicated the association between consequences and general self-efficacy. In addition, exercise outcome expectancies, chronic timeline, and control/cure beliefs were all positively associated with cardiac exercise self-efficacy. Finally, control/cure, exercise outcome expectancies, and cardiac exercise self-efficacy all positively predicted attendance at cardiac rehab.

Of studies that examined the influence of CSM and SCT beliefs on behaviors, some found significant associations between both CSM and SCT beliefs and medication adherence (Mann et al., 2008; Ross et al., 2004) whereas others suggested that only SCT factors predicted medication adherence (Bean et al., 2007; Byrne et al., 2005). Overall, results suggest that MASE (Bean et al., 2007; Mann et al., 2008) and positive medication outcome expectancies (Byrne et al., 2005) were positively associated with medication adherence whereas negative medication outcome expectancies was inversely associated with medication adherence (Byrne et al., 2005; Mann et al., 2008; Ross et al., 2004). With regard to CSM beliefs, one study found a positive association between personal control and medication adherence (Mann et al., 2008) whereas another found an inverse association between personal control and medication adherence (Ross et al., 2004). Finally two studies found no associations between CSM beliefs and medication adherence (Bean et al., 2007; Byrne et al., 2005). It is important to note that the Byrne and colleagues study created an aggregate score of illness beliefs by combining chronic timeline, consequences, treatment control (reverse scored), and personal control (reverse scored) beliefs. As such, results of this study should be interpreted with caution as it did not examine illness beliefs in a way that is in line with the original creators of the CSM.

Overall, these results examining both the CSM and SCT in conjunction suggest a relationship between illness beliefs and self-efficacy. In addition, SCT factors, particularly self-efficacy and negative outcome expectancies, appear to more consistently predict medication adherence compared to CSM beliefs. More recent work is focusing on the possible interplay between symptoms and different forms of self-efficacy, particularly task, self-regulatory, and recovery self-efficacy (Woodgate & Brawley, 2008). There is increasing theoretical reason to believe that different forms of self-efficacy may play a differential role depending on the course of an illness and possibly symptom status. For example, Woodgate and Brawley (2008) suggested that self-regulatory self-efficacy might be particularly important for maintaining health behaviors in the face of increased symptoms. They propose that self-regulatory self-efficacy beliefs will help a person to maintain appropriate self-regulatory behaviors despite possible fears regarding increased symptomatology.

By extension, other forms of self-efficacy may interact with symptom status depending on a person's commonsense beliefs about their illness. Based on the CSM, symptoms are expected to interact with an individual's beliefs about illnesses (H. Leventhal & Mora, 2008). As such, symptoms alone do not generate health relevant behaviors (Petrie et al., 2002) but instead may lead to changes in behaviors depending on beliefs. For example, symptoms may promote decreased physical activity if the symptoms are perceived as a sign of increased risk of reoccurrence (Cooper, Weinman, Hankins, Jackson, & Horne, 2007). In contrast, symptoms also have been shown to be an important motivator for seeking treatment (L. Cameron, Leventhal, & Leventhal, 1993; Martin & Leventhal, 2004). Based on previous research, symptoms may be expected to moderate the relationship between beliefs and behaviors, including social cognitive beliefs like task self-efficacy or outcome expectancies.

An integrative model designed to provide a framework for understanding the role of health-related beliefs in the self-management of chronic illness is depicted in Figure 1. Central to this model is an assumption of bidirectional interactions of behavior, environment, and personal factors. Key personal factors are symptoms, perceived level of functioning, schemas, beliefs, goals, and behavioral planning. Symptoms, schemas, and level of functioning influence beliefs about a behavior and about illness. These beliefs, in turn, influence goals and plans that guide behavior. Behavior then elicits change in symptoms, objective health cues, and level of functioning, thereby providing self-regulative feedback. Illness beliefs (i.e., identify, consequences, curability, timeline, causes) are identified using CSM constructs whereas behavior beliefs (i.e., self-efficacy, outcome expectations) are identified using SCT constructs.

It is important to note that this integrative model distinguishes between symptoms a person experiences and symptoms a person attributes to their illness. This was done because it is assumed that symptoms, regardless of attribution, will impact illness beliefs and behavioral beliefs, which in turn will impact health behaviors. Based on this, for the remainder of this dissertation the term "symptoms" will refer to symptoms that the person is experiencing regardless of the attribution. The identity component of the CSM will be discussed in terms of symptoms attributions.

In addition, the cure/control belief from the CSM was divided into three separate but related variables: personal control, treatment control, and curability following bypass. Personal control refers to a person's belief in his or her ability to influence heart disease. Treatment control refers to a person's belief in the efficacy of various health behaviors (e.g., medication adherence, exercise, diet, stress management) to impact heart disease. Finally, curability in this study refers to an individual's belief that their heart disease will be cured following surgery. Personal control and treatment control have already been distinguished in previous research using the CSM (Gump et al., 2001; Moss-Morris, Weinman, Petrie, Horne, Cameron, & Buick, 2002). The distinction of curability beliefs following heart surgery was done because it is theoretically plausible believing that heart disease is cured following surgery will have a different impact on health behaviors compared to personal control or treatment control beliefs. For example, if a person believes that he or she was cured by surgery, it is plausible that they will be less likely to engage in health behaviors regardless of their belief in their ability to control heart disease or the efficacy of treatment options other than bypass surgery.

Based on the above discussion, several main effect hypotheses of the impact of beliefs on health behaviors can be drawn.

Hypothesis 1: Illness beliefs (i.e., curability, personal control, treatment control, chronic timeline, consequences, medical cause beliefs, emotional cause beliefs) and symptoms, key factors of the CSM, will be associated with medication adherence and physical activity after controlling for age and cardiac risk factors.

Hypothesis 2: Behavioral beliefs based on social cognitive theory (i.e., self-efficacy, outcome expectancies) will be associated with medication adherence and physical activity after controlling for age and cardiac risk factors.

As social cognitive theory has been used extensively to predict health behaviors, particularly physical activity, it is important to establish that illness beliefs from the CSM significantly contribute to an overall predictive model beyond SCT. This hypothesis is plausible based on the integrative model and previous research that has examined components of both models in a single study (e.g., Mann et al., 2008).

Hypothesis 3: Illness beliefs based on the commonsense model will add significant predictive utility beyond behavioral beliefs based on social cognitive theory for predicting medication adherence and physical activity within regression models.

Besides beliefs, the integrated model focuses on the impact of symptoms for understanding health behaviors via their impact on both illness beliefs and behavioral beliefs. A key factor involved in illness beliefs is the symptoms a person attributes to their illness. Based on the CSM, symptoms will influence engagement of health behaviors if a person links the symptoms they experience with a specific health problem.

As such, it is likely that more specific symptoms related to heart disease such as chest pain, will be associated with health behaviors whereas other symptoms such as emotional symptoms like depression, will not be as strongly linked with a specific illness and therefore will not be associated with health behaviors directly.

> Hypothesis 4: Cardiac symptoms will be positively associated with medication adherence and physical activity whereas psychological and fatigue symptoms will not be associated with medication adherence and physical activity after controlling for age and cardiac risk factors.

As suggested by the CSM, a person's attribution of their symptoms to the illness is important as it sets up the link between symptoms and the illness. This link is critical for motivating individuals to engage in health behaviors known to impact the behavior. As such, the symptom that a person perceived as most troubling will likely have the most important influence on behaviors. Based on this, patients who attribute their most troubling symptom to their heart disease will likely be more motivated to engage in health behaviors than those that attribute their worst symptoms to something other than heart disease or are asymptomatic.

> Hypothesis 5: If a patient's self-described "most troubling symptom" is attributed to cardiac disease by the patient, the patient will be more adherent to recommended medications and physical activity levels compared to those that attribute their self-perceived most troubling symptom to something else (e.g., mental problem, physical activity, other disease).

As stated above, the integrative model of CSM and SCT suggests a dynamic process whereby patients monitor symptoms to understand the illness and subsequent coping behaviors. As such, symptoms will likely moderate the relationship between both illness beliefs and behavior beliefs and health behaviors. Specifically, the influence of an illness belief or behavioral belief on health behaviors will only be activated if a person is symptomatic as the symptoms set up a situation in which the beliefs and behaviors become relevant for possibly influencing symptom status and thus health. For those that are asymptomatic however, individuals lack information regarding the internal impact of heart disease and therefore these illness beliefs and behavioral beliefs will not be activated. Therefore, these beliefs will have little or no impact on health behaviors.

Hypothesis 6: Symptoms will moderate the influence of both illness beliefs based on the CSM and behavioral beliefs based on SCT when cross-sectionally predicting health behaviors (i.e., medication adherence, physical activity).

Method

Participants

Participants were recruited between December 2006 to May 2008. A total 343 patients were eligible for the study. Both elective (n= 70) and urgent surgery (n=181) patients were approached for inclusion in this study for a total of 251 approached patients or 63.7% of the total eligible patients. Of those, 50.6%, n = 127, consented to participate with a higher portion of elective surgery patients (n=53 or 75.7% of 70) agreeing to be in the study compared to urgent patients (n=74 or 40.9% of 181). There were no differences in gender or ethnicity between those that consented versus those that declined to participate in the present study, $\chi^2 = 0.2$, $p = 0.67$ and $\chi^2 = 2.7$, $p = 0.10$ respectively. Of the 127 consent participants, 98 completed the baseline interview. Eighty-seven participants had complete interview data and information about recent physical activity whereas 83 subjects had complete interview data coupled with information about medication adherence. The primary reason for the smaller sample with medication adherence data was that several participants were not taking medications. These two subsamples resulted in a total sample of 89 participants with complete interview data. As such, all descriptive statistics refer to the full sample of 89, see Table 1. All analyses with medication adherence are with the subsample of 83 and all analyses on physical activity are with the final sample of 87.

The average age was 65.4, *SD* 8.5, 73%, n = 65, were male, and the majority of the sample was white 73%, n =65. Of those who reported their income (n = 69), 59.3% had an average household income at or above $50k per year. A total of 40.6%, n = 36, of participants were currently employed either full or part-time of the 82 that reported employment status. Finally, 65.8%, n = 52, of subjects were married/living with someone out of the 79 that reported martial status.

Procedure

We recruited both elective and urgent care bypass surgery patients. For elective bypass surgery patients, following the initial surgical consultation for CABG surgery at RWJUH, patients were screened according to inclusion criteria. The surgeon then briefly described the project to the patient. Patients interested in learning more about the study were seen by research personnel. Informed consent was acquired and then the patients were scheduled to be interviewed; usually on the day of pre-admission testing, approximately six days prior to surgery, or an alternate time arranged by the researcher and patient if that time was not acceptable. Patients then were administered the MINI mental status exam if it appeared that the patient's mental status might impact his or her ability to participate in the research. If patients score below a 23, they were excluded from participation. A total of 2 were excluded based on this criterion.

Patients already admitted to the hospital for CABG surgery at RWJUH, were initially screened by a member of the medical team to determine eligibility. If the patient appeared to meet inclusion criteria listed below, a member of the research team approached the patients at bedside, described the project to the patient, and gave the patient an informed consent form. Following completion of the cosent process, the MINI mental status exam was be administered to determine cognitive functioning if it appeared that the patient's mental status may impact his/her ability to participate in the research. If the patient scores below a 23, he or she was not allowed to participate. If they scored above a 23, the baseline interview commenced at bedside. A total of 4 were excluded based on this criterion.

Patients were eligible for participation if they met the following criteria as determined by clinical examination: (1) scheduled for isolated CABG or CABG plus other procedures; (2) literate in English; (3) absence of any psychiatric, neurologic, or language difficulties that would interfere with psychosocial measurement; (4) 21 years of age or older.

Data were obtained from the following sources: (1) structured interviews were used to collect demographic and psychosocial data including illness beliefs, behavior beliefs, depression, medication adherence, and physical activity; (2) hospital medical charts were used to obtain medical history.

Measures

Demographic information, including age, gender, income, marital status, education, and ethnicity, was collected at the baseline interview. Information regarding previous cardiac events and co-morbid conditions was obtained from patients' medical charts.

The Illness Perception Questionnaire – Revised (IPQ-R Moss-Morris et al., 2002) was used to assess key components of the CSM (i.e., symptoms, timeline, cause, consequences, personal control). In addition, items labeled treatment control in the IPQ-R were revised to better reflect a patient's belief that heart surgery will cure their illness. Besides changes in the treatment control variables of the IPQ-R to reflect cure beliefs, the majority of other items were reworded slightly to increase their relevance among cardiac patients. For example, "your heart disease" replaced "your illness" in all items from the IPQ-R. This was done based on recommendations from the authors of the IPQ-R coupled with research on the CSM regarding item creation that suggests the need for items to be specific to an illness and personalized rather than more global (French, Marteau, Weinman, & Senior, 2004; Moss-Morris et al., 2002). As there were slight changes in some wording, exploratory factor analysis was used to confirm the factor structure of the IPQ-R. In addition, cause beliefs were examined separately from other illness beliefs using factor analysis as per recommendations from the authors of the IPQ-R (Moss-Morris et al., 2002). See Tables 2 and 3 for a list of all items within the IPQ-R chronic timeline, consequences, personal control, curability, and cause beliefs subscales. As is noted in Table 3, cause beliefs were separated between emotional cause beliefs ($\alpha = .75$) and medical cause beliefs ($\alpha = .76$).

The IPQ-R examines the identity construct by asking a person if he/she is experiencing a symptom by responding with either a yes or no. If the person is experiencing the symptom, a subsequent question asks if he or she attributes the symptom to his or her illness. To further examine symptoms we asked individuals to rate their level of symptomatology on a 5-point scale from 0-not at all to 4-very much. An aggregate symptom score was created by averaging the 14 symptom items. This full scale exhibited good reliability, $\alpha = .89$. To examine the impact of subsets of symptoms, exploratory factor analysis was used to derive symptom subscales, see Table 4. These subscales were used to test hypothesis 4.

With regard to symptom attribution, we asked each participant to identify the cause or causes of their illness. In addition, we asked each individual to identify the single symptom that they perceive as "most troubling" to them. This identified symptom coupled with information gathered regarding what the patient attributes as the cause of their symptoms, was used to test Hypothesis 5.

Treatment control was assessed using an 8-item measure based on Gump and colleagues (2001). We chose to use this measure of treatment control as it exhibited good psychometric properties and predictive utility in previous research among CABG patients (Gump et al., 2001). Participants were asked, "To what degree would each of the following reduce your chances of having further heart problems?" Participants were asked to respond on a 5-point scale from 0-not at all to 4-very much. Example items include: change exercise habits, quit smoking, and cope with stress better. This scale exhibited acceptable reliability in the current study, $\alpha = .79$.

Physical activity outcome expectancies were assessed using a scale designed for this study. This new scale was used primarily from recommendations from Williams et al. (2005) that suggested the possible distinction between sedentary outcome expectancies, emotion-related physical activity outcome expectancies, and health related physical activity outcome expectancies. As there was no clear measure in the literature that assessed physical activity with these distinctions, a new measure was developed for this study that exhibited good factor structure and reliability, see Table 5.

Medication outcome expectancies was assessed using the beliefs about medications questionnaire (BMQ: Horne et al., 1999). The BMQ was originally developed based on authors who customarily functioned from a CSM framework. As such, the subscales were not originally labeled as outcome expectancies but instead were labeled belief in the necessity of medications and belief about concerns about medications. Although these were developed from a CSM framework, they nonetheless are conceptually examining the same construct that is labeled outcome expectancies within a SCT framework. For the purposes of this dissertation, we will be using the BMQ as a measure of medication outcome expectancies and thus a measure of SCT beliefs rather than CSM beliefs despite the fact that the constructs fit within a CSM framework as well. Belief in the necessity of medications is henceforth labeled positive medication outcome expectancies (PMOE) whereas the concern about medications subscale is labeled negative medication outcome expectancies (NMOE). The PMOE scale consists of 5 items (e.g., my life would be impossible without my medicines) that exhibited acceptable reliability among cardiac patients $\alpha = .76$ in the original paper and good reliability in the current study, $\alpha = .89$. The NMOE scale also consists of 5 items (e.g., I sometimes worry about the long-term effects of my medicines) that exhibited good reliability in the original publication, $\alpha = .76$, and exhibited acceptable reliability in our current study, $\alpha = .67$.

Task self-efficacy for physical activity, which we will subsequently label physical activity self-efficacy (PASE) was assessed using a previously validated scale (Sniehotta, Scholz, & Schwarzer, 2005). The scale consists of 3 items that assess a person's confidence in his or her ability to live a healthy lifestyle. A sample item would be, "I am confident that I can be physically active at least once a week". Participants responded on a 0 to 3 point scale with 0 for not at all true to 3, exactly true. This measure exhibited good reliability in previous studies, $\alpha = 0.75$, and in the current study, $\alpha = .88$.

Medication adherence self-efficacy (MASE) was assessed using a scale devised to assess medication adherence self-efficacy among hypertensive patients (Ogedegbe et al., 2003). The original full scale consisted of a total of 26 items that asked patients to asses their confidence in there ability to take their medications all of the time for a variety of situations such as, "when you are busy at home". Based on concerns of patient burden, the medication adherence self-efficacy scale was trimmed to a total of 11 items. These items were chosen based on the factor analysis reported in the original paper that suggested a total of 5 different factors (Ogedegbe et al., 2003). The 11 items were the items that loaded best on the first factor that explained 57.2% of the total variance. This trimmed scale exhibited excellent reliability in the current study, $\alpha = .91$.

Physical activity was assessed using the International Physical Activity Questionnaire (IPAQ: Craig et al., 2003). This 7-item self-report questionnaire has been used in a number of different treatment studies and shown to have good psychometric properties (Spearman's ρ = .8). An example of the item includes "During the last 7 days, on how many days did you do vigorous physical activities?" This is then followed by a question about the length of time on average the person engages in the specific behavior. To help reduce possible over-reporting of behaviors, all participants were asked to identify the specific behavior (e.g., running) that they performed and believed was "vigorous physical activity." This was done to ensure that the categorization of the activity level conformed with actual exertion levels based on total level of METS a person uses when they engage in the behavior. The number of METS for each behavior was based on the Compendium of Physical Activities (Ainsworth et al., 2000), which lists the MET level of the most common activities people engage in. All interviewers were given a copy of this and told to reference it if they were unsure of the total amount of METS a given activity involved. Vigorous activity was defined as any activity with a total METS above 7, moderate active was defined as METS between 4 and 7 and walking was defined as METS between 3 and 4. Responses on these scales were then aggregated to calculate both a continuous scale of Total METS a person exerted throughout the week and a dichotomous measure that determined if they met American Heart Association recommendations for physical activity (Haskell et al., 2007). As there was a large skew to the total METS calculation, the dichotomous measure was used as the primary outcome variable. This was also used out of concerns of over-reporting and because of its clinical relevance.

Medication adherence was assessed using an 8-item version of the Morisky scale (Morisky, Green, & Levine, 1986). This scale has been used by other researchers to examine the relationship between beliefs and medication adherence (Mann et al., 2008).

It is a relatively simple measure that has been linked with other methods of assessing medication adherence including a pill count (Morisky et al., 1986). As such, it was used in this study because it is a quick and effective means of measuring medication adherence. Medication adherence was coded both as a continuous and dichotomous variable. Patients were determined to be adherent if they scored 7 or above on the 8 point scale. As 50.6%, $n = 42$, reported good adherence, the dichotomous measure was used as the primary outcome variable.

Analytic Plan

Exploratory factor analysis was used to assess the factor structure of the CSM beliefs and physical activity outcome expectancies. Principal components extraction was used with varimax rotation as this method has been shown to yield orthogonal factors that are often more readily interpretable compared to other extraction and rotation methods. Factors were used to create the corresponding scales used in all subsequent analyses. Inclusion in the scale was based on *a priori* theoretical expectations coupled with meeting a minimum of 0.50 loading on the factor. All scales were created by averaging the items that loaded in each factor.

Reliability was assessed using Cronbach's α. A number of statistical tools were used to assess bivariate associations depending on if the variables were dichotomous, categorical, or continuous. If both variables were continuous, Pearson Product correlations were calculated. If both items were dichotomous or categorical χ^2 analyses were used. Finally, if one variable was continuous and the other dichotomous, t-tests were used.

Logistic regression was used to test all hypotheses. Logistic regression was used rather than ordinary least squares regression for two reasons. Both the physical activity and medication adherence continuous scales exhibited non-normal distributions. In addition, the focus of this paper was primarily if patients were meeting recommended guidelines for health behaviors because that is most clinically relevant. As such, the dichotomous variables were thought to better reflect meeting recommended levels of medication adherence and physical activity.

Covariate selection was based on previous research and significant associations. Previous research suggested that age and medical history should both be considered as important covariates for analyses among CABG patients (Gump et al., 2001). In addition, age was found to be associated with both physical activity and medication adherence in our current sample (see results below). As such, age was included as a covariate for Hypotheses 1, 2, 3, 4, and 5.

To maximize statistical power, a cardiac risk factor index (CRFI) was created to capture a person's medical history related to cardiovascular disease in one measure. The patient's medical history was gathered from medical records and included dichotomous (yes/no) information regarding if the patient had a history of any of the following: angina, arrhythmia, myocardial infarction, congestive heart failure, cerebrovascular disease, diabetes, family history of coronary artery disease, hypertension, dyslipidemia, peripheral vascular disease, renal failure, past or current smoker, and current immunosuppressive therapy. These dichotomous variables (coded 0 and 1) were aggregated to form the CRFI. This technique has been used in previous research (Contrada et al., 2008).

To examine possible interactions, all main effects variables were first centered by calculating Z-scores. This conversion had no effect on the relative significance of associations found with non-Z-scores. All interaction terms were calculated by multiplying the two main effect variables of interest (e.g., symptoms by MASE). A full model of all interaction terms for predicting a given outcome variable was initially run. The trimmed model was subsequently run that included only those interaction terms that were significant within the full interaction model. If these items were significant, the log transformation of the predicted Odds Ratios (OR) for each participant was plotted on a scatterplot based on recommendations from Landau and Everitt (2004).

Results

Descriptive Statistics

Means, standard deviations, and/or frequency distributions of demographic, medical history, belief and behavior data are provided in Table 1. The average age was 65.4, *SD* 8.5, 73%, n = 65, were male, and the majority of the sample was white 73%, n =65. Of those who reported their income (*n* = 69), 59.3%, n = 28, had an average household income at or above 50k per year. Of the 82 participants that reported employment status, a total of 40.6%, n = 36, were currently employed either full or part-time. Finally, 65.8%, n =52, of subjects were married/living with someone out of the 79 that reported martial status.

Factor Analysis

Exploratory factor analyses with principal components extraction and varimax rotation were used to examine the factor structure of all CSM beliefs. Inclusion of an item into a scale was based on *a priori* theoretical expectations and a loading of 0.50. Table 2 presents the results of a factor analysis of items that were adapted from the IPQ-R. Results suggest the majority of items loaded on factors as expected thereby identifying the following factor labels: chronic timeline, consequences, curability, and personal control. Correlations between each scale can be found in Table 6 and 7. Each scale, which was formed by unit weighting and then averaging, had acceptable internal consistency reliability (i.e., *αs* between 0.65 to 0.90).

The same method of factor analysis was used to examine causal beliefs alone, as suggested by the authors of the IPQ-R (Moss-Morris et al., 2002), As can be seen in Table 3, results suggest two causal belief factors, emotional cause beliefs ($\alpha = 0.75$) and medical cause beliefs($\alpha = 0.76$). This distinction between emotional beliefs and medical beliefs is in line with previous research (Gump et al., 2001; Hekler et al., 2008). These two scales exhibited a small correlation, $r = 0.26$, $p < 0.05$. As these two factors likely capture different beliefs about the cause of heart disease, both factors were included in all regression models examining CSM beliefs.

Table 4 summarizes the factor analysis of the symptom items alone. Principal components factor analysis with varimax rotation revealed three factors reflecting an emotional symptom scale ($\alpha = .89$), a chest symptoms scale ($\alpha = 0.94$), and a fatigue symptoms scale ($\alpha = 0.70$). The symptom subscales exhibited small to moderate correlations (*rs* between 0.37 to 0.55). Correlations between symptom subscales can be found in Table 7. Based on the small to moderate associations between subscales and the good reliability of the full set of symptoms items ($\alpha = 0.89$), the full scale was used as a predictor in all initial analyses to minimize the loss of degrees of freedom within all regression analyses except hypotheses 4, which specifically examines the different influence of each symptom cluster.

Table 5 summarizes the results of the physical activity outcome expectancies scales. Results suggest a three factor solution related to bed rest outcome expectancies ($\alpha = 0.87$), physical activity emotional outcome expectancies ($\alpha = 0.74$) and physical activity health outcome expectancies ($\alpha = 0.65$). The physical activity emotional outcome expectancies and physical activity health outcome expectancies scales were not significantly correlated, $r = 0.14$. Nonetheless, in the interest of statistical power a scale that combined emotional physical activity outcome expectancies and health physical activity outcome expectancies was created and used in all regression analyses in conjunction with the bed rest outcome expectancies scale. The combined physical activity outcome expectancies scale exhibited acceptable reliability ($\alpha = 0.68$). In addition, the full scale physical activity outcome expectancies and bed rest outcome expectancies scales were inversely correlated, $r = -0.25$.

All of the aforementioned factors were used to calculate scale scores by averaging the items within in each factor. This resulted in the use of the following scales to reflect CSM beliefs: symptoms, chronic timeline, personal control, curability, treatment control, consequences, medical cause beliefs and emotional cause beliefs. Physical activity outcome expectancies were examined using the physical activity outcome expectancies scale and the bed rest outcome expectancies scales. Physical activity self-efficacy, MASE, and medication outcome expectancies were based on previously validated scales and described earlier.

Bivariate Correlations

Covariate correlations

Married/cohabiting patients reported significantly lower income compared to nonmarried individuals (t = -2.44, p < .05, $M_{M/Cohab}$ = 4.94 (40k-50kAv), M_{nonMar} = 6.29 (60k-70kAv); all other variables *NS ps* > 0.15). Unemployed/retired individuals were older compared to employed individuals (t = 4.70, p < .001, M_{emp} = 60.81, $M_{notempl}$ = 68.70; all others variables *NS ps* > 0.06). White participants exhibited higher levels of depression relative to other ethnic groups (t = 2.03,df = 86, p < .001, M_{white} = 11.71, $M_{notwhite}$ = 7.52; all others variables *NS ps* > 0.10). Age and income were inversely associated (r = -0.31, df = 87, p < 0.01). Education and income were marginally positively associated, r = 0.21, df = 87, p = 0.053. Age was positively associated with medication adherence, r = 0.22, p < 0.05, and inversely associated with physical activity, r = -0.22, p < 0.05. No other covariate was significantly associated with medication adherence or physical activity.

Bivariate associations linking covariates to predictors and outcomes

Table 6 presents bivariate associations between symptoms, beliefs, and health behaviors. The following symptom/beliefs exhibited moderate associations between each other: symptoms and emotional cause beliefs, r = 0.54, df = 87, p < 0.01, consequences and treatment control, r = 0.45, df = 87, p < 0.01, physical activity outcome expectancies and physical activity self-efficacy, r = 0.49, df = 87, p < 0.01, symptoms and depression, r = 0.68, df = 87, p < 0.01, emotional cause beliefs and depression, r = 0.48, df = 87, p < 0.01.

Table 7 presents the correlation matrix for symptom subscales, belief subscales and health behaviors. There were several subscales that were moderately correlated. Cardiac symptoms was moderately correlated with fatigue, $r = 0.47$, $df = 87$, $p < 0.01$. Psychological symptoms was correlated with fatigue, $r = 0.55$, $df = 87$, $p < 0.01$, emotional cause beliefs, $r = 0.61$, $df = 87$, $p < 0.01$, and depression, $r = 0.71$, $df = 87$, $p < 0.01$.

Bivariate correlations were calculated between belief and behavior variables and can be reviewed in Table 6. As dichotomous measures of medication adherence and physical activity were computed to be used later as outcome variables in logistic regression, t-tests were used to confirm the associations between (continuous) belief and (dichotomous) behavior measures. The medical and the emotional cause models along with the treatment control and NMOE were inversely associated with medication adherence, $t = 2.29$, $df = 81$, $p < 0.05$, $M_{+Ad} = 1.31$ $M_{-Ad} = 1.75$; $t = 2.55$, $df = 81$, $p < 0.05$, $M_{+Ad} = 0.63$ $M_{-Ad} = 0.87$; $t = 2.56$, $df = 81$, $p < 0.05$, $M_{+Ad} = 1.90$ $M_{-Ad} = 2.47$; $t = 3.49$, $df = 81$, $p < 0.01$, $M_{+Ad} = 0.79$ $M_{-Ad} = 0.95$ respectively. MASE was positively associated with medication adherence $t = -2.94$, $df = 81$, $p < 0.01$, $M_{+Ad} = 1.88$ $M_{-Ad} = 1.67$. All other beliefs were not significantly associated with medication adherence $ps > 0.08$. Symptoms, emotional cause beliefs, personal control, and physical activity outcome expectancies were positively associated with engagement in the recommended amount of physical activity $t = -2.22$, $df = 85$, $p < 0.05$, $M_{+PA} = 0.83$ $M_{-PA} = 0.45$; $t = -2.13$, $df = 85$, $p < 0.05$, $M_{+PA} = 0.87$ $M_{-PA} = 0.47$; $t = -2.58$, $df = 85$, $p < 0.05$, $M_{+PA} = 3.68$ $M_{-PA} = 3.29$; and $t = -3.03$, $df = 85$, $p < 0.01$, $M_{+PA} = 3.45$ $M_{-PA} = 3.08$ respectively. Bed rest outcome expectancies were inversely associated with physical activity, $t = 2.44$, $df = 85$, $p < 0.05$, $M_{+PA} = 1.44$ $M_{-PA} = 2.05$.

Logistic Regression Analysis

Logistic regression was used to test each hypothesis. Medication adherence was dichotomized as either good adherence (i.e., at least a 7 out of 8 on the Morisky Scale) or poor adherence. Physical activity also was dichotomized; individuals who reported meeting the AHA's recommended amount of physical activity per week (i.e., at least 30 minutes for 5 days per week of brisk walking or moderate intensity exercise or 20 minutes at least 3 days per week of vigorous activity) were labeled as physically active whereas those that did not report this minimum amount of physical activity were labeled inactive. Age and the Cardiac Risk Factor Index (CRFI) were included as covariates in main effects models; age because it was associated with both health behaviors, and the CRFI as it is an efficient means of controlling for health status. Age and the CRFI were not included in analyses of moderation effect based on concerns about statistical power. As emotional cause beliefs and symptoms exhibited a correlation above 0.50, all logistic regression analyses were run in which both were initially in the model and then emotional cause beliefs were subsequently dropped out of concerns of colinearity and to test for possible mediational pathways.

Hypothesis 1: Commonsense model factors (i.e., symptoms, curability, personal control, chronic timeline, consequences, medical cause beliefs, emotional cause beliefs) will be associated with medication adherence and physical activity after controlling for influential demographic and biomedical data.

Table 8 and 9 summarize results testing Hypothesis 1 in which the CSM alone was used to predict physical activity and medication adherence after controlling for age and medical history. Results suggest CSM beliefs significantly add to an overall model of physical activity beyond age and the cardiac risk factor index, $\chi^2 = 23.05$, $p < 0.01$. Personal control was positively associated with physical activity *OR* = 3.848 *CI* = 1.23 to 9.88, $p < 0.05$. Medical cause beliefs were inversely associated with physical activity *OR* = 0.34, *CI* = 0.15 to 0.76, $p < 0.01$. Finally, there was a trend towards a positive association between emotional cause beliefs and physical activity, *OR* = 2.71, *CI* = 0.90 to 8.20, $p = 0.08$. When emotional cause beliefs were dropped from the equation based on concerns of multiple collinearity, symptoms and personal control were both positively associated with physical activity, *OR* = 4.04, *CI* = 1.31 to 12.51, $p < 0.05$, and *OR* = 3.07, *CI* = 1.13 to 8.37, $p < 0.05$, respectively, whereas medical cause beliefs was inversely associated with physical activity, *OR* = 0.37, *CI* = 0.17 to 0.80, $p < 0.05$. These results are summarized in Table 8a.

Results suggest CSM beliefs do not significantly add any predictive utility beyond age and cardiac risk factor index in predicting medication adherence, $\chi^2 = 12.12$, $p = 0.14$. Nonetheless, examination of specific variables suggest a nonsignificant trend for an inverse association between treatment control and medication adherence *OR* = 0.60, *CI* 0.33 to 1.09, $p = 0.09$; all other CSM beliefs *NS*, *ps* > 0.11. When emotional cause beliefs were dropped from the equation based on concerns about multicolinearity, the overall model still did not predict medication adherence beyond age and the cardiac risk factor index $\chi^2 = 11.09$, $p = 0.14$. In addition, the trend for an inverse association between treatment control and medication adherence more closely approached significance, *OR* = 0.56, *CI* 0.31 to 1.00, $p = 0.051$, and a nonsignificant trend appeared for an inverse association between medical cause beliefs and medication adherence *OR* = 0.60, *CI* 0.33 to 1.09, $p = 0.09$.

In summary, results indicate that Hypothesis 1 is partially supported as CSM beliefs do significantly predict physical activity after controlling for age and medical history but they do not predict medication adherence. Examination of the specific CSM variables that are associated with physical activity include personal control. In addition, symptoms and medical cause beliefs were both associated with physical activity when emotional cause beliefs were excluded.

> Hypothesis 2: Social cognitive beliefs (i.e., self-efficacy, outcome expectancies) will be associated with medication adherence and physical activity after controlling for demographics.

Results suggested that SCT beliefs significantly added to the overall predictive model of physical activity beyond age and the cardiac risk factor index, $\Delta\chi^2 = 11.97$, $p < 0.05$. Results also suggested a nonsignificant trend toward a positive association between physical activity outcome expectancies and physical activity, *OR* = 3.08, *CI* = 0.94 to 10.05, $p = 0.06$, whereas there was a nonsignificant trend toward an inverse association between bed rest outcome expectancies and physical activity, *OR* = 0.58, *CI* = 0.33 to 1.04, $p = 0.07$, other SCT beliefs *NS, ps* > 0.63. Results of this regression analysis are summarized in Table 10.

Table 11 summarizes results testing Hypotheses 2 with regards to medication adherence. Results suggest SCT beliefs, as a group, significantly predicted medication adherence beyond age and medical history $\Delta\chi^2 = 18.28$, $p < 0.001$. Examination of effects of specific variables suggested an inverse association between NMOE and medication adherence, *OR* = 0.45, *CI* 0.24 to 0.84, $p < 0.05$, whereas an association between medication adherence self-efficacy and medication adherence just failed to reach significance *OR* = 7.72, *CI* 0.97 to 61.54, $p = 0.05$; positive outcome expectancies *NS*, $p = 0.84$. Further, when NMOE was excluded from the model, MASE was associated with medication adherence, which suggests that NMOE may be statistically mediating the relationship between MASE and medication adherence.

In summary, results for Hypothesis 2 indicated that SCT significantly add to the overall predictive model of medication adherence but not to physical activity. Results suggest that NMOE was a key factor for predicting medication adherence. In addition, MASE just failed to reach significance ($p = 0.05$).

Hypothesis 3: CSM beliefs as a set will add significant predictive utility beyond SCT beliefs for predicting health behaviors.

Table 10 summarizes results of logistic regression analyses testing Hypothesis 3 for physical activity. CSM beliefs significantly added to the overall predictive model beyond SCT beliefs, $\Delta\chi^2 = 21.40$, $p < 0.01$. Emotional cause beliefs, cure beliefs, and personal control were each positively associated with physical activity after controlling for SCT beliefs, though effects were statistically significant only for the emotional cause and cure belief variables, *OR* = 5.75, *CI* = 1.42 to 23.30, $p < 0.05$, *OR* = 2.23, *CI* = 1.04

to 4.78, $p < 0.05$, and $OR = 2.90$, $CI = 0.90$ to 9.23, $p = 0.07$. There also was an inverse association between medical cause beliefs and physical activity, $OR = 0.33$, $CI = 0.13$ to 0.82, $p < 0.05$. In addition, there was an inverse association between bed rest outcome expectancies and physical activity, $OR = 0.48$, $CI = 0.23$ to 1.00, $p < 0.05$. When emotional cause beliefs were dropped from the equation, the symptoms scale was positively associated with physical activity, $OR = 3.24$, $CI = 1.04$ to 10.08, $p < 0.05$, whereas medical cause beliefs was inversely associated with physical activity, $OR = 0.42$, $CI = 0.19$ to 0.95, $p < 0.05$. All other CSM and SCT beliefs were not associated with physical activity, *ps* > 0.10.

Table 11 summarizes results for analyses testing Hypothesis 3 for medication adherence. CSM beliefs did not significantly predict medication adherence beyond SCT beliefs, $\Delta\chi^2 = 12.02$, $p = 0.15$. Examination of effects for individual predictors indicated that NMOE was inversely associated with medication adherence, $OR = 0.35$, *CI* 0.16 to 0.80, $p < 0.01$. Of CSM beliefs there was a nonsignificant trend toward a positive relationship between both curability and chronic timeline with medication adherence, $OR = 1.72$, *CI* 0.91 to 3.26, $p = 0.09$, and $OR = 1.70$, *CI* 0.93 to 3.11, $p = 0.08$, respectively. In addition, there was a nonsignificant trend toward an inverse association between treatment control and medication adherence, $OR = 0.55$, *CI* 0.28 to 1.09, $p = 0.09$.

To summarize the results for Hypothesis 3, CSM beliefs significantly predicted physical activity whereas SCT beliefs significantly predicted medication adherence. When all variables were in the model, emotional cause beliefs, medical cause beliefs, and curability were CSM beliefs that significantly predicted physical activity. In addition, bed rest outcome expectancies was inversely associated with physical activity. However, when emotional cause beliefs were removed from the model, symptoms and medical cause beliefs were the only factors that significantly predicted physical activity. This is consistent with results seen when examining CSM beliefs alone. With regard to medication adherence, NMOE was the only variable that was associated with medication adherence. Further, MASE was predictive when NMOE was dropped from the model suggesting that NMOE statistically mediated the relationship between MASE and medication adherence.

> Hypothesis 4: Cardiac symptoms will be positively associated with medication adherence and physical activity, whereas psychological and fatigue symptoms will be inversely associated with medication adherence and physical activity, after controlling for influential demographic and biomedical predictors.

Table 12 summarizes results of logistic regression examining Hypothesis 4 with physical activity as the outcome variable. There was a nonsignificant trend toward a positive association between cardiac symptoms and physical activity, $OR = 2.33$, $CI = 0.98$ to 5.51, $p = 0.06$. Table 13 summarizes results of logistic regression examining Hypothesis 4 with medication adherence as the outcome variable. No subset of symptoms significantly predicted medication adherence, $ps > 0.10$.

> Hypothesis 5: If a patient's self-described "most troubling symptom" is attributed to cardiac disease by the patient, the patient will be more adherent to recommended medications and physical activity levels than will be the case for patients who either attribute their most troubling symptom to some other cause (e.g., mental problem, physical activity, other disease) or are asymptomatic.

Logistic regression analyses are summarized in Table 14 and 15. After controlling for age and CRFI, symptom attribution did not significantly predict either physical activity or medication adherence. This was true when all CSM beliefs were added to the regression model.

> Hypothesis 6: Symptoms will moderate the association between each of CSM beliefs and SCT beliefs on health behaviors (i.e., medication adherence, total physical activity).

Table 16 summarizes logistic regression analyses examining the interaction of symptoms with both CSM and SCT beliefs. All continuous main-effect variables were centered by calculated Z-scores. In Step 1 only main effects were entered into the model. Initially, all interaction terms between symptoms and beliefs were entered in Step 2. A second trimmed model was then run based on those variables that significantly predicted physical activity in the full model. This was done to help reduce Type I error. Table 16 summarizes this trimmed interaction model. Symptoms significantly moderated the relationship between both physical activity self-efficacy and bed rest outcome expectancies with physical activity. Figure 2 provides a graphic depiction of the interaction between symptoms and physical activity self-efficacy. Physical activity self-efficacy was positively associated with physical activity only for patients who had relatively high symptom scores. Physical activity self-efficacy was not associated with physical activity for patients with relatively low symptom scores. Figure 3 provides a graphic depiction of the interaction between symptoms and bed rest outcome expectancies. As with physical activity self-efficacy, the relationship between bed rest outcome expectancies and physical activity was only significant among those patients that were symptomatic. For symptomatic patients, bed rest outcome expectancies was not associated with physical activity.

The same trimming procedure described above was used to examine the interaction between symptoms and beliefs as they relate to medication adherence. With all interaction terms in the model, no interaction was significantly associated with medication adherence and step 2 did not significantly predict medication adherence beyond the main effects variables $\Delta\chi^2 = 10.29$, $p = 41$.

Discussion

The purpose of this study was to examine the utility of combining Leventhal' Commonsense Model of Self-regulation (CSM) and Bandura's Social Cognitive Theory (SCT) for predicting physical activity and medication adherence. A cross-sectional, correlational design was used to provide a preliminary test of hypotheses in a sample of patients about to undergo coronary artery bypass surgery. Results generally suggest that the CSM alone is effective at predicting physical activity whereas Bandura's SCT is effective at predicting medication adherence. In addition, integrating the CSM and SCT was found to be an effective strategy for predicting physical activity. In particular, symptoms – a key construct within CSM – moderated the relationship between both self-efficacy and outcome expectancies – key constructs of SCT – and physical activity. Specifically, physical activity self-efficacy and bed rest outcome expectancies were only associated with physical activity when patients were symptomatic. Among asymptomatic patients, SCT beliefs were not associated with physical activity. This moderating effect of symptoms on the relationship between both self-efficacy and outcome expectancies and physical activity has important implications for the design of future interventions among patients undergoing CABG surgery. A large number of studies designed to predict and promote physical activity among patients with heart disease have been based on SCT, with a particular emphasis on promoting self-efficacy (Woodgate & Brawley, 2008). Results of the current study suggest that these interventions may be less effective among asymptomatic cardiac patients. Other strategies, based on the CSM, may be more appropriate for physical activity promotion among asymptomatic patients with heart disease.

Main Effect Hypotheses

Results partially supported Hypothesis 1 in that CSM beliefs as a set significantly predicted physical activity but not medication adherence. Personal control was positively associated with physical activity, whereas medical cause beliefs were inversely associated with physical activity. In addition, there was a trend for a positive association between emotional cause beliefs and physical activity. Further, symptoms were positively associated with physical activity when emotional cause beliefs were not in the model, which could reflect a sequence in which the direct effect of symptoms is being partially mediated by emotional cause beliefs.

The positive association between personal control and physical activity is in accord with other studies (French et al., 2006; Searle et al., 2007b) and fits with *a priori* expectations. The inverse association between medical cause beliefs and physical activity is counter to expectations and previous research (Gump et al., 2001). The lack of association between chronic timeline, consequences, treatment control, and curability is counter to expectations but may be an issue of statistical power as the overall effect size of the influence of these constructs on health behaviors is generally small (French et al., 2006). Therefore, a larger sample may have provided sufficient statistical power to find significant associations between these CSM beliefs and physical activity.

With regard to the relationship between symptoms, emotional cause beliefs, and physical activity, results suggested a moderate correlation between symptoms and emotional cause beliefs. In addition, emotional cause beliefs were predictive of physical activity in the full model. This coupled with results that suggest symptoms were positively associated with physical activity but failed to be significant when emotional cause beliefs were entered into the model suggests that emotional cause beliefs were statistically mediating the relationship between symptoms and physical activity (Baron & Kenny, 1985). An association between symptom severity and causal beliefs has been found in other studies (L. D. Cameron, K. J. Petrie, C. Ellis, D. Buick, & J. A. Weinman, 2005a). In addition, Leventhal has suggested that symptoms may influence behaviors differently depending on a person's illness beliefs (H. Leventhal & Mora, 2008). As such, it is plausible that as symptoms increase, this activates a person's beliefs about the impact of emotion on heart disease. These people with high symptoms may start to perceive heart disease to be caused by these emotional factors such as stress, which has been found in work among patients with hypertension (Hekler et al., 2008). Based on this belief, patients may then be more likely to be physically active in an attempt to alleviate the symptoms and subsequent heart disease.

The null results linking CSM beliefs with medication adherence, although counter to expectations are not unprecedented in the literature. While some studies have linked CSM beliefs with medication adherence (Brewer et al., 2002; Mann et al., 2008; Ross et al., 2004; Searle et al., 2007a; Senior et al., 2004) others have not (Bean et al., 2007; Byrne et al., 2005; Hekler et al., 2008). Further, there was significant variability with regard to the CSM belief that was associated with medication adherence across studies. For example, in some studies personal control was positively associated with medication adherence (Mann et al., 2008; Senior et al., 2004) whereas others found an inverse association between personal control and medication adherence (Ross et al., 2004) or no association (Brewer et al., 2002). Although this is at least partially attributable to the different but related chronic disease states assessed in each study, it nonetheless suggests that further examination of the relationship between CSM constructs and medication adherence among cardiac patients is in order.

Results also provided partial support for Hypothesis 2 as SCT factors predicted medication adherence but not physical activity. Negative medication outcome expectancies (NMOE) was inversely associated with medication adherence, and there was a near significant positive association between MASE and medication adherence that was significant when NMOE was not in the equation. These results are in line with other studies that have linked NMOE with medication adherence (Byrne et al., 2005; Mann et al., 2008; Ross et al., 2004). In addition, the near significant association between MASE and medication adherence also fits with previous research that found a significant association (Bean et al., 2007; Mann et al., 2008).

Negative medication outcome expectancies and MASE were bivariately associated. In addition, NMOE was inversely associated with medication adherence. These results coupled with findings that MASE significantly predicted medication adherence when NMOE was not in the regression model suggests that NMOE was statistically mediating the relationship between MASE and medication adherence (Baron & Kenny, 1985). This is in line with theoretical reasoning laid out by the CSM (H. Leventhal & Mora, 2008). Specifically, Leventhal and Mora suggest that outcome expectations of a behavior are likely to be of prime importance for motivation to engage in a behavior because these outcome expectancies define the value of the behavior. For example, a person will likely not engage in physical activity if they do not perceive some benefit from it such as health benefits. Based on this line of reasoning, it is understandable that NMOE mediated the relationship between MASE and medication adherence. Self-efficacy will likely only be important if a person perceives that being adherent to medications is more beneficial than costly to them.

Results suggesting no significant associations between SCT beliefs and physical activity are counter to expectations and previous research (Williams et al., 2005; Woodgate & Brawley, 2008). These nonsignificant results are better accounted for however when symptom status is taken into account. Specifically, when patients are symptomatic, physical activity self-efficacy and bed rest outcome expectancies are both associated with physical activity in the anticipated direction. Therefore it is likely that the lack of a main effect of these constructs on physical activity is at least partially due to a relatively high portion of participants that were asymptomatic, 32.6% of the sample. This interaction is discussed in more detail below.

Results give partial support for hypothesis 3 as CSM beliefs added predictive utility beyond SCT beliefs when predicting physical activity but not medication adherence. CSM beliefs significantly add beyond SCT beliefs to the overall predictive model for physical activity. Specifically, when all variables were entered into a regression model, emotional cause beliefs and cure beliefs were positively associated with physical activity whereas medical cause beliefs and bed rest outcome expectancies were inversely associated with physical activity. As was found when examining CSM beliefs alone, emotional cause beliefs statistically mediated the relationship between symptoms and physical activity because symptoms were positively associated with physical activity when emotional cause beliefs were dropped from the equation.

With regard to SCT beliefs predicting medication adherence, results were similar when SCT beliefs were examined alone compared to when both SCT and CSM beliefs were in the model. Specifically, NMOE was inversely associated with medication adherence. Although the trend between MASE and medication adherence was not apparent in the full model, when NMOE was dropped from the model, MASE was significantly associated with medication adherence. This further reinforces the conclusion that NMOE is statistically mediating the relationship between MASE and medication adherence.

As was reviewed above, these associations between NMOE and MASE with medication adherence are in line with previous research (Bane et al., 2006; Byrne et al., 2005; Horne & Weinman, 1999; Mann et al., 2008; Ross et al., 2004). In addition, the null findings for CSM beliefs predicting medication adherence are likely the result of similar issues of statistical power and potential problems with the differential influence of beliefs including personal control on medication adherence as was suggested by previous research (Brewer et al., 2002; Mann et al., 2008; Ross et al., 2004; Senior et al., 2004).

Results did not support Hypotheses 4 and 5. Specifically, the symptom subscales (i.e., cardiac symptoms, emotional, and fatigue) did not differentially predict either physical activity or medication adherence. With regard to physical activity, this was likely a problem of statistical power as there was a trend for a positive association between cardiac symptoms and physical activity. This was the anticipated association, which therefore suggested that a larger sample would have likely found significant results. The lack of association between different types of symptoms and medication adherence is counter to expectations. This may be due to a problem of statistical power or it may due to the differential influence of symptoms depending on beliefs as suggested by Leventhal (H. Leventhal & Mora, 2008). For example, a person may be symptomatic but may also believe that medications cause more harm than good to their illness because of all of the side-effects. For these people, symptoms would be a sign to take medications LESS. This interactive relationship between symptoms and beliefs was tested however in the current study and lead to nonsignificant results. Nonetheless, the pathway is still plausible and may have been related to a broader illness schema that was not captured within our measures.

Results do not support Hypothesis 5 as there was no association between symptom attribution of an individual's most troubling symptom and either physical activity or medication adherence after controlling for age and the CRFI. These results are counter to expectations because it was hypothesized that patients who attribute their most troubling symptom to heart disease will likely have activated illness beliefs and behavioral beliefs related to heart disease. This activation was believed to increase engagement in health behaviors known to impact heart disease such as medication adherence. This null finding may be attributed to poor statistical power or to a possible interaction between symptoms and beliefs as discussed above and suggested by

Leventhal and Mora (2008). Further examination of the possible interaction between symptom attribution and beliefs is in order.

Interaction Hypotheses

Results supported Hypothesis 6 when predicting physical activity but not medication adherence. Symptoms moderated the effects of self-efficacy beliefs on physical activity. Specifically, PASE was positively associated with physical activity only when symptoms were high. For patients with little or no symptomatology, PASE was not associated with physical activity. In addition, the relationship between bed rest outcome expectancies and physical activity was moderated by symptoms. Specifically, if a person was symptomatic, bed rest outcome expectancies were inversely associated with physical activity. If a person was asymptomatic bed rest outcome expectancies was not associated with physical activity. Results suggested symptoms did not interact with beliefs when predicting medication adherence.

As stated above, PASE has been linked with physical activity and used as a primary factor to change in intervention research (Bandura, 1997; Woodgate & Brawley, 2008). The present findings suggest that self-efficacy only influences health behaviors when a person is symptomatic. This is likely due to the motivational influence of symptoms for promoting health behaviors. Individuals that are symptomatic recognize the need to engage in health behaviors as a way to influence the symptoms. Among these symptomatic individuals, cognitive factors, including self-efficacy and outcome expectancies, will influence health behaviors. These cognitive factors, however, do not have any impact on behaviors when a person is asymptomatic because there is likely no strong motivational factor to focus more time and energy on engagement in the health behaviors.

Although the potential interaction between symptoms and different forms of self-efficacy have been suggested in the literature (e.g., Woodgate & Brawley, 2008), to the best of the current author's knowledge, this study is the first that examined the interaction between symptoms and self-efficacy when predicting physical activity among cardiac patients. This finding fits well within an integrated CSM and SCT framework.

The relationship between symptoms, self-efficacy, outcome expectancies, and physical activity is likely influenced by dispositional characteristics such as neuroticism or trait negative affectivity. Previous research has linked trait negative affect to increased awareness of illness-specific symptoms among asthma patients (Mora, Halm, Leventhal, & Ceric, 2007). In addition, previous research has highlighted the important moderating influence of trait negative affect on the relationship between CSM beliefs and health behaviors (L. D. Cameron et al., 2005b; Petrie et al., 2002). Specifically, trait negative affect was found to moderate the impact of an intervention designed to change CSM beliefs. Results suggested that for those high in trait negative affect, the intervention reduced worry but also resulted in reduced exercise and increased fat intake relative to those that were low on trait negative affect or who were in the control condition.

This previous research coupled with results of this study suggesting that symptoms is mediated by emotional cause beliefs and moderates the influence of self-efficacy and outcome expectancies on physical activity suggests a causal pathway from disposition, to present symptoms, to beliefs, to behaviors. Specifically, trait negative affect increases a person's monitoring of illness specific symptoms. These illness-specific symptoms influence both beliefs about the cause of an illness and interact with self-efficacy and outcome expectancies. These beliefs all in turn influence engagement in physical activity. This line of reasoning is further reinforced by the moderate association found between symptoms and depression – arguably a proxy of trait negative affect – in our study. This hypothesized full causal pathway should be further examined in a longitudinal study that could better parse out this full mediational pathway.

Within the social cognitive realm, task and self-regulatory self-efficacy have been found to predict health behaviors (Bandura, 1997; Woodgate & Brawley, 2008). In addition, several interventions focusing on self-efficacy have been shown to be effective for promoting health behaviors (Allison & Keller, 2004; Izawa et al., 2005; Sniehotta, Scholz, Schwarzer, Fuhrmann, Kiwus, & Voller, 2005). Although these studies suggest the importance of self-efficacy, the effect sizes are relatively small suggesting room for inclusion of other constructs to improve promotion of health behaviors.

It is plausible to hypothesize that the relatively small effect sizes of these interventions occurred at least partially because of a lack of focus on the influence of symptoms. Specifically, our results suggest that interventions promoting health behaviors via self-efficacy will only be effective for patients that are relatively symptomatic. For patients that are asymptomatic, the promotion of self-efficacy will likely have little impact on engagement in health behaviors. Therefore, an intervention focused on something other than self-efficacy is likely important.

The CSM suggests that several factors, including symptoms, objective health indicators (e.g., blood pressure) and, level of functioning, will all play an important role in motivating health behaviors as each offers feedback about a person's health status.

Based on this conceptualization, beliefs will likely have little impact on behaviors unless a patient has some health indicator that will function to motivate engagement in health behaviors. Therefore, asymptomatic individuals require some other means of monitoring their health that will function to motivate engagement in health behaviors prior to the use of any interventions that will promote changes in beliefs. A likely intervention to be used could be self-monitoring of success for specific behaviors and activities that a patient might find gratifying alone (McAndrew et al., 2008). For example, among patients with asthma an intervention was designed that helped patients better monitor their daily functioning by becoming more aware of their ability to do things like climb stairs. This type of intervention is thought to be effective as it gives the necessary feedback required to reinforce the efficacy of the health behaviors for influencing the illness. Interventions like this, such as monitoring of functioning, would likely be an effective strategy for promoting increased physical activity among asymptomatic cardiac patients.

Limitations

This study had several limitations. First, the design was cross-sectional and therefore cannot support causal interpretations. In addition, our sample is relatively small (N=89) and thus statistical power to run models with multiple covariates was limited. Generalizability of our sample is limited potentially limited. We attempted to recruit all patients being seen at Robert Wood Johnson University Hospital during the recruitment period. Our data suggests that we contacted approximately two thirds of all subjects being seen for bypass surgery between December 2006 and June 2008. During recruitment for this study, another study started that was given top priority for recruiting CABG surgery patients. As such, our percentage of those that we could contact dropped dramatically. Finally, of those that we could contact, we recruited approximately half. As such, generalizability of our sample is questionnable. Nonetheless, we did recruit both urgent and elective surgery patients and therefore likely saw a broader range of subjects than would have otherwise been found if we had only focused on either just urgent or elective subjects. Further, our data suggests that there were no differences between those recruited and not with regard to gender or ethnicity thus provide some evidence that our sample was at least someone representative of those patients been seen at Robert Wood Johnson University Hospital.

Regarding measurement issues, behaviors were assessed by interview. Thus we cannot be certain if patients were actually engaging in the behaviors to a degree that corresponds with their self-report. Self-report measures tend to over-estimate the degree to which a person engages in behaviors such as adherence to medications (Osterberg & Blaschke, 2005). Nonetheless, self-report measures of adherence are simple, inexpensive, reflect what clinicians rely upon in clinical practice, and have been found to be useful in previous research. In addition, our behavioral measures have been validated and compared with other more objective means of assessing both medication adherence and physical activity (Craig et al., 2003; Morisky et al., 1986).

In addition, several of our measures were either adapted or created for this project. For example, the IPQ-R was adapted to better conform to beliefs of patients undergoing CABG surgery. Although this aligns with general recommendations from the authors of the IPQ-R (Moss-Morris et al., 2002), it nonetheless creates some degree of uncertainty with regard to the reliability of the measures. Despite this, factor analyses suggested that the majority of items clustered into the appropriate factors and resulted in good overall reliability. Besides these scales, a scale was created to better reflect physical activity outcome expectancies and bed rest outcome expectancies. Although there are other validated scales of physical activity outcome expectancies, we chose to create our own scales based on an interest in the possible distinction between physical activity outcome expectancies and bed rest outcome expectancies. Our factor analyses resulted in a measure that met our *a priori* expectations and suggested important distinctions in predicting physical activity between physical activity outcome expectancies and bed rest outcome expectancies. Other scales including the treatment control scale (Gump et al., 2001), the task physical activity self-efficacy scale (Sniehotta, Scholz, & Schwarzer, 2005; Sniehotta, Scholz, Schwarzer et al., 2005), the medication adherence self-efficacy (MASE) scale (Ogedegbe et al., 2003), and outcome expectancies for medications (Horne et al., 1999) were all previously validated measures that exhibited good reliability within our sample.

Future Directions

As suggested above, current results require validation using a longitudinal design. Follow-up data for this project are currently being collected. The final dataset will include data about symptoms, beliefs and behaviors collected prior to surgery, directly following surgery while the patient is still in the hospital, and 3-months post surgery. These three time points allows for longitudinal examination of the impact of changes in symptoms and beliefs on behaviors three months later. As suggested by others, (Weinstein, 2007) this type of design will allow for a better examination of the impact of beliefs on behaviors, particularly because the health behaviors are – in essence – set to a similar baseline across participants when in the hospital. Besides future prospects of the current study, additional research should examine the potential link between trait negative affect, symptoms, beliefs, and behaviors as described earlier.

Besides descriptive studies, interventions should be developed among bypass surgery patients that are tailored to a patient's symptom status. For symptomatic patients, previously validated interventions that promote physical activity via SCT constructs will likely continue to be effective. For those patients that are asymptomatic however, other interventions based on the CSM will likely be more appropriate (McAndrew et al., 2008). For example, asymptomatic patients can be taught to monitor improvements in level of functioning in an effort to link the health behaviors with health improvements related to the illness.

Conclusion

Overall, results suggest that integrating the CSM with SCT provides a useful framework for understanding both medication adherence and physical activity. Of particular interest is the moderating effect symptoms – a key component of the CSM – have on the relationship between self-efficacy and physical activity. Self-efficacy has been shown in a variety of contexts to be one of the key factors that predicts physical activity. Our current results suggest that self-efficacy only impacts health behaviors when a person is symptomatic. This is likely due to the motivational influence symptoms plays in promoting health behaviors. Specifically, individuals that are symptomatic recognize the need to engage in health behaviors to help alleviate the symptoms. Therefore, cognitive factors including self-efficacy and possibly others such as outcome expectancies influence engagement in health behaviors only after these motivational factors come into play.

Future research is required to examine prospective associations between beliefs and behaviors. Included within these studies should be a more thorough temporal examination of possible mediators and moderators of treatment. Data collection of follow-up data is currently underway for the current dataset and should be completed by September. Included with this data will include three interview sessions, one prior to surgery, one directly after surgery while the participant is still in the hospital, and one three months post surgery. This design will allow for a prospective, correlational examination of the impact of symptoms and beliefs on behavior. Beyond longitudinal analyses of the current dataset, results require replication in a larger sample. Nonetheless, these results suggest the importance of taking into account symptoms when designing interventions for promoting health behaviors. Specifically, our current results suggest that interventions need to be tailored to patients based on their current symptom status. For those that are symptomatic, conventional interventions that promote self-efficacy will likely be effective. Asymptomatic patients would likely fair better from sorts of interventions that are suggested by the CSM (McAndrew et al., 2008).

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Table 1: Descriptive Statistics

Variables	***N***	***α***	***Pos. range or %***	***Obs. Min***	***Obs. Max***	***M***	***SD***	***Skew***	***Skew SE***
Demographics									
Age			-	40.0	86.0	65.35	8.53	0.13	0.51
Male	65		73.0%						
White	71		79.8%						
Household Income ≥ 50k per year (n=69)	41		59.4%			58k	25k	0.28	0.29
Currently Employed (n= 82)	36		43.9%						
Married/Living with Someone (n=79)	52		65.8%						
Education (years; n= 87)			-	8.0	20.0	14.16	2.75	0.57	0.26
Biomedical Information	***N***	***α***	***Pos. range or %***	***Obs. Min***	***Obs. Max***	***M***	***SD***	***Skew***	***Skew SE***
Elective surgery	35		39.3%						
Number of days when physical act. was “normal” (n=87)				0.00	803.0	65.79	138.34	14.8	0.51

Cardiac Risk Factor index (all Med Chart data out of 56)	57		0-13	1.00	11.00	5.39	1.91	0.46	0.62
History of Angina	30		70.2%						
History of Arrhythmia	15		26.3%						
History of MI	23		40.4%						
History of Congestive Heart Failure	26		45.6%						
History of Cerebrovascular Disease	4		7.0%						
History of Diabetes	30		52.6%						
Family history of Coronary Artery Disease	15		26.3%						
History of Hypertension	55		96.5%						
History of Dyslipidemia	48		84.2%						
History of Immunosuppresive Therapy	1		1.8%						
History of Peripheral Vascular Disease	5		8.8%						
History of Renal Failure	4		7.0%						
Past or Current Smoker	41		71.9%						
Commonsense Model Illness Beliefs	***N***	***α***	***Pos. range or***	***Obs. Min***	***Obs. Max***	***M***	***SD***	***Skew***	***Skew SE***

			%						
Symptoms		0.89	0-4	0.00	2.71	0.74	0.70	1.18	0.26
Cardiac Symptoms – Subscale		0.94	0-4	0.00	4.00	0.85	1.17	1.46	0.26
Emotional Symptoms – Subscale		0.89	0-4	0.00	3.83	0.66	0.80	1.67	0.26
Fatigue Symptoms – Subscale		0.70	0-4	0.00	3.00	0.76	0.76	0.94	0.26
Percent of asymptomatic or only slightly symptomatic Patients	29		32.6%						
Self-perceived worst symptom cardiac symptom	32		39.0%						
Self-perceived worst symptom is NOT caused by cardiac Disease	27		32.9%						
Perceive heart disease is only present when symptoms are or don't perceive have heart disease	33		37.5%						
Emotional Cause Beliefs		0.75	0-4	0.00	3.40	0.76	0.78	0.90	0.51
Medical Cause Beliefs		0.76	0-4	0.00	3.40	1.54	0.91	-0.87	0.51
Consequences beliefs		0.65	0-4	0.00	4.00	3.08	0.85	1.57	0.51
Curability Belief		0.87	0-4	0.00	4.00	3.02	1.09	1.00	0.51

Personal Control		0.76	0-4	1.25	4.00	3.58	0.63	2.42	0.51
Chronic Timeline		0.90	0-4	0.00	4.00	2.83	1.20	-0.16	0.51
Treatment Control – Full Scale		0.79	0-4	0	4	1.97	1.16	-0.93	0.51
Emotional Treatment Control – Subscale		0.87	0-4	0.00	4.00	1.52	1.34	-1.03	0.51
Physical Treatment Control – Subscale		0.72	0-4	0.00	4.00	2.81	1.09	-0.54	0.51
Social Cognitive Theory Beliefs		***α***							
Physical Activity Outcome Expectancies – Full Scale		0.68	0-4	2.00	4.00	3.36	0.51	-0.50	0.51
Physical Activity Health Outcome Expectancies– Subscale		0.65	0-4	1.00	4.00	3.56	0.58	3.27	0.51
Physical Activity Emotion Outcome Expectancies– Subscale		0.74	0-4	0.67	4.00	3.09	0.84	0.18	0.51
Bed Rest Outcome Expectancies		0.87	0-4	0.00	4.00	1.56	1.02	-0.82	0.51
Walk Self-efficacy		0.98	0-10	0.00	10.00	5.00	3.72	-1.64	0.52
Physical Activity Self-Efficacy		0.88	0-3	0.00	3.00	2.15	0.76	0.23	0.52
Medication Adherence Self-efficacy		0.91	0-2	0.40	2.00	1.78	0.34	4.05	0.52

BMQ – Necessity of medications		0.89	0-4	0.00	4.00	2.83	0.96	0.11	0.52
BMQ – Concerns about medications		0.67	0-4	0.00	3.80	1.60	0.93	-0.67	0.52
Health Behaviors									
Morisky Medication Adherence Measure		0.67	0-8	2.50	8.00	6.42	1.57	-0.19	0.52
Adherent (score above 7 on Morisky Scale)	42		50.6%						
IPAQ – Physical Activity – Total METS				0.00	19650	3710	4527.5	2.37	0.52
IPAQ – Physical Activity – Total METS Sq. Rt Transformed				0.00	140.2	49.28	36.02	-0.43	0.52
Meets minimum recommended amount of physical activity	66		75.9%						
Psychosocial Variables		***α***							
CESD – Depression		0.86	0-60	0.00	34.00	10.86	7.96	0.07	0.51
SF-12v2 – General Health Subscale: T-score			*M*=50 *SD*=10	18.9	62.0	35.50	14.20	-1.07	0.54
SF-12v2 – Physical Function Subscale: T-score			*M*=50 *SD*=10	22.1	56.5	41.29	12.45	-1.25	0.54

NOTE: Subscales or recalculations of data are indicated in *Italics*. Risk Factor Index includes history of: Angina, Arrhythmia, myocardial infarction, Congestive Heart Failure, Cerebrovascular Disease, Diabetes, Family history of Coronary Arter Disease, Hypertension, Dyslipidemia, peripheral vascular disease, renal failure, past or current smoker, and current immunosuppressive therapy. BMQ – Beliefs about Medications Questionnaire; IPAQ – International Physical Activity Questionnaire; CESD – Center f or Epidemiologic Studies – Depression scale; SF-12v2 – Medical Outcomes Study – Quality of Life scale Short-form 12 version 2.

Table 2. *Factor Analysis of Commonsense Beliefs w/out cause or symptoms*

Items	TL-Chr $\alpha = 0.90$	Pers Cont $\alpha = 0.76$	Cure beliefs $\alpha = 0.87$	Cons. $\alpha = 0.65$
Indicate source of item for each (e.g., IPQ)				
Timeline – Chronic				
My heart disease will last for a long time. [1]	0.85			
My heart disease is likely to be permanent [1]	0.84			
My heart disease will be with me for the rest of my life. [1]	0.84			
My heart disease will pass quickly. [1]	-0.84			
My heart disease will last a short time. [1]	-0.71			
Personal Control Beliefs				
Nothing I do will affect my heart condition. [1]		0.77		
There is a lot which I can personally do to control my heart condition. [1]		-0.75		
My actions will have no affect on the outcome of my heart condition. [1]		0.73		
There is nothing that can help my heart		0.68		

condition. [1]				
My heart disease is a serious condition. [1]	*0.34*	*-0.37*	-0.01	0.13
My heart disease strongly affects the way others see me. [1]	*0.01*	*-0.27*	*-0.09*	*0.27*
Curability				
My doctors can cure my heart condition.[2]			0.89	
My heart disease will be cured following surgery. [2]			0.88	
My treatment overall can cure my heart condition. [1]			0.81	
Consequences				
My heart disease causes difficulties for those who are close to me. [1]				0.76
My heart disease has major consequences for my life. [1]				0.70
My heart disease does not have much effect on my life. [1]				-0.65
My heart disease has serious financial				0.60

consequences. [1]

Response set is from 1 – strongly disagree to 3- neutral to 5 – strongly agree for all items; Principal Component w/ varimax rotation factor analysis was used; * These variables did not clearly load on any one factor and therefore was dropped from subsequent analyses. [1] Indicates items taken or adapted from the Illness Perception Questionnaire – Revised; [2] Indicates new items created for this study.

Table 3. *Factor Analysis of Cause Beliefs*

Items	Emot	Med Dis	Uncont.
	$\alpha = 0.75$	$\alpha = 0.76$	$\alpha = 0.03$
Emotional cause			
Feeling anxious	0.85		
Feeling depressed	0.76		
Stress	0.76		
Feeling angry	0.67		
Bad luck	*0.37*		
Medical model			
High blood pressure		0.79	
Lack of exercise		0.73	
Diabetes		0.72	
High cholesterol		0.67	
Diet		0.56	
Uncontrollable Factors			
Genetics	0.14	-0.05	-0.73
God	0.15	-0.04	0.62
Old age	*0.24*	*0.27*	*0.39*

Response set is from 1 – not at all to 5 – very much for all items; Principal Component w/ varimax rotation factor analysis was used

Table 4. *Factor Analysis of Symptoms*

Items (Total Scale α = 0.89)	Emot α = 0.89	Chest pain α = 0.94	Fatigue α = 0.70
Emotional Symptoms			
Depressed	0.83		
Stressed	0.80		
Sadness	0.79		
Hopelessness	0.77		
Anxiety	0.76		
Overwhelmed	0.63		
Chest Symptoms			
Pressure in Chest		0.92	
Chest discomfort		0.91	
Chest pain		0.86	
Fatigue Symptoms			
Sleep disturbances			0.70
Difficulty breathing			0.68
Fatigue			0.67
Loss of libido			0.53
Dizziness			0.51

Table 5. *Factor Analysis of Physical Activity/Bed rest outcome expectancies*

Items	Bed rest OE $\alpha = 0.87$	PA Emotion OE $\alpha = 0.74$	PA Health OE $\alpha = 0.65$
Bed rest Outcome Expectancies			
A lot of bed rest makes me feel much better afterwards.	-0.81		
A lot of bed rest negatively impacts my mood.	0.76		
A lot of bed rest will be bad for my heart.	0.73		
A lot of bed rest will increase my risk of a heart attack.	0.71		
A lot of bed rest will have a positive impact on my general health.	-0.70		
A lot of bed rest is enjoyable to me.	-0.68		
A lot of bed rest will have a positive impact on my heart condition.	-0.67		
A lot of bed rest is boring to me.	0.60		
A lot of bed rest will increase my risk of future health	0.59		
Physical Activity – Emotional Outcome Expectancies			
Physical activity is enjoyable to me.		0.79	
Physical activity is boring to me.		-0.75	
Physical activity negatively impacts my mood.		-0.74	
Physical activity makes me feel much better		0.68	

afterwards.	
Physical Activity – Health Outcome Expectancies	
Physical activity will be bad for my heart.	0.70
Physical activity will have a positive impact on my heart condition.	-0.68
Physical activity will have a positive impact on my general health.	-0.66
Physical activity will increase my risk of future health problems.	0.56
Physical activity will increase my risk of a heart attack.	0.54

Response set is from 1 – strongly disagree to 5 – strongly agree for all items; Principal Component w/ varimax rotation factor analysis was used; All items were created for this study.

Table 6: Correlation Matrix

	2)	3)	4)	5)	6)	7)	8)	9)	10)	11)	12)	13)	14)	15)	16)	17)	18)
1) Medication Adherence	-0.08	-0.18	-0.27*	-0.32**	-0.10	0.04	-0.01	-0.12	-0.27*	0.10	-0.01	0.09	0.04	0.46**	0.02	-0.35**	-0.18
2) Physical Activity		0.17	0.24*	-0.09	0.12	-0.04	0.27*	0.12	0.19	0.24*	-0.15	0.05	0.21	0.01	-0.15	0.13	0.10
3) Symptoms			0.54**	0.19	0.03	-0.05	0.10	0.16	0.26*	0.10	-0.14	-0.10	-0.01	0.12	0.19	0.17	0.68**
4) Emotional Cause Beliefs				0.26*	0.19	-0.16	0.06	0.20	0.37**	-0.05	0.04	-0.03	-0.11	0.02	-0.01	0.15	0.48**
5) Medical Cause Beliefs					0.31**	0.02	0.23*	0.32**	0.33**	-0.23*	0.15	-0.14	-0.11	-0.21	0.19	0.08	0.19
6) Timeline – Chronic						-0.34**	0.24*	0.29**	0.22*	-0.06	-0.07	-0.11	-0.04	0.04	0.06	0.07	0.13
7) Cure beliefs							0.17	-0.03	0.10	-0.04	0.24*	0.03	0.01	-0.08	0.12	0.03	-0.07
8) Personal Control								0.20	0.34**	0.33**	-0.00	0.21*	0.29**	0.16	0.05	0.02	-0.09
9) Consequences									0.45**	-0.05	-0.01	-0.22*	-0.12	-0.02	0.07	0.33**	0.31**
10) Health Behavior Efficacy Beliefs										0.04	0.01	-0.09	0.06	0.01	0.05	0.20	0.24*
11) Physical Activity Outcome Expectancies											-0.25*	0.28**	0.49**	0.23*	0.00	-0.10	-0.17
12) Bed rest Outcome Expectancies												-0.11	-0.06	0.12	0.02	-0.08	-0.05
13) Walk Self-efficacy													0.39**	0.05	-0.04	-0.20	-0.15
14) Physical Activity Self-efficacy														0.28**	-0.17	-0.19	-0.30**

15) Medication Adherence Self-efficacy															-0.04	-0.35**	-0.08
16) Positive Medication Outcome Expectancies																-0.03	0.15
17) Negative Medication Outcome Expectancies																	0.35**
18) Depression																	

$*p < 0.05$, $**p < 0.01$.

Table 7: Correlation Matrix of subscales

	2)	3)	4)	5)	6)	7)	8	9)	10)
1) Medication Adherence	-0.08	-0.16	-0.11	-0.17	-0.27*	-0.32**	0.09	0.06	-0.18
2) Physical Activity		0.21^{τ}	0.18	0.02	0.24*	-0.09	0.21*	0.15	0.10
3) Cardiac Symptoms			0.37**	0.47**	0.27*	0.14	0.20	0.04	0.33**
4) Psychological symptoms				0.55**	0.61**	0.17	0.09	0.05	0.71**
5) Fatigue Symptoms					0.37**	0.15	0.01	0.02	0.53**
6) Emotional Cause Beliefs						0.26*	-0.13	0.06	0.48**
7) Medical Cause Beliefs							0.02	-0.33**	0.19^{τ}
8) Physical Activity Outcome Expectancies – physical health subscale								0.14	-0.11
9) Physical Activity Outcome Expectancies – emotion subscale									-.014
10) Depression									

$^{\tau}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$.

Table 8: CSM Predicting Physical Activity controlling for Age and Cardiac Risk Factor Index

Variable	*B*	*S.E.*	*OR*	95.0% *CI*.for *OR*		*p*
Step 1: χ^2 *= 0.38, p* = 0.83				Lower	Upper	
Age	-0.02	0.03	0.98	0.93	1.04	0.58
Cardiac Risk Factor Index	-0.04	.17	0.96	0.69	1.33	0.80
Step 2: χ^2 *= 23.05, p* < 0.01						
Age	0.02	0.04	1.02	0.95	1.10	0.62
Cardiac Risk Factor Index	-0.07	0.20	0.93	0.64	1.36	0.71
Symptoms	0.92	0.62	2.52	0.75	8.44	0.13
Medical Cause	-1.09	0.42	0.34**	0.15	0.76	0.01
Emotion Cause	1.00	0.56	2.71$^{\tau}$	0.90	8.20	0.08
Cure	0.46	0.32	1.58	0.85	2.94	0.15
Personal Control	1.25	0.53	3.48*	1.23	9.88	0.02
Chronic Timeline	0.43	0.31	1.53	0.83	2.81	0.17
Consequences	0.29	0.43	1.34	0.58	3.10	0.50
Treatment Control	-0.26	0.33	0.77	0.40	1.49	0.44

$^{\tau}p < 0.10$, $*p < 0.05$, $**p < 0.01$. Cardiac Risk Factor Index includes history of: Angina, Arrhythmia, myocardial infarction, Congestive Heart Failure, Cerebrovascular Disease, Diabetes, Family history of Coronary Artery Disease, Hypertension, Dyslipidemia, peripheral vascular disease, renal failure, past or current smoker, and current immunosuppressive therapy. Full Model: $N = 87$, $\chi^2 = 23.42$, $p < 0.01$.

Table 8a: CSM Predicting Physical Activity controlling for Age and Cardiac Risk Factor Index excluding emotional cause

Variable	*B*	*S.E.*	*OR*	95.0% *CI*.for *OR*		*p*
Step 1: χ^2 *= 0.38, p* = 0.83				Lower	Upper	
Age	-0.02	0.03	0.98	0.93	1.04	0.58
Cardiac Risk Factor Index	-0.04	.17	0.96	0.69	1.33	0.80
Step 2: χ^2 *= 23.05, p* < 0.01						
Age	0.02	0.04	1.02	0.95	1.09	0.66
Cardiac Risk Factor Index	-0.07	0.19	0.93	0.64	1.35	0.70
Symptoms	1.40	0.58	4.04*	1.31	12.51	0.02
Medical Cause	-1.01	0.40	0.37*	0.17	0.80	0.01
Cure	0.31	0.30	1.36	0.75	2.46	0.31
Personal Control	1.12	0.51	3.07*	1.13	8.37	0.03
Chronic Timeline	0.50	0.31	1.65	0.90	3.00	0.10
Consequences	0.23	0.44	1.26	0.53	2.99	0.60
Treatment Control	-0.13	0.32	0.88	0.47	1.64	0.68

$^{\tau}p < 0.10$, *$p < 0.05$, **$p < 0.01$. Cardiac Risk Factor Index includes history of: Angina, Arrhythmia, myocardial infarction, Congestive Heart Failure, Cerebrovascular Disease, Diabetes, Family history of Coronary Artery Disease, Hypertension, Dyslipidemia, peripheral vascular disease, renal failure, past or current smoker, and current immunosuppressive therapy. Full Model: $N = 87$, $\chi^2 = 23.42$, $p < 0.01$.

Table 9: CSM Predicting Medication adherence controlling for Age and Cardiac Risk Factor Index

Variable	*B*	*S.E.*	*OR*	95.0% *CI*.for *OR*		*p*
Step 1: $\chi^2 = 6.02, p < 0.05$				Lower	Upper	
Age	0.05	0.03	1.05	0.99	1.12	0.10
Cardiac Risk Factor Index	-0.30	0.17	0.74$^{\tau}$	0.53	1.02	0.07
Step 2: $\chi^2 = 12.12$, $p = 0.14$						
Age	0.05	0.03	1.05	0.98	1.12	0.15
Cardiac Risk Factor Index	-0.28	0.19	0.76	0.52	1.10	0.14
Symptoms	0.13	0.44	1.14	0.48	2.72	0.77
Medical Cause	-0.50	0.31	0.61	0.33	1.12	0.11
Emotion Cause	-0.42	0.42	0.66	.29	1.49	0.32
Cure	0.37	0.27	1.45	.86	2.44	0.16
Personal Control	0.29	0.45	1.33	0.55	3.20	0.53
Chronic Timeline	0.38	0.25	1.46	.89	2.40	0.14
Consequences	0.17	0.34	1.18 2	0.61	2.31	0.62
Treatment Control	-0.51	0.30	0.60$^{\tau}$	0.33	1.09	0.09

$^{\tau}p < 0.10$, $*p < 0.05$, $**p < 0.01$. Cardiac Risk Factor Index includes history of: Angina, Arrhythmia, myocardial infarction, Congestive Heart Failure, Cerebrovascular Disease, Diabetes, Family history of Coronary Artery Disease, Hypertension, Dyslipidemia, peripheral vascular disease, renal failure, past or current smoker, and current immunosuppressive therapy. Full Model: $N = 83$ $\chi^2 = 18.18$, $p = 0.05$.

Table 10: CSM and SCT beliefs predicting physical activity controlling for age and risk factor index

Variable	B	$S.E.$	OR	95.0% CI.for OR		p
				Lower	Upper	
Step 2: $\Delta\chi^2 = 11.74$, $p < 0.01$ *Model:* $\chi^2 = 12.11$, $p < 0.05$						
Age	-0.01	0.03	0.99	0.93	1.06	0.81
Cardiac Risk Factor Index	0.07	0.17	1.08	0.78	1.49	0.66
Physical Activity Outcome Expectancies	1.16	0.60	3.18^{τ}	0.98	10.31	0.05
Bed rest Outcome Expectancies	-0.55	0.30	0.58^{τ}	0.32	1.04	0.07
Physical Activity Self-efficacy	0.19	0.42	1.21	0.53	2.77	0.65
Step 3: $\Delta\chi^2 = 21.30$, $p < 0.01$						
Age	0.02	0.04	1.02	0.94	1.11	0.60
Cardiac Risk Factor Index	0.06	0.21	1.06	0.70	1.61	0.79
Physical Activity Outcome Expectancies	0.80	0.71	2.23	0.55	9.06	0.26
Bed rest Outcome Expectancies	-0.74	0.38	0.48*	0.23	1.00	0.049
Physical Activity Self-efficacy	0.67	0.54	1.96	0.68	5.62	0.21
Symptoms	0.45	0.66	1.57	0.43	5.65	0.49

Medical Cause	-1.11	0.46	0.33*	0.13	0.82	0.02
Emotional Cause	1.75	0.71	5.75*	1.42	23.30	0.01
Cure	0.80	0.39	2.23*	1.04	4.78	0.04
Timeline – chronic	0.43	0.34	1.53	0.79	2.97	0.20
Consequences	0.32	0.51	1.38	0.51	3.74	0.53
Treatment control	-0.35	0.38	0.71	0.33	1.49	0.36
Personal Control	1.06	0.59	2.90^{τ}	0.91	9.23	0.07

$^{\tau}p < 0.10$, $*p < 0.05$, $**p < 0.01$. Step 1 is the same as step 1 in Table 8. Cardiac Risk Factor Index includes history of: Angina, Arrhythmia, myocardial infarction, Congestive Heart Failure, Cerebrovascular Disease, Diabetes, Family history of Coronary Artery Disease, Hypertension, Dyslipidemia, peripheral vascular disease, renal failure, past or current smoker, and current immunosuppressive therapy. Full Model: $N = 87$, $\chi^2 = 33.41$, $p < 0.01$.

Table 11: CSM and SCT beliefs predicting medication adherence controlling for age and risk factor index

Variable	*B*	*S.E.*	*OR*	95.0% *CI*.for *OR*		*p*
				Lower	Upper	
Step 2: $\Delta\chi^2 = 18.28, p < 0.001$ *Model:* $\chi^2 = 24.35, p < 0.001$						
Age	0.07	0.03	1.07^{τ}	1.00	1.14	0.05
Cardiac Risk Factor Index	-0.41	0.20	0.67*	.45	0.98	0.04
Medication Adherence Self-Efficacy	2.04	1.06	7.72^{τ}	0.97	61.54	0.05
BMQ – Medication Need	-0.06	0.27	0.95	0.56	1.60	0.84
BMQ – Medication Concerns	-0.78	0.32	0.45*	0.24	0.84	0.01
Step 3: $\Delta\chi^2 = 12.02, p = 0.15$						
Age	0.08	0.04	1.08^{τ}	1.00	1.17	0.07
Cardiac Risk Factor Index	-0.49	0.24	0.61*	0.39	0.98	0.04
Medication Adherence	1.81	1.26	6.13	0.52	72.88	0.15
Pos Med Outcome Exp	-0.06	0.33	0.94	0.49	1.81	0.86
Neg Med Outcome Exp	-1.04	0.42	0.35*	0.16	0.80	0.01
Symptoms	0.32	0.55	1.38	0.47	4.05	0.56
Medical Cause	-0.42	0.38	0.66	0.31	1.40	0.28
Emotional Cause	-0.48	0.48	0.62	0.25	1.57	0.32
Cure	0.54	0.33	1.72^{τ}	0.91	3.26	0.09
Personal Control	0.08	0.55	1.08	0.37	3.16	0.89

Timeline – chronic	0.53	0.31	1.70$^{\tau}$	0.93	3.11	0.08
Consequences	0.57	.43	1.76	0.76	4.06	0.19
Treatment control	-0.60	0.35	0.55$^{\tau}$	0.28	1.09	0.09

$^{\tau}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$. Step 1 is the same as step 1 in Table 8. Cardiac Risk Factor Index includes history of: Angina, Arrhythmia, myocardial infarction, Congestive Heart Failure, Cerebrovascular Disease, Diabetes, Family history of Coronary Artery Disease, Hypertension, Dyslipidemia, peripheral vascular disease, renal failure, past or current smoker, and current immunosuppressive therapy. Full Model: $N = 83$, $\chi^2 = 36.36$, $df = 13$, $p < 0.01$.

Table 12: Symptoms predicting physical activity

Variable	B	$S.E.$	OR	95.0% CI.for OR		p
Step2: Symptoms $\Delta\chi^2 = 8.90$, $p < 0.05$				Lower	Upper	
Age	-0.00	0.03	1.00	0.94	1.06	0.97
Cardiac Risk Factor Index	-0.07	0.17	0.93	0.67	1.31	0.69
Psychological Symptoms	0.44	0.49	1.55	0.59	4.07	0.37
Fatigue Symptoms	-0.14	0.46	0.87	0.35	2.15	0.78
Cardiac Symptoms	0.84	0.44	2.33^{τ}	0.98	5.51	0.06

$^{\tau}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$. Step 1 includes only age and cardiac risk factor index. Step 1 is identical to previous models listed above. Full model $\chi^2 = 9.28$, $p = 0.10$.

Table 13: Symptoms predicting medication adherence

Variable	B	$S.E.$	OR	95.0% CI.for OR		p
Step2: Symptoms $\Delta\chi^2 = 4.43$, $p = 0.22$				Lower	Upper	
Age	0.05	0.03	1.05	0.99	1.11	0.14
Cardiac Risk Factor Index	-0.28	0.17	0.76	0.54	1.06	0.10
Psychological Symptoms	0.33	0.35	1.40	0.70	2.80	0.35
Fatigue Symptoms	-0.67	0.42	0.51	0.23	1.15	0.11
Cardiac Symptoms	-0.12	0.23	0.89	0.56	1.40	0.61

$^{\tau}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$. Step 1 includes only age and cardiac risk factor index. Step 1 is identical to previous models listed above. Full model $\chi^2 = 10.49$, $p = 0.06$.

Table 14: Symptom Attribution and CSM Beliefs Predicting Physical Activity controlling for Age and Cardiac Risk Factor Index

Variable	*B*	*S.E.*	*OR*	95.0% *CI*.for *OR*		*p*
Step 2: $\Delta\chi^2 = 1.75$, $p = 0.19$				Lower	Upper	
Age	0.01	0.03	1.01	0.94	1.07	0.87
Cardiac Risk Factor Index	-0.10	0.18	0.91	0.64	1.29	0.58
Symptom attribution	0.75	0.58	2.11	0.68	6.57	0.20
Step 3: $\Delta\chi^2 = 19.19$, $p <$ 0.05						
Age	0.04	0.04	1.04	0.96	1.13	0.35
Cardiac Risk Factor Index	-0.18	0.21	0.83	0.55	1.26	0.39
Symptom Attribution	1.20	0.76	3.32	0.74	14.85	0.12
Symptoms	0.41	0.48	1.51	0.59	3.87	0.39
Medical Cause Beliefs	-1.06	0.42	0.35	0.15	0.78	0.01
Emotional Cause Beliefs	0.89	0.50	2.44	0.91	6.56	0.08
Curability	0.56	0.38	1.75	0.83	3.70	0.14
Personal Control	0.83	0.38	2.30	1.08	4.88	0.03
Chronic Timeline	0.65	0.39	1.91	0.88	4.12	0.10
Consequences	0.36	0.40	1.44	0.66	3.12	0.36
Treatment Control	-0.41	0.40	0.66	0.31	1.43	0.29

$^{\tau}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$. Step 1 is age and the cardiac risk factor index. This step is similar to previous regression models and therefore was not duplicated here. Symptom Attribution coded 0 – asymptomatic or attribute worst symptom to something other than heart disease; 1 – attribute self-perceived most troubling symptom to heart disease. Cardiac Risk Factor Index includes history of: Angina, Arrhythmia, myocardial infarction, Congestive Heart Failure, Cerebrovascular Disease, Diabetes, Family history of Coronary Artery Disease, Hypertension, Dyslipidemia, peripheral vascular disease, renal failure, past or current smoker, and current immunosuppressive therapy. Full Model: $N = 80$, $\chi^2 = 21.04$, $p < 0.05$.

Table 15: Symptom Attribution and CSM Beliefs Predicting Medication Adherence controlling for Age and Cardiac Risk Factor Index

Variable	*B*	*S.E.*	*OR*	95.0% *CI*.for *OR*		*P*
Step 2: $\Delta\chi^2 = 3.55$, $p = 0.06$				Lower	Upper	
Age	0.24	0.04	1.02	0.97	1.09	0.43
Cardiac Risk Factor Index	-0.30	0.19	0.74	0.51	1.08	0.12
Symptom attribution	-0.94	0.50	0.39	0.15	1.05	0.06
Step 3: $\Delta\chi^2 = 11.93$, $p = 0.15$						
Age	-0.31	0.21	0.73	0.48	1.11	0.15
Cardiac Risk Factor Index	0.02	0.04	1.02	0.95	1.09	0.56
Symptom Attribution	-0.80	0.59	0.45	0.14	1.42	0.17
Symptoms	-0.04	0.36	0.96	0.48	1.92	0.90
Medical Cause Beliefs	-0.33	0.31	0.72	0.40	1.32	0.29
Emotional Cause Beliefs	-0.29	0.37	0.75	0.37	1.54	0.43
Curability	0.61	0.34	1.85	0.96	3.58	0.07
Personal Control	0.22	0.31	1.25	0.68	2.27	0.47
Chronic Timeline	0.40	0.32	1.49	0.79	2.82	0.22
Consequences	0.11	0.32	1.12	0.59	2.10	0.73
Treatment Control	-0.50	0.38	0.60	0.29	1.26	0.18

$^{\tau}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$. Step 1 is age and the cardiac risk factor index. This step is similar to previous regression models and therefore was not duplicated here. Symptom Attribution coded 0 – asymptomatic or attribute worst symptom to something other than heart disease; 1 – attribute self-perceived most troubling symptom to heart disease. Cardiac Risk Factor Index includes history of: Angina, Arrhythmia, myocardial infarction, Congestive Heart Failure, Cerebrovascular Disease, Diabetes, Family history of Coronary Artery Disease, Hypertension, Dyslipidemia, peripheral vascular disease, renal failure, past or current smoker, and current immunosuppressive therapy. Full Model: $N = 78$, $\chi^2 = 21.31$, $p < 0.05$.

Table 16: Symptom interacting with CSM and SCT beliefs when predicting physical activity

Variable	*B*	*S.E.*	*OR*	95.0% *CI*.for *OR* Lower	Upper	*p*
Step 1: $\chi^2 = 33.05$, $p < 0.01$						
Symptoms	0.33	0.45	1.40	0.58	3.36	0.46
Medical Cause	-0.97	0.41	0.38*	0.17	0.84	0.02
Emotional Cause	1.33	0.55	3.77*	1.29	11.02	0.02
Cure beliefs	0.85	0.42	2.34*	1.04	5.26	0.04
Timeline – Chronic	0.52	0.41	1.69	0.76	3.73	0.20
Consequences	0.23	0.41	1.26	0.57	2.81	0.57
Personal Control	0.62	0.36	1.87^{τ}	0.92	3.79	0.08
Treatment control	-0.40	0.40	0.67	0.30	1.48	0.32
Physical Activity outcome Expectancies	0.40	0.37	1.49	0.73	3.05	0.28
Bed rest outcome expectancies	-0.73	0.37	0.48*	0.24	0.99	0.046
Physical Activity Self-efficacy	0.50	0.40	1.65	0.76	3.62	0.21
Step 2: $\Delta\chi^2 = 11.33$, $p < 0.01$						
Symptoms X Physical Activity Self-Efficacy	1.73	0.77	5.62*	1.234	25.56	0.03

Symptoms X Bed rest Outcome Expectancies	-1.79	0.824	0.17*	0.03	0.84	0.03

$^{\tau}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$. To center main-effects variables, all were recalculated as Z-scores. The following interaction terms were initially entered to assess for significance symptoms by: physical activity self-efficacy, physical activity outcome expectancies, bed rest outcome expectancies, consequences, treatment control, timeline – chronic, curability, personal control, medical cause, emotional cause. Of these a significant interaction was found between symptoms and both self-efficacy and bed rest outcome expectancies. These two interaction terms were run in a trimmed model that only included these two interaction terms to control for possible Type I error. This trimmed model is listed above in Step 2. Cardiac Risk Factor Index includes history of: Angina, Arrhythmia, myocardial infarction, Congestive Heart Failure, Cerebrovascular Disease, Diabetes, Family history of Coronary Artery Disease, Hypertension, Dyslipidemia, peripheral vascular disease, renal failure, past or current smoker, and current immunosuppressive therapy. Full Model: $N = 87$, $\chi^2 = 44.38$, $p < 0.001$.

Figure 1: Integrative Model of the Commonsense Model of Self-regulation and Social Cognitive Theory

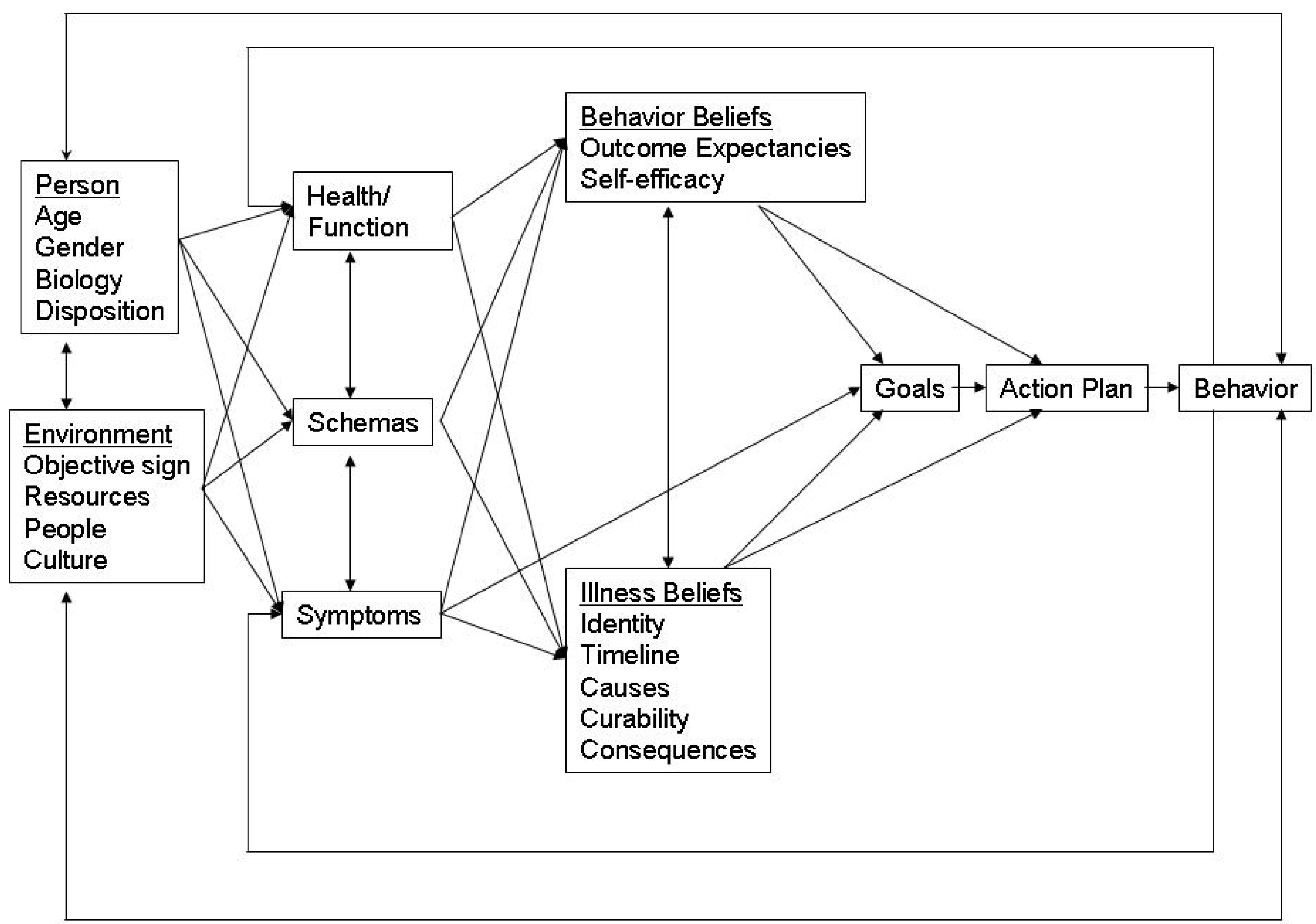
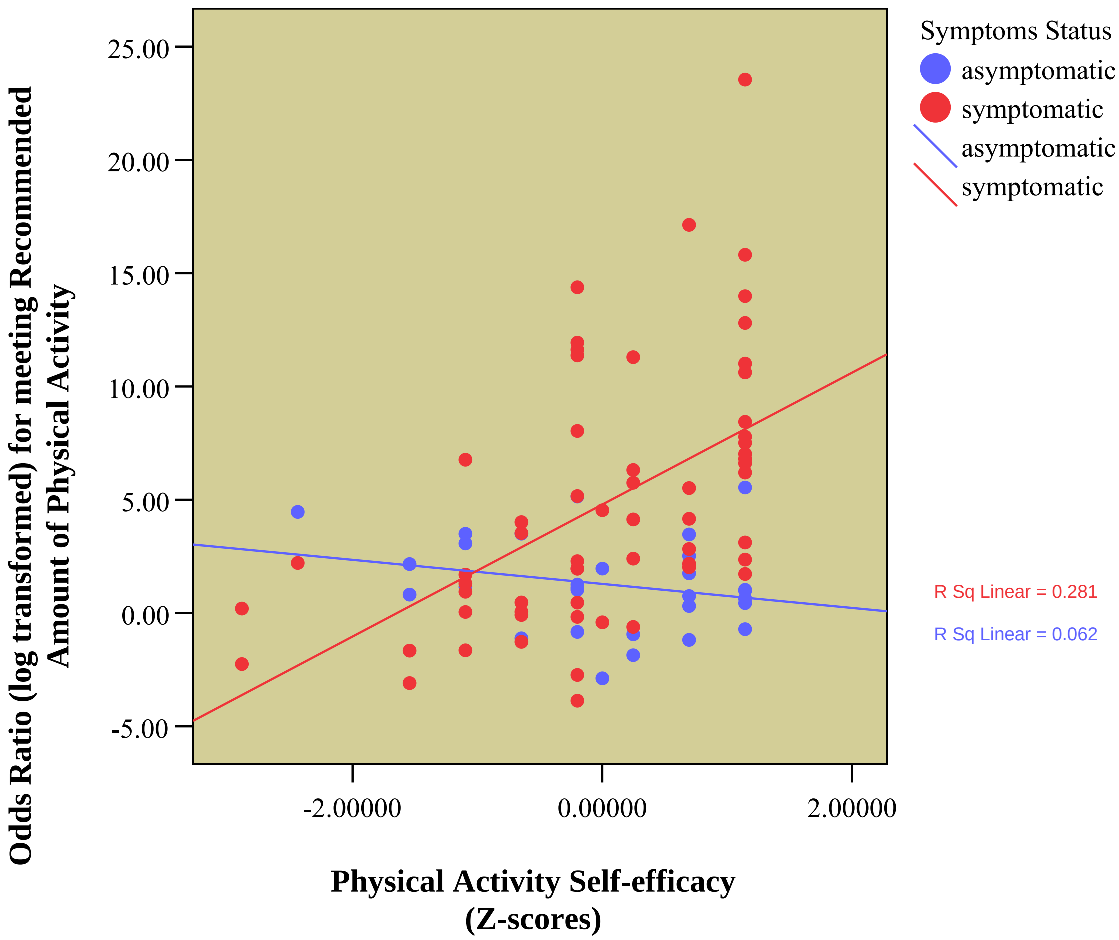
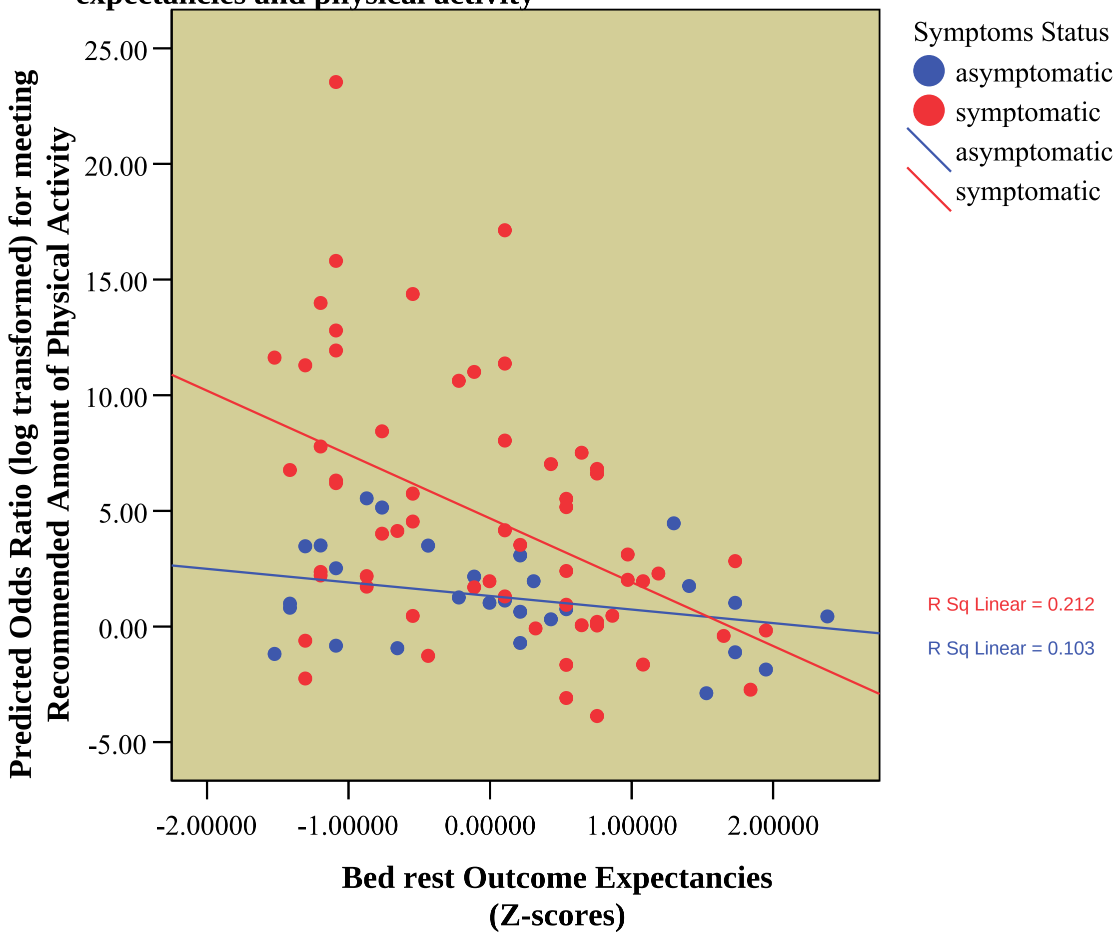


Figure 2: Symptoms moderating the relationship between self-efficacy and physical activity



The figure is a plot of a logistic regression analysis that included the following variables: symptoms, emotional cause, medical cause, consequences, curability, personal control, physical activity self-efficacy, physical activity outcome expectancies, bed rest outcome expectancies, symptoms by physical activity self-efficacy interaction term, and Symptoms by bed rest outcome expectancies interaction term. The symptoms by physical activity self-efficacy interaction term was significant, *OR* = 5.62, *CI* = 1.23 to 25.56, $p < 0.05$.

Figure 3: Symptoms moderating the relationship between bed rest outcome expectancies and physical activity



The figure is a plot of a logistic regression analysis that included the following variables: symptoms, emotional cause, medical cause, consequences, curability, personal control, physical activity self-efficacy, physical activity outcome expectancies, bed rest outcome expectancies, symptoms by physical activity self-efficacy interaction term, and Symptoms by bed rest outcome expectancies interaction term. The symptoms by bed rest outcome expectancies interaction term was significant, $OR = 0.17$, $CI = 0.17$ to 0.84, $p < 0.05$.

Appendix A: Measures Matrix

Construct	**Measure**
Cure beliefs	Illness Perception Questionnaire adaptation
CSM beliefs	IPQ adaptation
Physical activity outcome expectancies	Developed for current study
Rest outcome expectancies	Developed for current study
Medications outcome Expectancies	Beliefs about Medications Questionnaire (Horne et al)
Exercise Self-efficacy	Schwartzer physical activity scale
Walk self-efficacy	McCauley walk self-efficacy scale
Medication adherence self-efficacy	Ogedegbe medication adherence scale adaptation
Depression	CESD
Medication adherence	Morisky medication adherence scale
Physical Activity	IPAQ

Curriculum Vita

Eric B. Hekler

Academic History

The State University of New York at Albany **1998-2002**

BA, Psychology, May 2002

Minors: Biology, Education, Music

Rutgers – The State University of New Jersey **2002-2008**

MS, Psychology, October 2004

Occupational History

Rutgers – The State University of New Jersey **2002-2008**

Teaching Assistant

VA Maryland Health Care System, Baltimore, MD **2007-2008**

Clinical Health Psychology Intern, Completed June 2008

Publications

Hekler, E.B., Rubenstein, J., Coups, E.J., Gilligan, S., Steiner, M.J., Krause, T.J., et al. (2007). Inflammatory markers in acute myocardial infarction patients: prospective associations with depressive symptoms. *Journal of Applied Biobehavioral Research, 12*, 65-81.

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