THE EFFECTS OF CATASTROPHIZING AND ACCEPTANCE ON FUNCTIONAL INTERFERENCE IN PERSONS WITH CHRONIC PAIN: LABORATORY FINDINGS, SUBJECTIVE REPORTS, AND THE MODERATING ROLE OF ACCEPTANCE

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EFFECTS OF CATASTROPHIZING AND ACCEPTANCE ON FUNCTIONAL INTERFERENCE IN PERSONS WITH CHRONIC PAIN: LABORATORY FINDINGS, SUBJECTIVE REPORTS, AND THE MODERATING ROLE OF ACCEPTANCE

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ABSTRACT

Chronic pain has pervasive effects in many aspects of living, including emotional state and the ability to function in day-to-day activities. Cognitive factors such as catastrophic thoughts regarding pain, and conversely, one’s acceptance of that pain, may affect functional outcomes in chronic pain. Thus, the aims of the present study were to examine the effects of both catastrophizing and acceptance on task performance, ratings of laboratory induced ischemic pain, and also self-reports of pain interference in day-to-day activities and depressive symptoms. Further, the relationship between these two constructs and the possible moderating role of acceptance was examined. Lastly, a secondary aim was to investigate the degree to which observed laboratory-based functioning corroborated self-reported day-to-day functioning. Sixty-seven chronic pain patients completed self-report measures of catastrophizing, acceptance, pain interference and depressive symptoms. In addition, participants underwent an ischemic pain induction procedure during which a cognitive task of attention was administered. Acceptance was a significant and stronger predictor than catastrophizing for both task functioning during induced pain and also self-reports of day-to-day pain interference. Conversely, catastrophizing was a stronger and significant predictor of sensory and intensity ratings, but not affective ratings, of the induced pain and also self-reported depressive symptoms. Results also showed a moderating role for acceptance on the relationship between
catastrophizing and task performance during laboratory induced pain, such that higher levels of acceptance were associated with better performance in the presence of catastrophizing. Lastly, a modest relationship was found between observed laboratory and self-reported interference from pain on functioning. Exclusive focus should not be placed on either catastrophizing or acceptance; both constructs appear to contribute to important, but different, outcomes. In terms of pain interference, acceptance appears to attenuate the negative impact of catastrophizing on task functioning.
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<tr>
<td>ACT</td>
<td>Acceptance and Commitment Therapy</td>
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<tr>
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<td>CBT</td>
<td>Cognitive Behavioral Therapy</td>
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<td>PPI</td>
<td>Present Pain Intensity</td>
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<td>PRIME-MD</td>
<td>Primary Care Evaluation of Mental Disorders</td>
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<tr>
<td>SEM</td>
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<td>UAB</td>
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INTRODUCTION

Pain is a multifaceted phenomenon defined by not only the unpleasant sensory response to tissue damage; rather, it is a subjective experience influenced by affective, motivational, cognitive and behavioral factors. Traditionally, pain has been characterized in two broad categories: acute and chronic pain. Acute pain is of short duration, typically lasting no more than three months (Merskey, 1986). It is often associated with apparent tissue damage, which, when healed, leads to the elimination of pain (Walsh, Dumitru, Ramamurthy, & Schoenfeld, 1988). Chronic pain, on the other hand, has been characterized by a duration of at least three months (Merskey, 1986), although a marker of 6 months is more typically applied (Doleys, 2000; Russo & Brose, 1998). This type of pain may continue despite apparent healing of the tissues involved, or it may be secondary to long-standing disease or other pathology (Walsh et al., 1988). Nonetheless, chronic pain is becoming increasingly seen as a syndrome rather than the mere persistence of pain. Its presence is often associated with negative physiological changes, increased emotional distress, strained interpersonal relationships and substantial economic burden from lost work days and incurred treatment costs. Moreover, components of the chronic pain syndrome do not simply co-occur but are dynamically operating; e.g., chronic pain may produce negative psychosocial sequelae which, in turn, may magnify that pain.
The pervasive effects of chronic pain have provided a strong impetus to identify interventions not only to attenuate the adverse experience of pain in and of itself, but also to improve the various life activities and functioning with which it interferes. Not all persons living with chronic pain conditions experience interference with day-to-day functioning (McCracken & Samuel, 2007; Milliard, Wells, & Thebarge, 1991). Similarly, not all chronic pain patients exhibit symptoms indicative of major depression (Turner & Romano, 1984). An important question then, is what allows for pain to interfere with one individual while another is able to continue with normal psychological and physical functioning in day-to-day living? The intensity of experienced pain may be one such factor associated with greater interference. Zelman, Dukes, Brandenburg, Bostrom, and Gore (2005) found, on a pain rating scale of 0-10, individuals with diabetic neuropathic pain could be classified as having mild (0-3), moderate (4-6) and severe (7+) pain intensity, and that higher levels of pain intensity were associated with a greater degree of psychosocial, emotional, and functional interference.

The intuitive relationship between pain intensity and interference has steered therapeutic goals to reduce experienced pain intensity. First line treatment of chronic pain has often involved pharmacologic regimens; however, medication use has been moderately effective at best (Curatolo & Bogduk, 2001; Turk, 2002a). Moreover, many of the pharmacological treatments such as opioids show minimal long-term efficacy and increase the risk for addiction or aberrant medication use (Martell, O’Connor, Kerns, Becker, Morales, Kosten, & Fiellin, 2007). Other treatments for chronic pain include invasive techniques, including surgery, intrathecal pumps and anesthetic procedures (e.g., nerve blocks). Although these modalities may be effective for many suffering chronic
pain, the goal with such procedures is not usually a cure per se. Rather, the inherent
goalie of many specialized pain clinics is management of chronic pain. Hence,
chronic pain treatment, in itself, becomes a perpetual process. Continued efforts by the
patient to pursue a “cure” may potentially become all-consuming, inadvertently drawing
from resources and energy that could otherwise be devoted to important aspects of living
(McCracken, Carson, Eccleston, & Keefe, 2004).

The biopsychosocial perspective suggests that an alternative route to targeting
experienced pain intensity and associated sequelae is through behavioral and cognitive
factors believed to influence outcome. Interventions within this realm were initially
operant-behavioral with the fundamental assumption being that positive non-pain
behaviors could be promoted via reinforcement contingencies (Fordyce, 1976). Today,
the majority of psychotherapeutic approaches not only focus on behavioral variables
affecting outcome, but also incorporate pain coping strategies and negative cognitive
“sets” which may enhance the pain experience. Cognitive Behavioral Therapy (CBT)
based on Beck’s cognitive theory (Beck, Rush, Shaw & Emery, 1979) is widely used in
chronic pain populations (Eimer & Freeman, 1998; Thorn, 2004; Turk, 2002b; Turk &
Flor, 2006). The guiding principle of this approach is that negative thoughts or
cognitions engender maladaptive behavior, which in turn results in poorer outcomes.
Therefore, reducing the frequency and form of those thoughts will promote positive
emotional and physical functioning.

In the chronic pain literature, increasing evidence suggests one negative thought
process in particular, catastrophizing, to be a powerful influence on the experience of
pain (Jensen, Turner, Romano, & Karoly, 1991; Sullivan et al., 2001). Catastrophizing
has broadly been conceptualized as a construct comprised of both cognitive appraisal and affective elements (Jensen et al., 1991; Jones, Rollman, White, Hill, & Brooke, 2003) and is a process that involves an exaggeration or magnification of the perceived threat of incoming pain sensations (Sullivan et al., 2001; Turner & Aaron, 2001).

Two models that Sullivan and colleagues (2001) highlight include an appraisal model and an attentional model when considering ways in which catastrophic thinking affects pain. The appraisal model used to describe the effects of catastrophic thinking on pain is rooted within the context of the transactional model of Lazarus & Folkman (1984). In this conceptualization, catastrophizing is seen as a negative mental set comprising both a primary and secondary appraisal (Sullivan, Bishop, & Pivik, 1995). Thus, an individual who catastrophizes may magnify his or her pain experience and perceived threat through the primary appraisal process. In turn, this individual may secondarily appraise him or herself as helpless and unable to cope successfully with the pain. However, interference due to pain may be a function of the degree to which one’s cognitive resources are consumed by such a negative and threatening appraisal. The attentional model implies that individuals who catastrophize may fixate attention on these exaggerated appraisals (Sullivan et al., 2001). Catastrophizing, or the magnification and perceived inability to adequately manage that pain, will subsequently increase the demand for one’s attention to the heightened threat. Thus, the attentional capacity available for other stimuli or tasks judged as less threatening will be reduced. The appraisal and attentional models therefore appear to be associated, with attentional disruptions resulting from catastrophic appraisals.
Pain, Catastrophizing and Interference

One characteristic of catastrophic thinking is fixating or ruminating on the perceived threat (Sullivan et al., 1995). Corollary to the tendency to ruminate on the pain experience is an inability to attend to tasks at hand or divert attention in order to carry out other activities (Sullivan et al., 2001). In general, attention and processing speed are common neuropsychological domains that are disrupted in chronic pain populations when compared to pain-free controls (Hart, Martelli, & Zasler, 2000). Specifically, persons with chronic pain show longer reaction times on a selective attention task (Grisart & Plaghki, 1999). Furthermore, the degree to which pain interrupts and diverts attention away from other cognitive activity appears to be a function of catastrophic thinking. In normal, pain-free individuals, those scoring high on catastrophizing show the greatest interference and deterioration in performance on a tone discrimination task when in the presence of painful stimuli (Crombez, Eccleston, Baeyens, & Eelen, 1998). This effect was also seen in 33 patients with chronic low back pain (Crombez, Eccleston, Van den Broeck, Van Houdenhove, & Goubert, 2002). In a similar vein, Van Damme, Crombez, & Eccleston (2004) found that persons without a chronic pain condition but who catastrophized about pain showed greater difficulty shifting attention from pain to non-pain related stimuli. It is conceivable then, that persons with chronic pain who tend to catastrophize during painful experiences, and thus experience greater attentional disruption, may show greater difficulty in carrying out day-to-day activities. Indeed, persons with chronic pain who catastrophize report greater pain-related disability (Severeijns, Vlaeyen, van den Hout, & Weber, 2001; Keefe, Brown, Wallston, &

**Chronic Pain, Catastrophizing and Emotional Distress**

Approximately half of chronic pain patients exhibit a substantial level of depressive symptomatology (Fishbain, Goldberg, Meagher, Steele, & Rosomoff, 1986; Romano & Turner, 1985; Turk, Okifuji, & Scharff, 1995), a rate which exceeds the 2-9% found in the general population (American Psychiatric Association *Diagnostic and Statistical Manual of Mental Disorders –Text Revision*, 2000; Kessler, Chiu, Demler, & Walters, 2005). The degree to which an individual experiences psychosocial distress in the context of pain may be mediated by cognitive appraisal variables (Rudy, Kerns, & Turk, 1988; Turk et al., 1995). Catastrophizing, a process comprised of cognitive appraisal and affective components (Jones et al., 2003), may thus serve to explain emotional distress in the face of chronic pain. Indeed, levels of catastrophizing in chronic pain patients have been found to be associated with more negative affective ratings of pain (Geisser, Robinson, Keefe, & Weiner 1994; Sullivan, Lynch, & Clark, 2005) and also depressive symptoms and general affective distress (Bishop & Warr, 2003; Edwards, Bingham, Bathon, & Haythornthwaite, 2006; Li, Gignac, & Anis, 2006; Roth, Lowery, & Hamill, 2004).

Within the theoretical framework of CBT, catastrophizing is viewed as a type of cognitive error or distortion in thought (Eimer & Freeman, 1998; Thorn 2004; Turk, 2002b; Turk & Flor, 2006). More specifically, those who catastrophize about pain may erroneously interpret pain sensations in an exaggerated and threatening manner. These distortions in thinking stem from maladaptive schemas that form from, and are
perpetuated by, multiple pain experiences over time as seen in chronic pain (Sullivan, et al., 2001). It would follow that perhaps catastrophizing would contribute to or engender a depressive disorder. Indeed, levels of catastrophizing at earlier time points have been found to significantly predict depression at subsequent time points (Keefe et al., 1989; Keefe et al., 1991). This suggests that catastrophizing – or the distorted processing of incoming pain related information – may not only be associated with depressive symptoms but also precipitate generalized depressive schema.

Catastrophizing also appears to be both an independent and powerful predictor of emotional functioning, as levels of catastrophizing predict degree of depressive symptomatology even when controlling for pain intensity, cognitive beliefs and coping variables (Turner, Jensen, & Romano, 2000). Such a strong association has led to concern regarding possible construct overlap of catastrophizing and depression (Sullivan et al., 2001), yet prior relationships found between catastrophizing and depression have not been sufficiently high to justify a single underlying concept (Jensen et al., 1991). Collectively, this evidence along with longitudinal data (Keefe et al., 1989; Keefe et al., 1991), not only suggests construct distinction, but also indicates catastrophizing as a process variable by which pain affects depression.

The Role of Acceptance in Functional and Emotional Outcomes in Chronic Pain

A predominant focus of prior investigations examining the effects of cognitive variables in pain outcomes has been on maladaptive thought patterns and coping strategies. However, there has been increasing interest in clarifying the adaptive mechanisms through which individuals maintain psychological well-being and achieve
maximal day-to-day functioning despite the presence of chronic pain. One such factor has been acceptance, a multifaceted and complex construct that has been conceptualized as a psychological state in which one does not attempt to control pain or a state of submission to the adverse experience of pain; rather, it is acknowledgement that pain does not necessarily need to interfere with living (McCracken, Carson, Eccleston, & Keefe, 2004; McCracken & Eccleston 2005). Thus, acceptance of chronic pain allows for a shift in an individual’s efforts regarding his or her pain: from active efforts to avoid pain and pain provoking activities to engagement in other, positive aspects of living despite pain.

Although research in this area is not as extensive as that which has investigated the effects of negative cognitive sets associated with pain (e.g., catastrophizing), evidence exists to suggest acceptance as a powerful predictor of both psychological and functional outcomes in the context of chronic pain. When negative coping and acceptance variables are investigated simultaneously for their effects on functioning, acceptance was found to account for more variance in both emotional distress and physical disability (McCracken & Eccleston, 2003; McCracken & Eccleston, 2006).

There is also evidence to suggest a directional relationship between acceptance and both emotional and physical functioning. In one longitudinal study involving a heterogeneous sample of chronic pain patients, the level of acceptance at an initial assessment was found to be negatively correlated with physical disability nearly four months later, including reduced work and shorter amounts of time engaged in standing and walking as a result of pain (McCracken & Eccleston, 2005). In addition, individuals who reported more acceptance at time 1 showed less depressive and anxiety symptomatology at follow-up (McCracken & Eccleston, 2005).
The attentional model of pain and its effects on functioning suggest that pain may serve as a form of attentional interference impeding the pursuit of goals and activities (Sullivan et al., 2001). Acceptance, like catastrophizing, may affect the degree to which pain distracts individuals from daily activities or engagement in a task at hand. Viane and colleagues (2004) found that individuals who showed greater acceptance of their pain devoted less attention to that pain and reported more engagement in daily activities. This suggests that acceptance allows for the re-direction of attention to daily activities or a task at hand. McCracken (2007) recently investigated the degree to which acceptance affects the amount of “cognitive interference” (e.g., somatic awareness, anxious thoughts regarding the pain and alertness) and found that those individuals who tended to be more accepting of their chronic pain condition had lower levels of cognitive interference. These findings were in addition to significant negative relationships with physical disability, work status and depressive symptomatology (McCracken, 2007). Although these findings suggest the positive effect of greater acceptance on functioning, interference variables from this study were measured via subjective report; thus, the relationship between acceptance and functioning is less tenable.

Two studies were identified that examined the effects of acceptance on direct assessment of physical functioning, however. McCracken, Vowles, and Eccleston (2005) found that chronic pain patients who underwent acceptance-based psychotherapy to better cope with their chronic pain showed increased levels of acceptance of their pain and also improvement in tests of physical functioning (walking time, sit-to-stand task) compared with non-treated, wait-listed patients. Other researchers (Vowles, McNeil et al., 2007) noted that when provided brief acceptance-based instruction and guidance (focusing on
the task at hand and not the pain), chronic back pain patients exhibited better performance on a test of physical impairment administered by physical therapist.

Relatively little experimental data exist implicating the positive role of acceptance on task performance in the context of pain. Results from a few studies involving healthy, pain-free individuals showed that a brief acceptance focused intervention resulted in longer tolerance times to a cold pressor task (Hayes et al., 1999) and electrical stimulation (Gutiérrez, Luciano, Rodríguez, & Fink, 2004; McMullen et al., 2008). Although the results from these two studies imply a form of persistence in behavior, they do little to elucidate the role of acceptance on task performance, or interference for that matter, that one may engage in concurrent with pain. Further, it remains unclear as to how levels of acceptance affect observed cognitive and emotional functioning in persons with chronic pain.

Catastrophizing and Acceptance: Are They Related?

The literature on catastrophizing and acceptance indicates that both of these constructs, when investigated separately, are significantly associated with various outcomes among persons with chronic pain. As noted previously, emotional and physical functioning outcomes have been shown to be associated with catastrophizing (Bishop & Warr, 2003; Edwards et al., 2006; Keefe et al., 1989; Li et al., 2006; Roth et al., 2004; Severeijns et al., 2001; Sullivan et al., 1998) and acceptance (McCracken, 2007; McCracken & Eccleston, 2003; McCracken & Eccleston, 2005; McCracken & Eccleston, 2006; Viane et al., 2004). There has been at least one study identified that investigated catastrophizing and acceptance simultaneously when evaluating the outcome of chronic
pain patients completing a multidisciplinary treatment program (Vowles, McCracken, & Eccleston, 2007). Results from regression analyses in this investigation indicated that changes in both of these variables across treatment were comparable in predicting outcomes in emotional and physical functioning.

The question remains, however, as to how these constructs may be generally related; and further, if or how they may work in tandem in the prediction of functional outcomes in chronic pain populations. Surprisingly, the literature offers little even in the realm of basic correlational analyses. Two studies found weak to moderate relationships between various ways of coping and levels of acceptance though catastrophizing was excluded from these analyses (McCracken & Eccleston, 2003; McCracken & Eccleston, 2006). Only two studies were identified that examined the relationship between acceptance and catastrophizing per se. In one investigation (Nicholas & Asghari, 2006), catastrophizing was operationalized by a 9-item subscale of the Pain-Related Self Statements Scale (Flor, Behle, & Birbaum, 1993). One other study by Viane and colleagues (2003) utilized a larger score range via a 17-item subscale on the Pain Cognition List (Vlaeyen et al., 1990) to measure catastrophizing. Both studies found a significant negative relationship between catastrophizing and measures of acceptance, but the instruments used appear to be less familiar and not as widely used as other measures of coping and catastrophizing, such as the Pain Catastrophizing Scale (Sullivan et al., 1995) or the Coping Strategies Questionnaire (Rosenstiel & Keefe, 1983).

In clarifying the degree to which these constructs are potentially interrelated, it is important to comparatively examine the conceptualizations of both catastrophizing and acceptance and postulate how they may function in a theoretical model of pain and
functioning. To date, it appears that such an examination has only been alluded to in the literature base (McCracken & Eccleston, 2003). McCracken and Eccleston (2003) posited that both catastrophizing and acceptance, in the context of chronic pain, involve the belief that pain is enduring. Catastrophizing, in essence, is a sense of helplessness in the face of ongoing pain. Acceptance, on the other hand, is a sense of ability to engage in life activity with ongoing pain (McCracken, Carson, Eccleston, & Keefe, 2004; McCracken & Eccleston, 2003). In terms of an attentional model (Sullivan et al., 2001), catastrophizing could be viewed as drawing attention to perceived pain, whereas acceptance directs it elsewhere. Thus, these two constructs are perhaps the proverbial two sides of the same coin.

However, acceptance has also been characterized as a means by which one is able to pursue valued goals despite feelings, thoughts or beliefs – whatever their valence may be (Hayes, Luoma, Bond, Masuda, & Lillis, 2006). This conceptualization is a fundamental tenet in a more recent offshoot of traditional cognitive behavioral therapy called Acceptance and Commitment Therapy (ACT; Hayes, 2004). Whereas traditional cognitive approaches aim to reduce the frequency and change the content of distorted negative thoughts, ACT focuses more on diffusing the influence of those thoughts (Hayes & Wilson, 1995). Individuals may, in a sense, become “fused” with their negative emotions, i.e., a negative cognition or appraisal of an event may be interpreted as true and one may act in a manner so as to reduce the assumed negative outcome. In the context of chronic pain, one may be faced with the possibility of engaging in a task, have the thought that the pain will become excruciating, and thus avoid that task in order to reduce the fear or anxiety that the thought produced. This “experiential avoidance” (Blackledge
& Hayes, 2001 p. 244) becomes maladaptive when it begins to obstruct the pursuit of valued goals and life activities.

Acceptance may aid in “defusing” the connection between negative cognitions and behavioral responses. Individuals with greater levels of acceptance may no longer be compelled to behave in a way to reduce these negative thoughts or private experiences because the believability of those very thoughts begins to dissolve (Blackledge & Hayes, 2001). Thoughts and feelings may inevitably arise from time to time, but the accepting individual sees them for what they are – mere thoughts or feelings that do not necessarily have to determine actions. Accordingly, acceptance may attenuate the effect of such negative thoughts or appraisals on functioning (Blackledge & Hayes, 2001; Hayes et al., 2006; Hayes & Wilson, 1995). In that vein, one who is accepting of his or her chronic pain may simultaneously perceive their pain to be intense and experience some degree of emotional distress but is not as influenced by the potential control of catastrophic thoughts over behavior. Indeed, treatments based on the ACT approach have been applied to chronic pain populations with success in terms of emotional and physical functioning outcomes (McCracken & Eccleston, 2005; McCracken, Vowles et al., 2005).

In sum, the predominant focus of acceptance-based treatment methods is development of a willingness to engage in valued goals even when one may be experiencing unpleasant thoughts, sensations or emotions (Hayes et al., 2006). This focus stems from the view that the pursuit of valued goals does not necessarily depend on reducing or eliminating negative thoughts or emotions antecedent to that behavior; rather, it is promoted by fostering acceptance of thoughts, emotions or sensations for what they are and not undue regulators of one’s choice in action. Following this theory, acceptance
could be viewed as a buffer to the impact of catastrophic thoughts on function. In statistical modeling, this parallels a moderational model, whereby the level of acceptance may explain the extent to which catastrophizing affects functional outcomes. One such hypothetical model is depicted in Figure 1.

Figure 1. Hypothesized model of acceptance as a moderator between catastrophizing and functional outcome.

Aims and Hypotheses

Understanding the role of psychological constructs such as catastrophizing and acceptance in the context of pain can yield possible alternative treatment avenues targeting the debilitating effects of chronic pain. Yet our knowledge to date about the potential effects of such factors has been mostly limited to subjective report in the absence of direct observation. Furthermore, and to the best of our knowledge, the laboratory-based studies directly examining interference due to psychological variables (e.g., catastrophizing) have been conducted mainly with normal healthy controls (Crombez et al., 1998; Vancleef & Peters, 2006; Van Damme et al., 2004) and not necessarily in chronic pain populations in which interference due to pain is of a greater
concern. Of the two published studies found that do involve chronic pain patients, one (Crombez et al. 2002) involved a relatively small sample size and utilized an experimental pain procedure (electrocutaneous shock) which may be less analogous to the pain found in chronic disease than the pain produced by other methods (e.g., ischemic tasks; Rainville, Feine, Bushnell, & Duncan, 1992). The other study used a pain provocation procedure that was somewhat equivocal; it involved having patients with chronic whiplash syndrome perform neck rotations and extensions that were perceived as threatening by the patients (Vangronsveld et al., 2007). This procedure had, at best, only the potential for inducing pain and no empirical evidence to suggest this to be a valid experimental pain procedure. Direct observation of the effects of psychological variables (e.g., catastrophizing and acceptance) on task performance within an induced pain state among persons with chronic pain not only will clarify the impact which these variables have on functioning among persons with chronic pain, it also will aid in corroborating existing evidence suggesting their role in functioning as defined by subjective report (Keefe et al., 1989; Severeijns et al., 2001; Sullivan et al., 1998).

Lastly, it remains unclear how catastrophizing and acceptance work individually, and possibly interrelatedly, on functional outcomes in chronic pain. In light of these gaps in the literature, the overarching aims of the present study are threefold. These aims are to investigate within a chronic pain population, 1) the effects of pain catastrophizing and acceptance on task performance and affective evaluations of pain in a laboratory pain-induced condition, 2) the effects of pain catastrophizing and acceptance on self-report measures of pain interference with daily activities and emotional functioning, and 3) the relationship between these two constructs and the potential moderating effect of
acceptance on the relationship between catastrophizing and functional outcomes. The four hypotheses for aim 1, the laboratory component of this study, were as follows:

1) Greater levels of catastrophizing would predict greater interference with task performance.
2) Greater levels of catastrophizing would predict higher affective ratings of pain in the evoked pain condition.
3) Greater levels of acceptance would predict less interference with task performance.
4) Greater levels of acceptance would predict lower affective pain ratings in the evoked pain condition.

There were also four hypotheses for aim 2, the investigation of the effects of catastrophizing and acceptance in subjects’ reports of pain interference on daily activities and emotional functioning. In this component of the study, the hypotheses were as follows:

1) Greater pain catastrophizing would be associated with greater pain interference in a variety of daily activities.
2) Greater pain catastrophizing would be associated with more self-reported depressive symptoms.
3) Greater levels of acceptance would be associated with less interference in day-to-day functioning.
4) Greater levels of acceptance would be associated with fewer self-reported depressive symptoms.
Finally, there were two hypotheses for aim 3. This aim was to examine the relationship between these two constructs and also the potential moderating effect of acceptance on the relationship between catastrophizing and functional outcomes. Specifically, it was hypothesized that:

1) A significant inverse relationship would emerge between catastrophizing and acceptance.

2) Acceptance moderates the relationship between catastrophizing and the four functional outcomes measured (interference in experimentally induced pain, self-reported pain interference, affective pain ratings, and depressive symptoms).

Secondary Goal and Aim

In addition, it appears that the majority of studies investigating catastrophizing, acceptance and functioning in the context of pain have involved either laboratory-based pain provocation paradigms or information obtained via subjective report (e.g., questionnaires). What appears lacking within this line of research is the bridging of these methodologies. Capturing data to elucidate mechanisms of interference, concurrent with subjective data, would provide a method with which to corroborate self-report. For this ancillary aim of the study, it is hypothesized that poorer performance during laboratory induced pain would be associated with higher self-reported pain interference in daily activities.
METHODS

Participants

Participants were 67 patients recruited from the University of Alabama at Birmingham Highlands Hospital Pain Clinic and the Doleys Clinic Pain and Rehabilitation Institute in Birmingham, Alabama. Patients needed to be 19-65 years of age, have a history of lumbar surgery (e.g., lumbar laminectomy and/or fusion) at least six months prior, and a diagnosis of chronic low back pain for six months or longer in order to be eligible for the study. Exclusion criteria included a diagnosis of severe psychiatric or personality disorder and, due to the ischemic nature of the induced pain procedure, patients were also ineligible if they had a history of peripheral vascular disease, severe cardiovascular disease or untreated hypertension (i.e., those with systolic pressure greater than 160 mm Hg or a diastolic pressure greater than 95 mm Hg). For ethical reasons, participants were not asked to discontinue pain medications. All participants gave informed consent for the study as required by the University of Alabama at Birmingham IRB. Monetary compensation was provided for participation.

The means of age, years of education and pain duration for the group are included in Table 1. Racial composition of the group was 94% Caucasian and 6% African American. Among the group, 58.2% were married, 32.9% were divorced/separated, 4.5% were widowed, and 4.5% were single/never married. There were 24 men (41.8%) and 39 women (58.2%). The majority of participants (61.2%) received disability benefits.
Measures

Pain Catastrophizing

To assess the degree of pain catastrophizing, the Pain Catastrophizing Scale (PCS; Sullivan et al., 1995) was used. This 13-item self-report scale has been used in both clinical and non-clinical samples. Participants were asked to rate on a scale of 0 (not at all) to 4 (all the time) the degree to which they experienced the thought or feeling as indicated by the item. The score range is 0-52, with higher scores indicating more catastrophizing. The PCS has been shown to have good internal consistency (Chronbach’s alpha = .87), test-retest reliability and construct validity (Sullivan et al., 1995).

Acceptance

To assess the degree of acceptance of participants’ chronic pain condition, the 20-item version of the Chronic Pain Acceptance Questionnaire (CPAQ) was used (McCracken, Vowles et al., 2004). Items on the CPAQ assess the level of activity participation despite pain and the degree to which one attempts to control or avoid pain. Individuals are instructed to rate on a scale of 0 (never true) to 6 (always true) the extent to which a given statement applies to them. The original form of this measure has been found to correlate with other measures of psychosocial functioning and data indicate good internal consistency (Geiser, 1992). The 20 items can be summed (with 9 items reversed scored prior to summing) for a total score of acceptance. Higher scores indicate a greater level of acceptance regarding one’s pain condition.
Performance Task

The performance outcome measure used in the present study was the Color-Word Inhibition condition from the Color-Word Interference Test of the Delis-Kaplan Executive Function System (D-KEFS; Delis, Kaplan, & Kramer, 2001). The Color-Word Inhibition task is essentially the Stroop procedure (Stroop, 1935), requiring examinees to state the ink color of printed words that spell a dissonant color. The Stroop procedure is a well established measure of concentration and attention (Lezak, 1995). Using the D-KEFS version, examinees have a maximum of 180 seconds to complete a stimulus page of 50 words although they are instructed to proceed as quickly as possible.

Although the Color-Word Inhibition condition was the primary outcome measure, the Word Reading condition of the Color-Word Interference Test of the D-KEFS was also used at baseline. This condition required one to read, as quickly as possible, words printed in black ink on a stimulus sheet. Only the Color-Word Inhibition condition scaled scores for both baseline and induced pain conditions were used in the analyses. To calculate the scaled score, the total number of errors was converted into a scaled score based on the examinee’s age. A higher scaled score for the color-word inhibition test indicates better task performance.

Pain Ratings

Pain Intensity was measured via a 0-10 numeric rating scale (NRS), with 0 = “no pain” and 10 = “absolute worst pain.” NRS pain ratings have been shown to be valid measures of pain intensity (Jensen & Karoly, 2001).
The Short Form McGill Pain Questionnaire (SF-MPQ; Melzack, 1987) was used to assess qualitative aspects of the ischemic pain experience and also ischemic pain intensity. The SF-MPQ consists of 15 descriptors (11 sensory; 4 affective) that are rated based on intensity using a Likert scale ranging from 0 (none) to 3 (severe). Three pain scores are derived from the sum of the intensity rank values of the words chosen for sensory, affective and total descriptors. The SF-MPQ also includes the Present Pain Intensity (PPI) score which requires respondents to mark the degree of experienced pain intensity from 0 (no pain) to 5 (excruciating). For the present study, the Affective, Sensory and PPI scores were used in analyses. The SF-MPQ is sensitive to changes in pain brought about by pharmacologic agents (Harden, Carter, Gilman, Gross, & Peters, 1991). It also demonstrates good validity and stability over time (Melzack & Katz, 1994).

Depressive Symptoms

The Patient Health Questionnaire-9 (PHQ-9, Spitzer, Kroenke, & Williams, 1999), a brief 9-item self-report depression screen, was used to assess the degree of depressive symptoms. The PHQ-9 was derived from the clinician administered Primary Care Evaluation of Mental Disorders (PRIME-MD), and as such, was developed specifically for use with medical patients in clinical settings. The nine items included on the PHQ-9 reflect Diagnostic and Statistical Manual of Mental Disorders (DSM) symptoms of depression and encompass both purely psychological (hopelessness, anhedonia) and somatic (fatigue, loss of appetite) symptoms. Each item is scored on a scale of 0-3, with a total possible score range of 27. Higher scores on the PHQ-9 are
indicative of greater depressive symptomatology. When used as a continuous measure, a cut-off score of 10 or more showed good sensitivity and specificity for clinically significant symptoms of depression (Kroenke, Spitzer, & Williams, 2001).

**Pain Interference**

Pain interference in activities of daily living was measured using the interference scale of the Brief Pain Inventory (BPI; Cleeland, 1989). This scale consists of seven items referencing general activity, mood, walking ability, work, social relationships, sleep and enjoyment in life. Respondents were asked to rate, on a scale of 0-10 (0 = does not interfere; 10 = completely interferes) the degree to which their pain interferes with each of these domains.

**Pain Provocation**

Ischemic pain was induced by a modified submaximal tourniquet procedure (Moore, Duncan, Scott, Gregg, & Ghia, 1979), as both affective and sensory pain responses have been shown to be evoked via ischemic pain (Raineville et al., 1992). Using this procedure, the participant was first required to elevate their arm above the heart level for 30 seconds in order to be exsanguinated. A standard blood pressure cuff was then wrapped around the arm above the elbow and inflated to 250 mmHg. Once the arm was occluded, participants performed 20 handgrip exercises of 2 seconds duration at 4-second intervals. This was done via a hand dynamometer at 50% of maximum grip strength. Participants’ maximum grip strength was determined prior to starting the ischemic procedure. Participants were asked to indicate the moment at which pain from
the procedure was first experienced (threshold) and the NRS level of the ischemic pain at that time was recorded. The NRS pain rating for ischemic pain at the time participants wished to discontinue the procedure (tolerance) was also recorded. The times and NRS ratings for both ischemic pain threshold and tolerance were not used in main outcome analyses for the present study. The ischemic procedure was stopped when the participants reached tolerance or after 15 minutes, whichever occurred first.

Procedures

*Self-Report Data Collection*

For the non-laboratory component of the study, participant scores on the PHQ-9 and BPI Interference Scale were obtained in order to investigate the relationship between catastrophizing and physical and emotional dysfunction. These measures were administered prior to the ischemic arm task.

*Laboratory-Based Data Collection*

Blood pressure vitals, current NRS scores related to chronic low back pain (baseline pain), CPAQ, and PCS scores were obtained from each participant prior to pain inducement. In addition, each participant was given the word reading and color-word inhibition test prior to the ischemic procedure in order obtain a baseline level of performance. The word reading task was given as a primer prior to the color-word inhibition task only in the baseline condition due to the limited time available during the procedure. When the ischemic procedure was initiated, the color-word inhibition task was conducted again when reported pain threshold was reached. SF-MPQ scores were
obtained immediately following termination of the procedure with the specific instruction to complete this questionnaire relative to the maximal pain experienced during the ischemic procedure (i.e., at pain tolerance). The protocol order for all measures administered is shown in Figure 2.

*Figure 2.* Procedural order of protocol for each participant. Abbreviations not elsewhere identified: W-R=word reading; C-W=color word inhibition; IP=ischemic pain; IPThr=ischemic pain threshold; IPTol=ischemic pain tolerance.

**Data Analyses**

Prior to conducting the main analyses, data were first inspected for any violations of the planned statistical tests. Tolerance values were all within normal limits indicating that there was no multicollinearity between the independent variables. Examination of partial regression plots and residual error distribution revealed that the assumptions of linearity, normal distribution and homoscedasticity were met. Lastly, leverage values for
individual cases did not indicate any extreme outliers and the Durbin-Watson values for all models were within normal range and thus the absence of uncorrelated error terms (autocorrelation) could be assumed. Therefore, no data transformations or statistical modifications were required for analyses.

**Testing of the Dependent Variables of Interest**

Analyses corresponding to the first and third aims of the study included a series of hierarchical multiple regressions. The first aim of this study was to conduct a laboratory-based investigation of the effects of pain catastrophizing and acceptance on affective evaluations and task performance in provoked pain conditions among chronic pain patients. Specifically, it was hypothesized that during an induced pain condition, 1) greater catastrophizing would predict higher affective ratings of pain, 2) greater catastrophizing would predict increased interference with task performance during induced pain, 3) greater acceptance levels would predict less interference with task performance, and 4) greater acceptance would predict lower affective ratings of pain. To explore the effects of catastrophizing and acceptance on task interference, demographic variables (education and duration of chronic low back pain) and performance on the color-word inhibition task prior to pain provocation were entered first into the model. Age was excluded in this model as the computed scaled score for the color-word inhibition task was based on age and therefore was already accounted for. This first block of variables was followed by baseline pain severity (participant’s background clinical back pain at the time of the study procedures) in order to determine if catastrophizing and acceptance account for variance in task performance independent of baseline pain.
severity. To test for relative changes in SF-MPQ ratings, a series of hierarchical multiple regression analyses (one for each scale) was performed. For each analysis, demographics (age, education, duration of chronic low back pain) and NRS ratings of baseline back pain obtained prior to pain provocation was entered first followed by catastrophizing and acceptance scores.

The second aim of the study was to investigate the effects of pain catastrophizing and acceptance on self-report measures of depression and pain interference with daily activities. In this non-laboratory component, it was hypothesized that the degree of catastrophizing would be significantly and positively associated with 1) self-reported depressive symptoms and 2) pain interference in daily activities. It was also hypothesized that higher levels of acceptance would be associated with 3) lower depression ratings and 4) less interference with daily activities. To determine these relationships, hierarchical regression analyses were used with demographics and baseline NRS pain ratings entered first followed by acceptance and catastrophizing.

In the above analyses, gender was not included as a demographic variable in order to maintain power with the current sample size. Although prior evidence suggests no significant differences between men and women on severity ratings of induced ischemic pain (Manning & Fillingim, 2002) or pain induced via cold pressor task (Robinson & Wise, 2003), effects of gender on the experience of pain have been established previously (Fillingim, 2000). Such effects may be attributable to the various phases of the menstrual cycle (Fillingim et al., 2007; Hellström & Anderberg, 2003) and controlling for that factor was not feasible and also deemed beyond the scope of this study. Tests of group
mean differences (t-tests) were conducted in order to examine any potential gender differences that may have emerged.

Tests of Moderation

The third aim of the study was to examine the relationship between catastrophizing and acceptance and to also investigate the potential moderating effect of acceptance on the relationship between catastrophizing and functional outcomes. The Pearson correlation between these two variables was first examined for indication of mutual relationship exclusive of other variables. Moderating properties of acceptance were examined via multiple regression analyses, a method that has been outlined previously (Baron & Kenny, 1986). Because the predictor and assumed moderator most likely are correlated with one another, these variables were centered by subtracting the variable mean from each score (Aiken & West, 1991; Cohen, Cohen, West, & Aiken, 2003). After centering of the data, interaction terms were created by the product of catastrophizing and acceptance scores. These variables were next used in hierarchical regression with catastrophizing and acceptance entered prior to the interaction term. Significance of a moderator effect was determined by the $F$ value associated with the change in variance after the interaction term was added to the model. If significance emerged, predicted outcome values were derived from simple slopes and intercepts in order to examine the particular form of the moderator effect. These values were used to graph the relationship between catastrophizing and outcome at different values of acceptance. The values chosen to graphically examine this effect were the mean of the moderator, the moderator plus 1 SD and the moderator less one SD (Cohen et al., 2003).
The ancillary aim of this study was to investigate the degree to which subjective report of “real-world” pain interference was corroborated by observed interference during laboratory induced pain. To determine this relationship, baseline color-word inhibition scores were controlled for and the partial correlation coefficient between color-word inhibition scores during evoked pain and self reported BPI scores was examined. An alpha level of $p=.05$ was adopted for all statistical analyses.
RESULTS

The ischemic task procedure was effective for inducing pain as the average pain rating (based on a 0-10 scale of ischemic pain in arm) was 5.09 (SD=2.12, range = 2-10) at threshold and 7.96 (SD = 1.93, range = 2-10) at tolerance. Means of the predictor and outcome variables are presented in Table 1. The mean and variability of CPAQ scores are comparable to the range of means and standard deviations (Ms=46.50-58.22, SDs = 6.90-18.03) found in previous studies in chronic pain populations (McCracken & Eccleston, 2005; McCracken, Vowles et al., 2005; Nicholas & Asghari, 2006; Viane et al., 2003; Vowles, McCracken et al., 2007). The mean and variability of PCS scores were higher than the range of means (Ms =14.17-18.95; SDs = 6.5-8.4) found in non-pain healthy individuals (Crombez et al., 1998; Van Damme et al., 2004; Vancleef & Peters, 2006) but analogous to the range of means and standard deviations (Ms = 15.08-27.96, SDs = 10.47-12.78) found in chronic pain samples (Crombez et al., 2007; Sullivan et al., 1998; Tripp et al., 2006; Vangronsveld et al., 2006).

To examine whether gender would pose as a potential confounding variable, t-tests were conducted on the various outcomes. Due to the sample size discrepancy, t values were based on pooled variance estimates. Results from Levene’s test of inequality of variances were all non-significant with the exception of PCS mean scores. Thus, the Welch-Satterthwaite correction for unequal variances was used in this case when determining the degrees of freedom with which to compare the computed t-value. In
Table 1
Means and Standard Deviations of Predictors and Outcome Measures Used in Regression Analyses

<table>
<thead>
<tr>
<th>Predictor Variables</th>
<th>M</th>
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<th>Range</th>
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<tbody>
<tr>
<td>Age</td>
<td>50.43</td>
<td>8.39</td>
<td>24-65</td>
</tr>
<tr>
<td>Education</td>
<td>12.94</td>
<td>2.37</td>
<td>8-19</td>
</tr>
<tr>
<td>Duration of Pain (in years)</td>
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<td>10.77</td>
<td>1.5-50</td>
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<tr>
<td>C-W (Time 1)</td>
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<td>2.75</td>
<td>3-12</td>
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<tr>
<td>Baseline Pain Severity (0-10)</td>
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<td>2.19</td>
<td>0-10</td>
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Variables of Interest

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<tr>
<th></th>
<th>M</th>
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<tr>
<td>Catastrophizing</td>
<td>25.63</td>
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<td>Acceptance</td>
<td>49.79</td>
<td>20.97</td>
<td>11-99</td>
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Outcome Measures (Lab-Based)

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<th></th>
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<tr>
<td>C-W (IP)*</td>
<td>7.84</td>
<td>3.45</td>
<td>1-12</td>
</tr>
<tr>
<td>MPQ Sensory</td>
<td>14.14</td>
<td>8.41</td>
<td>1-35</td>
</tr>
<tr>
<td>MPQ Affective</td>
<td>2.49</td>
<td>3.26</td>
<td>0-11</td>
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<tr>
<td>MPQ PPI</td>
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Outcome Measures (Self-Report)

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<tr>
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<th>SD</th>
<th></th>
</tr>
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<tbody>
<tr>
<td>PHQ-9</td>
<td>12.87</td>
<td>6.15</td>
<td>2-27</td>
</tr>
<tr>
<td>BPI</td>
<td>45.73</td>
<td>13.96</td>
<td>12-70</td>
</tr>
</tbody>
</table>

Note. * Mean and standard deviation of the C-W (IP) scaled scores are based on the 63 participants completing this task during the ischemic procedure. C-W=Color-Word Inhibition; IP=ischemic pain; SF-MPQ=Short Form McGill Pain Questionnaire; SF-MPQ PPI=Short Form McGill Pain Questionnaire Present Pain Intensity; PHQ-9=Patient Health Questionnaire-9; BPI=Brief Pain Inventory interference items.

regards to PCS scores, there were no differences between men ($M = 25.07, SD = 10.13$) and ($M = 26.03, SD = 13.92; t(64.8) = -.309, ns$). Likewise, no differences were found in terms of levels of acceptance for men ($M = 50.11, SD = 17.70$) versus women ($M = 49.56, SD = 23.28; t(65) = -1.065, ns$). SF-MPQ Sensory, Affective and PPI scores were relatively the same for men ($M = 14.61, SD = 8.86; M = 3.07, SD = 3.53$; and $M = 2.43, SD = 1.03$ respectively) as they were for women ($M = 13.79, SD = 8.16; M = 2.08, SD = 3.04$; and $M = 2.67, SD = 1.06$ respectively), as respective $t$ values were $t(65) = .332, ns$; $t(65) = 1.222, ns$; and $t(65) = -.920, ns$. Although ischemic pain threshold and tolerance
NRS ratings were not used in the primary analyses, potential differences in perceived severity of the pain provocation procedure were also examined. No significant difference emerged between men ($M = 4.79, SD = 1.93$) and women ($M = 5.31, SD = 2.25$) in terms of ischemic pain severity at threshold ($t(65) = -0.985, ns$). Similarly, ratings at ischemic pain tolerance were also found to be equivalent between men ($M = 7.89, SD = 2.01$) and women ($M = 8.00, SD = 1.91; t(65) = -0.224, ns$).

Potential differences across the two pain treatment centers from which participants were recruited were also examined. A total of 43 and 24 individuals from the UAB Highlands and Doleys Clinics, respectively, participated in the study. Tests to detect inequality of variances were non-significant for all comparisons between the two sites. Due to unequal sample sizes, however, $t$ values based on a pooled variance estimate were used. CPAQ scores were slightly lower among participants at UAB Highlands ($M = 48.26, SD = 22.20$) than at the Doleys Clinic ($M = 52.54, SD = 18.70$), but this was not a significant difference, $t(65) = -0.792, ns$. There was also a non-significant difference between PCS scores of those recruited from UAB Highlands ($M = 25.74, SD = 13.47$) versus those from the Doleys Clinic ($M = 25.42, SD = 10.49; t(65) = .100, ns$). No differences with respect to age of participants from UAB Highlands ($M = 51.47, SD = 7.54$) versus those from the Doleys Clinic ($M = 48.58, SD = 9.63$) were found ($t(65) = 1.35, ns$). Education levels were also similar between those from UAB ($M = 12.77, SD = 2.16$) and those from the Doleys Clinic ($M = 13.25, SD = 2.74; t(65) = -0.784, ns$).

Participants from UAB Highlands had somewhat shorter durations of pain ($M = 15.17, SD = 9.71$) than the participants from the Doleys Clinic ($M = 18.00, SD = 12.46$), but this did not differ significantly ($t(65) = -1.02, ns$). Baseline pain severity also did not differ
between the groups (UAB $M = 5.44, SD = 2.31$; Doleys $M = 6.33, SD = 1.86$; $t(65) = -.891$, $ns$). Lastly, baseline color-word inhibition scores of participants from UAB Highlands ($M = 7.51, SD = 2.66$) versus those from the Doleys Clinic ($M = 8.83, SD = 2.76$) were also not significant ($t(65) = -1.90$, $ns$).

For the one analysis of task interference during induced pain, 63 of the 67 participants completed the color-word inhibition test during the ischemic procedure. The remaining four participants were unable to tolerate the ischemic procedure long enough to complete the color-word inhibition trials during induced pain; consequently, any items not attempted by these participants could not be counted as errors per se and no total score could be computed. Based on such a large sample size discrepancy, the Welch-Satterthwaite correction for unequal variances was used for all comparisons. Using $t$ values based on pooled variance estimates, inspection of possible differences between those who completed the test during ischemic pain and those who did not was conducted. No differences with respect to age of those who completed the task ($M = 50.25, SD = 8.61$) versus those who did not ($M = 53.25, SD = 2.63$) were found ($t(6.94) = -.670$, $ns$). Education among those who completed the task ($M = 12.94, SD = 2.41$) and those who did not ($M = 13.00, SD = 2.00$) were also similar ($t(3.58) = -.049$, $ns$). Pain duration in years for those completing ($M = 16.07, SD = 10.06$) and for those who did not ($M = 18.00, SD = 21.37$) did not differ significantly ($t(3.10) = -.374$, $ns$) as well as the baseline pain severity on for those completing ($M = 5.80, SD = 2.25$) versus those who did not complete the task under induced pain conditions ($M = 5.25, SD = 0.50$; $t(14.29) = .601$, $ns$). The difference in means between those completing the second trial of the color-word inhibition test during induced pain ($M = 8.05, SD = 2.80$) versus those who did not ($M =
7.00, $SD = 1.83$) was also not significant ($t(3.95) = .799, ns$). Although the mean of acceptance scores for the participants who completed the test during the ischemic pain procedure was higher ($M = 50.37, SD = 20.75$) than for those who did not ($M = 40.75, SD = 25.75$), this difference did not reach significance ($t(3.25) = 0.963, ns$). Catastrophizing scores for those who completed the task were lower ($M = 25.05, SD = 12.38$) than for participants who did not complete the task ($M = 34.75, SD = 9.98$) but this difference was not statistically significant ($t(3.61) = -1.662, ns$).

Correlations Between Predictors and Outcome Variables

Correlations between the predictor variables controlled for (age, education, pain duration, baseline pain, baseline color-word inhibition scores), predictor variables of interest (catastrophizing and acceptance) and outcome measures (color-word inhibition scores during induced pain, the SF-MPQ scales, PHQ-9 and BPI) are presented in Table 2. As expected, age was positively correlated with pain duration. Higher levels of severity in terms of baseline pain were also associated with age. More education was associated with higher acceptance scores, lower catastrophizing scores, less task interference during induced pain, lower reported depressive symptoms and less self-reported pain interference in day-to-day activities. Baseline pain severity was also found to be positively associated with depressive symptoms and daily pain interference. Among the predictor variables of interest, levels of acceptance were associated with less catastrophizing, better task performance during the ischemic pain procedure, lower scores on the sensory, affective and total subscales of the SF-MPQ, and lower self-reported
Table 2
Correlations Between Study Variables

<table>
<thead>
<tr>
<th></th>
<th>Age</th>
<th>Educ.</th>
<th>Pain Duration</th>
<th>Baseline Pain</th>
<th>Baseline Task</th>
<th>PCS</th>
<th>CPAQ</th>
<th>Time 2 Task</th>
<th>MPQ SEN</th>
<th>MPQ AFF</th>
<th>MPQ PPI</th>
<th>PHQ-9</th>
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<td>C-W (IP)</td>
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<td>-.184</td>
<td>.004</td>
<td>-.006</td>
<td>.442**</td>
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<td>-.119</td>
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<td>.580**</td>
<td>.617**</td>
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<td>-.300*</td>
<td>.701**</td>
<td>-.541**</td>
<td>-.406**</td>
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<td>.116</td>
<td>.341**</td>
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<td>.247*</td>
<td>.245*</td>
<td>.244*</td>
<td>.642**</td>
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</table>

Note. n = 63 for coefficients related to relationship between C-W IP and study variables. All other study variables are based on the total group, n = 67. PCS = Pain Catastrophizing Scale; CW=color-word inhibition; IP=ischemic pain; CPAQ = Chronic Pain Acceptance Questionnaire; MPQSEN, MPQAFF, and MPQPPI = McGill Pain Questionnaire Short Form Sensory Score, Affective Score and Present Pain Intensity Score respectively; PHQ-9 = Patient Health Questionnaire-9; BPI = Brief Pain Inventory.

* p < .05. **p < .01.
depressive symptoms and pain interference. Catastrophizing was found to be negatively associated with task performance during induced pain. Conversely, catastrophizing was positively associated with all four SF-MPQ scales, depressive symptoms and self-reported pain interference.

Laboratory-Based Task Interference During Ischemic Pain

A hierarchical regression analysis was used to investigate the relative contribution of levels of acceptance and catastrophizing to task interference during evoked pain. As noted in Table 3, demographic variables and baseline color-word inhibition scores were entered first in the model and accounted for 54% of the variance in the color-word inhibition scores obtained during the ischemic procedure, $F(3, 59) = 23.477, p < .001$. In order to examine the effects of acceptance and catastrophizing on induced pain task interference above and beyond the effect of any baseline pain, baseline pain severity scores were entered next in the model. The contribution of baseline pain severity was found to be non-significant, $F(1, 58) = .287, ns$. Finally, when acceptance and catastrophizing scores were entered, an additional and significant 11.8% of the variance in task performance during induced pain was accounted for, $F(2, 56) = 9.80, p < .001$. Examination of the standardized regression coefficients for this model revealed a significant and positive association between acceptance on task performance (i.e., predicted less task interference) during induced pain ($t = 3.65, p = .001$), whereas catastrophizing showed no effect ($t = 0.30, ns$).
Laboratory-Based Pain Ratings of Ischemic Pain

Hierarchical regression analyses were conducted to examine the relative contributions of levels of acceptance and pain catastrophizing to SF-MPQ pain ratings of the induced ischemic pain. In all of these analyses, demographics were entered first followed by baseline pain severity in order to determine the effects of the variables of interest on ischemic pain ratings above and beyond baseline pain severity. Levels of acceptance and catastrophizing were entered last. Table 4 shows the results from the first analysis examining the prediction of SF-MPQ Sensory scores. The demographic variables did not account for a significant portion of variance in SF-MPQ Sensory scores, $F(3, 63) = 1.65$, *ns*, nor did baseline pain severity, $F(1, 62) = .003$, *ns*. However, entering
acceptance and catastrophizing scores last in the model accounted for an additional 15.4% of the variance in SF-MPQ Sensory scores which was found to be significant, $F(2, 60) = 5.984, p = .004$. The standardized regression coefficients for this model indicated that only catastrophizing showed a significant and positive effect on SF-MPQ Sensory pain ratings of induced ischemic pain ($t = 2.903, p = .005$). The degree to which acceptance had an effect was not significant ($t = 0.193, ns$).

Table 4
Hierarchical Regression Analysis for Prediction of SF-MPQ Sensory Scores From Pain Catastrophizing and Acceptance

<table>
<thead>
<tr>
<th>Model and Predictors</th>
<th>$B$</th>
<th>$SE$</th>
<th>$\beta$</th>
<th>$\Delta R^2$</th>
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<tbody>
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<td>.137</td>
<td>.103</td>
<td>.073</td>
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<td>-.210</td>
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<tr>
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<td>.148</td>
<td>.100</td>
<td>.000</td>
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<td>.457</td>
<td>-.167</td>
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<td>.515</td>
<td>-.007</td>
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<tr>
<td>Age</td>
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<td>.137</td>
<td>.092</td>
<td>.154 **</td>
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<td>Education</td>
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<td>.442</td>
<td>-.076</td>
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<tr>
<td>Duration of Pain</td>
<td>-.107</td>
<td>.104</td>
<td>-.137</td>
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<tr>
<td>Baseline Pain</td>
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<td>-.079</td>
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<td>Catastrophizing</td>
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<td>.102</td>
<td>.438 **</td>
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<tr>
<td>Acceptance</td>
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<td>.060</td>
<td>.029</td>
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</tr>
</tbody>
</table>

* denotes $p \leq .05$; ** denotes $p \leq .01$

Results from the hierarchical regression for the prediction of SF-MPQ Affective scores are shown in Table 5. The demographic variables accounted for a significant portion of variance in SF-MPQ Affective scores, $F(3, 63) = 2.295, p = .041$, and this appeared to be most attributable to age. Specifically, greater age was associated with
Table 5  
*Hierarchical Regression Analysis for Prediction of SF-MPQ Affective Scores From Pain Catastrophizing and Acceptance*

<table>
<thead>
<tr>
<th>Model and Predictors</th>
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<th>$\Delta R^2$</th>
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<td>.165</td>
<td>-.195</td>
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<tr>
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<td>.041</td>
<td>-.161</td>
<td>.122</td>
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<td>Age</td>
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<td>.284</td>
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<td>.042</td>
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<td>-.029</td>
<td>.001</td>
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<td>3</td>
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<tr>
<td>Age</td>
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<td>.053</td>
<td>.276</td>
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<td>.040</td>
<td>-.099</td>
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<td>Baseline Pain Severity</td>
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<td>.188</td>
<td>-.077</td>
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<td>.040</td>
<td>.235</td>
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<tr>
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<td>.023</td>
<td>-.156</td>
<td>.108</td>
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</tbody>
</table>

* denotes $p \leq .05$; ** denotes $p \leq .01$

higher affective ratings. Adding baseline pain severity did not account for any significant proportion of variance, $F(1, 62) = .049, ns$. While there was a substantial change in variance when catastrophizing and acceptance were entered into the model, $F(2, 60) = 4.204, p = .02$, the regression coefficients for these two variables did not reach significance ($t = 1.561, ns$, for catastrophizing; $t = -1.053, ns$, for acceptance).

Interestingly, age appeared to have a significant effect throughout the steps of the model, with a significant regression coefficient ($t = 2.019, p = .048$) for age emerging after the final step.

Finally, the results of the hierarchical regression analysis predicting SF-MPQ PPI scores are shown in Table 6. Similar to the analysis on SF-MPQ Sensory scores,
demographics, $F(3,63) = 1.506, ns$, and baseline pain severity, $F(1, 62) = 1.095, ns$, did not contribute significantly to the variance in SF-MPQ PPI pain ratings of induced ischemic pain. Entering catastrophizing and acceptance scores last in the model accounted for an additional and significant 16.8% of the variance in SF-MPQ PPI scores, $F(2,60) = 6.723, p = .002$. Examination of standardized regression coefficients indicated that higher catastrophizing scores were significantly associated with greater SF-MPQ PPI pain ratings of induced ischemic pain ($t = 3.504, p = .001$), whereas no relationship emerged with acceptance ($t = 1.194, ns$).

Table 6
Hierarchical Regression Analysis for Prediction of SF-MPQ PPI Scores From Pain Catastrophizing and Acceptance

<table>
<thead>
<tr>
<th>Model and Predictors</th>
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<th>$\Delta R^2$</th>
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<td>.013</td>
<td>-.150</td>
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<td>Age</td>
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<td>Baseline Pain Severity</td>
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<td>.061</td>
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* denotes $p < .05$; ** denotes $p < .01$
Catastrophizing, Acceptance and Self-Reported Depressive Symptoms

A total of 47 participants (70.1%) had total scores of 10 or higher on the PHQ-9 which is considered indicative of clinically significant depressive symptoms (Kroenke et al., 2001). The relative contributions of pain catastrophizing and levels of acceptance to self-reported depressive symptoms were also investigated via hierarchical regression. These results are shown in Table 7. Similar to the aforementioned analyses, demographics were entered first; however, baseline pain severity was also included in this first block as induced pain was not a focus of this particular investigation and therefore baseline pain was not considered as a potentially significant confounding variable affecting outcome. Nonetheless, when this block was entered, it accounted for a small but significant portion of the variance in PHQ-9 scores, $F(4,62) = 2.540, p = .049$. When catastrophizing and acceptance scores were entered next, these variables increased the amount of variance accounted for by 41.9% and this was significant, $F(2,60) = 28.492, p < .001$. The standardized regression coefficients indicated baseline pain severity to be associated with PHQ-9 scores in the final model ($t = 2.043, p = .045$). Catastrophizing showed a significant and positive association with self-reported depressive symptoms ($t = 5.077, p < .001$). An inverse relationship emerged with acceptance, although this did not reach significance ($t = -1.517, ns$).

Catastrophizing, Acceptance and Self-Reported Pain Interference

The final regression analysis examined the prediction of self-reported pain interference from catastrophizing and levels of acceptance. Similar to the model predicting PHQ-9 scores, the first block of demographic variables and baseline pain
severity contributed to a significant portion of the variance in PHQ-9 scores, $F(4,62) = 3.455, p = .013$. The amount of variance accounted for increased by 49% when catastrophizing and acceptance scores were entered, $F(2,60) = 44.882, p = .000$. As seen in Table 7, a significant inverse relationship emerged between levels of acceptance and the degree of self-reported pain interference ($t = -6.451, p = .000$). Baseline pain severity and catastrophizing showed a trend towards significance ($t = 1.840, p = .071$ and $t = 1.798, p = .077$, respectively) in the final model.

Table 7

Hierarchical Regression Analyses for Prediction of Self-Reported Depressive Symptoms and Pain Interference from Pain Catastrophizing and Acceptance

<table>
<thead>
<tr>
<th>Model and Predictors</th>
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<th>β</th>
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<tr>
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<tr>
<td>Age</td>
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<td>.061</td>
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* denotes $p \leq .05$; ** denotes $p \leq .01$
Moderating Effects of Acceptance

As noted in Table 2, catastrophizing and acceptance are indeed significantly related and in a moderate to strong negative direction ($r = -.629, p = .000$).

When examining the moderating effects of acceptance on the various outcomes, only the model predicting task performance during laboratory induced pain produced significant results. In this model, centered education and baseline C-W scores were entered followed by the centered catastrophizing and acceptance scores. When the interaction terms were added in the final step, this produced a significant change in the variance of task performance accounted for, $F(1,57) = 4.893, p = .031$. To elucidate the nature of the interaction, simple slopes analysis was conducted (Cohen et al., 2003). Simple slopes corresponding to the relationship between catastrophizing and color-word inhibition scaled score during ischemic pain at varying levels of acceptance are graphically depicted in Figure 3. Specifically, it appears that when acceptance is high, task performance improves even as catastrophizing increases. Conversely, when acceptance is low, task performance is reduced as catastrophizing increases.

The simple slopes depicted in Figure 3 were also tested to determine if they were statistically significant from zero. When acceptance was high, the degree to which performance varies with levels of catastrophizing showed a trend toward significance, $t(59) = 1.756, p = .08$. The slopes at both moderate and low levels of acceptance were non-significant ($t(59) = .625$, ns; $t(59) = -.741$, ns, respectively).

Although the moderating effect of acceptance showed a trend toward significance in the prediction of self-reported pain interference, $F(1,61)=3.171, p = .08$, the interaction
terms did not significantly contribute to this model nor the models predicting self-reported depressive symptoms or pain ratings of laboratory induced pain.

Figure 3. Relationship between catastrophizing and task performance during the ischemic procedure at varying levels of acceptance.

Relationship Between Laboratory-Based Task Interference and Self-Reported Pain Interference

The secondary aim of the present study was to investigate the degree to which observed task interference corroborated self-report of pain interference in day-to-day activities. As noted in Table 2, better performance of those completing the color-word inhibition test during induced ischemic pain was significantly and inversely related to the
degree of self-reported pain interference ($r = -.313, p = .013$). This relationship remained significant even when controlling for baseline task performance ($pr = -.301, p = .018$).
DISCUSSION

The primary objective of the current investigation was to clarify the role of psychological constructs such as catastrophizing and acceptance in pain interference and emotional functioning. This study accomplished this objective by means of both an experimental pain procedure and also measures of self-report.

For the experimental portion of the study, it was hypothesized that more catastrophizing would be associated with poorer task performance (i.e., more interference) while acceptance, on the other hand, would be associated with better performance. Overall, results indicated that 1) level of catastrophizing was not associated with task interference during evoked pain, and 2) greater acceptance of one’s chronic pain condition was associated with better task performance (i.e., less interference) during evoked pain. The prediction of task performance from level of acceptance was significant above and beyond any contributions from baseline pain, performance without induced pain, and education. Thus, only the hypothesis predicting an effect from acceptance on task performance during experimentally induced pain was supported.

During the ischemic procedure, SF-MPQ pain ratings based on the induced ischemic pain were also investigated, with specific focus on scores from the SF-MPQ Affective Scale serving as a proxy for lab-based emotional status from induced pain. Therefore, a hypothesis was only posited for the potential results regarding this scale. This hypothesis was not supported, however, as neither catastrophizing nor acceptance
showed an effect on the affective evaluations of pain. For the other scales of the SF-MPQ, catastrophizing consistently showed a significant effect on pain ratings, such that greater catastrophizing was associated with endorsement of sensory verbal descriptors of pain and general pain intensity. No effect emerged with acceptance in regards to any of the pain rating scales.

In terms of the effects of pain catastrophizing and acceptance on self-report measures of in vivo pain interference with daily activities, it was hypothesized that higher levels of catastrophizing would be associated with greater pain interference while acceptance would show the converse. Together, both catastrophizing and acceptance accounted for nearly half the variance in subjective report of pain interference. Upon closer examination, this appeared to be due mainly to the effect of acceptance, such that higher acceptance of one’s pain was associated with higher self-reports of day-to-day functioning. Thus, the present results indicated support for only the hypothesis that acceptance would be positively associated with self-reports of pain interference.

The role of catastrophizing and acceptance in reported depressive symptoms was also examined. It was hypothesized that greater catastrophizing would be associated with higher self-reported depression and that acceptance would be associated with fewer of these symptoms. Only the hypothesis concerning catastrophizing in this domain was supported. When both catastrophizing and acceptance were entered into the model, nearly 42% of the variance of reported depressive symptoms was accounted for which appeared to be attributable to catastrophizing. Specifically, results of the present study indicated that greater catastrophizing was associated with greater depressive symptomatology, whereas no relationship emerged between acceptance and depressive symptoms.
While the first objective of this study was to elucidate how catastrophizing and acceptance work individually, a second objective was to clarify how these constructs may function in tandem on functional outcomes in chronic pain. Given the theoretical framework of acceptance-based interventions (Hayes, 2004; Hayes et al., 2006), tests for a moderating role of acceptance were conducted. From the literature base, it appears that this is the first study to provide evidence that acceptance may moderate the relationship between catastrophizing and task interference during induced pain in the laboratory. This was the only model supported in the hypothesized role of acceptance as a moderator in functional outcome. The moderating effect did not reach significance in the model predicting self-reported pain interference and no effect was observed on the relationship between catastrophizing and self-reported depressive symptoms and ratings of induced pain.

In addition to investigating the experimental and self-report interference outcomes in a mutually exclusive manner, the current study also sought to examine the degree to which experimental outcome corroborated self-report of pain interference. There was indeed some degree of corroboration between self-report and laboratory based interference from induced pain, albeit this relationship was small to moderate at best.

Catastrophizing and Interference

*Self Reports of Pain Interference*

Studies have consistently shown that among individuals with chronic pain conditions, those tending to catastrophize about their pain report greater disability and functional interference (Keefe et al., 1989; Severeijns et al., 2001; Sullivan et al., 1998).
Yet results from the current investigation did not find a positive relationship between catastrophizing and pain interference in various life activities when controlling for other factors. One study did produce results similar to the present findings in terms of catastrophizing and self-reported physical functioning. Jensen, Turner, and Romano (2001) investigated the changes in catastrophizing and patient reported disability pre and post treatment at a multidisciplinary pain management facility. These researchers found that changes in catastrophizing showed significant and positive associations with patient reported disability; however, when changes in catastrophizing were entered into a regression analysis with other predictors (e.g., pain beliefs and coping), the relationship with reported disability was not significant. The present study also indicated a significant correlation between catastrophizing and reported pain interference, but this relationship did not exhibit significance above and beyond demographics or the construct of acceptance.

One explanation of the possible discrepancy between the current findings and those of prior studies may be in the measures utilized. Many of the existing studies examining the effect of catastrophizing on functional interference have utilized versions of the Roland and Morris Disability Questionnaire, a measure comprised of 24 yes/no items addressing specific forms of physical functioning and movements (Roland & Morris, 1983). Studies utilizing this scale that have found positive relationships between catastrophizing and functional disability have involved general chronic pain patients (Tan, Jensen, Robinson-Whelen, Thornby, & Monga, 2001; Jensen Turner & Romano, 2001) and individuals with chronic low back pain (Smeets et al., 2006; Woby, Watson, Roach, & Urmston, 2004). In the present investigation, reported pain interference in daily
activities was measured by the seven interference items on the BPI (Cleeland, 1989). This scale is more global in nature, as respondents are asked to indicate the degree to which pain interferes generally with not only physical (e.g., general activity, walking ability) but also emotional, psychosocial, and potentially cognitive (e.g., mood, social relationships, work, enjoyment in life) domains as well. These items are also rather non-specific; thus, there is some degree of subjective inference when responding. Interference in work, for example, may either imply more cognitive or physical functional impairments depending on the respondent. Perhaps inclusion of generalized and more heterogeneous facets of functioning may have confounded any relationship that may have emerged.

*Interference from Laboratory Induced Pain*

Previous research has indicated that in healthy, pain-free individuals, catastrophic thinking about pain was associated with greater interference during experimentally induced pain (Crombez et al., 1998; Crombez et al., 2002; Vancleef & Peters, 2006). The construct of catastrophizing has been characterized as a proclivity to ruminate or fixate upon a painful experience (Sullivan et al., 1995) which consequently leads to a reduced ability to divert attention to other stimuli outside of that pain (Sullivan et al., 2001). In line with this theory, existing evidence indeed shows that catastrophizing about pain is related to greater difficulty in shifting one’s attention from pain to non-pain related stimuli (Van Damme et al., 2004). In the present study, results supporting this notion were not found. One possibility is that the majority of the experimentally based catastrophizing and interference studies have been conducted on pain-free individuals. It is possible that the effects of catastrophizing may manifest differently in those living with
pain on a chronic basis. Moreover, studies measuring catastrophizing in pain-free samples have asked participants to recall prior painful experiences and rate catastrophic thinking according to those painful experiences (Crombez et al., 1998; Vancleef & Peters, 2006; Van Damme et al., 2004). In pain-free individuals, heterogeneity in “painful events” is likely, whereas individuals with chronic low back pain, as participants had in this study, have at least some consistency in context for which they are rating their catastrophic appraisals. Catastrophic thinking in terms of chronic low back pain may differ from episodes of pain stemming from a variety of causes.

Two studies have investigated the effect of catastrophizing on task interference among persons with chronic pain. One study involving patients with chronic whiplash found greater task performance deterioration during induced pain when compared to pain-free individuals (Vangronsveld et al., 2007). Unlike this prior study, the current results noted no relationship between catastrophizing and task performance during experimentally induced pain among persons with chronic pain. Methodological differences do exist between the current investigation and the former, however. The pain provocation procedure used in the study by Vangronsveld et al. (2007) was neck rotations and extensions that were perceived as threatening by the patients. Although ischemic pain is considered comparable to that which is experienced in chronic pain conditions (Rainville et al., 1992), perhaps an induction procedure that involves activity directly related to what one catastrophizes about produces greater interference. Crombez and colleagues (2002) also examined catastrophizing and experimentally observed pain interference among 33 chronic low back pain patients from electrocutaneous shock. Unlike the results from the current study, Crombez et al. (2002) found that those who
reported a greater degree of catastrophic thinking about their pain showed greater task interference on a tone discrimination task in the presence of painful stimuli. At present, available data are insufficient to clarify this issue.

Another explanation for the discrepancy between the results of prior studies and the present investigation lies in the definition of task interference. All of the aforementioned studies of both pain free and chronic pain samples defined interference on the basis of retardation in reaction times on a tone discrimination task, and not observed errors per se. In fact, Crombez and colleagues (1998) noted no difference among catastrophizers and non-catastrophizers in the number of errors committed during painful conditions. What these researchers describe as attentional interference (Vancleef & Peters, 2006) or attentional interruption (Crombez et al., 2002) may more accurately reflect the cognitive domain of processing speed and not necessarily attention. Catastrophizing aside, persons with chronic pain show greater impairments on processing, psychomotor speed and also tasks of attention in which performance is based on error (Hart et al., 2000). In regards to Sullivan and colleagues’ (1995, 2001) attentional model of the effect of catastrophizing on pain interference, the question remains as to whether “attentional interference” denotes completion of that task with relatively poorer outcome (i.e., error) or a reduced speed by which a task is completed with good outcomes. At present, this may remain arbitrary when examining the role of catastrophizing on cognitive aspects of attention, as this cognitive domain consists of rather heterogeneous components (Mirsky & Duncan, 2001). Consensus on the definition of task or attentional “interference” is warranted for future validation of this theoretical model.
Lastly, the significant findings on task interference in prior literature (Crombez et al., 1998; Vancleef & Peters, 2006; Van Damme et al., 2004) and the lack thereof in the current study may be due to when, in the study protocol, the participants were asked to complete the PCS. In the previous studies cited above, the PCS was given following the pain provocation procedure and attention tasks. This ordering of methods may have inadvertently introduced response bias. It is conceivable that individuals’ awareness of their own performance may have influenced ratings on this measure. Moreover, catastrophizing has been found to be associated with negative affect (Bishop & Warr, 2003; Edwards et al., 2006; Li et al., 2006; Roth et al., 2004). Negative affect – arising from perceived poorer performance or the induced pain itself – may also have contributed to the nature of responses. The present study aimed to control for this possible confound by having the participants rate catastrophic thinking of their pain conditions prior to evoking experimental pain.

Acceptance and Interference

*Self Reports of Pain Interference*

The pain literature is replete with data describing negative coping or cognitive “sets” that may adversely impact functional outcome. The endeavor to identify and examine the effects of more positive psychological variables such as acceptance on functional interference is relatively new; thus, the data lending evidence to any effect are few. Most of the studies that do exist entail self-reported interference from pain. McCracken and Eccleston (2006) found that individuals with greater acceptance of their chronic pain reported less disability in a variety of areas including physical and
psychosocial domains. Previous investigations also found that the degree of acceptance is associated with less reported vigilance and attention to pain and greater involvement in life activities (McCracken, 2007; Viane et al., 2004). The results of the present study support and extend these previous findings of the inverse association between acceptance and self-reported pain interference in various life activity domains. Moreover, this study appears to be the first to find these effects utilizing the seven pain interference items from the BPI, a brief self-report measure of daily pain interference across a variety of areas. Such a measure may prove to have greater feasibility in terms of time-constrained clinical or research protocols in comparison to the 136-item Sickness Impact Profile (SIP; Bergner, Bobbitt, Carter, & Gilson, 1981) that was used in prior studies (McCracken & Eccleston, 2005; McCracken & Eccleston, 2006; McCracken, Vowles et al., 2005).

Interference from Laboratory Induced Pain

The inherent characteristic comprising the construct of acceptance is an acknowledgment that pain experienced does not need to interfere with life activities (McCracken, Carson et al., 2004; McCracken & Eccleston 2005). It is therefore reasonable to assume that corollary to this cognitive belief, positive behavior (e.g., engaging in valued activities) would ensue. Thus, in line with the attentional model of pain (Sullivan et al., 2001), acceptance may aid in offsetting the attentional dominance from pain that may impede upon the pursuit of one’s goals and activities. As noted in the present results and in prior literature (McCracken, 2007; Viane et al., 2004), the degree of acceptance that one has is indeed positively related to self-reported pain interference in various activities, yet data are sparse regarding the positive role of acceptance on task
performance exclusive of self-report. One study identified examined the effect of brief acceptance-based instruction and guidance on physical functioning (Vowles, McNeil et al., 2007). Results from this study showed that those receiving the brief instructional set based on pain acceptance demonstrated less impairment on a physical therapist administered test of functioning. In the Vowles, McNeil et al. (2007) study, however, only baseline levels of acceptance were directly measured and therefore, it is unclear whether this effect is concurrent to increases in levels of pain acceptance.

Among healthy, pain-free individuals, those trained in acceptance as a means to deal with pain exhibited longer tolerance times to a cold pressor task (Hayes et al., 1999) and electrical stimulation (Gutiérrez et al., 2004; McMullen et al., 2008). The current investigation extends these findings to a chronic low back pain population. Moreover, findings from the present study do more than imply mere persistence in behavior; these results elucidate the role of acceptance on task performance during the experience of pain.

These few existing studies that involved both clinical and non-clinical samples found a positive effect of acceptance on a criterion of behavioral persistence or gross physical functioning. However, this criterion does not allow for tenable inference in terms of acceptance, attentional demand and the quality of performance ensuing from that attentional demand. Nonetheless, the present results generally reflect those of prior studies in that greater acceptance was associated with better performance on an attentional task. Although Sullivan and colleagues (2001) formulated the attentional model of pain with the construct of catastrophizing in mind, perhaps acceptance – or the mindset that one can engage even in the presence of pain – is more related to one’s
allocation of attention when pain is experienced. Specifically, results from this study in conjunction with evidence from patients’ self report (Viane et al., 2004) suggest that acceptance of one’s chronic pain allows for the re-direction of attention in order to engage more fully in daily activities or a task at hand.

Catastrophizing, Emotional Functioning and Pain Ratings

*Self Reports of Depressive Symptoms*

Using the PHQ-9 in the present sample, it was found that just over two-thirds of the patients scored above the cut-off that is indicative of clinically significant depressive symptoms for that measure (Kroenke et al., 2001). This finding is nearly a fifth higher in proportion to prevalence rates of depression found in general chronic pain populations (Fishbain et al., 1986; Romano & Turner, 1985; Turk et al., 1995), but is similar to the reported 72%-73.3% found in chronic low back pain groups (Gallagher, Moore, & Chernoff, 1995; Krishnan, France, Pelton, & McCann, 1985). Regardless of the type of chronic pain condition, these rates exceed the 2-9% found in the general population (DSM-IV-TR, 2000; Kessler et al., 2005). More specifically, the current investigation’s results indicated a significant effect of catastrophizing on self-reported depressive symptoms after accounting for demographics and baseline pain severity. This is consistent with prior literature indicating that individuals with chronic pain who catastrophize about that pain show more depressive symptoms and general affective distress (Bishop & Warr, 2003; Edwards et al., 2006; Li et al., 2006; Roth et al., 2004).

The catastrophizing – depression relationship has been conceptualized in terms of Beck’s cognitive model (Beck et al., 1979; Sullivan et al., 2001) and as such, a focus of
many cognitive behavioral treatment approaches within chronic pain populations (Eimer & Freeman, 1998; Thorn, 2004; Turk, 2002b; Turk & Flor, 2006) may target catastrophizing as an erroneous thought pattern adversely affecting emotional state. These distortions in thinking stem from maladaptive schemas that form from and are perpetuated by multiple pain experiences over time as seen in chronic pain (Sullivan et al., 2001). It follows that perhaps catastrophizing would contribute to a depressive affect or symptoms. Prior evidence indicates that greater catastrophizing at earlier time points has been found to significantly predict depression at subsequent time points (Keefe et al., 1989; Keefe et al., 1991). This suggests that catastrophizing – or the distorted thought process surrounding pain related information – may not only be associated with depressive symptoms but also may precipitate a generalized depressive schema. Although results of the current study found a significant effect of catastrophizing on reported depressive symptoms, this study was cross-sectional in nature and therefore inference regarding any causal relationship cannot be made from the current results.

*Ratings of Laboratory Induced Pain*

A model related to the cognitive schema model but perhaps more useful in understanding the acute dynamic of pain and functioning is that of Lazarus and Folkman (1984). In this model, catastrophizing is viewed as a form of negative appraisal by which one magnifies the extent and threat value of incoming pain (Sullivan et al., 1995). Levels of catastrophizing in chronic pain patients have been found to be associated with more negative affective ratings of pain (Geisser et al., 1994; Sullivan et al., 2005), in particular the SF-MPQ Affective Scale (Tripp et al., 2006), and also pain severity ratings in general
(Sullivan et al., 1995). In the present study, levels of catastrophizing were found to positively affect SF-MPQ Sensory and the overall general pain intensity (SF-MPQ PPI scale) but failed to reach significance for SF-MPQ Affective ratings of induced ischemic pain. No prior data were found to reveal effects of catastrophizing on experimentally induced pain ratings among persons with chronic low back pain or chronic pain in general. Therefore, comparison of the current results were limited to effects previously found in studies comprising ratings of clinical pain conditions and not a separately induced pain experience per se. Similar to the explanation for the present findings of catastrophizing and task interference, the methodological difference in having persons with chronic pain affectively rate an induced pain as opposed to pain associated with their chronic pain condition may explain the incongruent results. Perhaps the foresight that the induced pain would ultimately end influenced participants’ perceived severity of that pain. Results from this investigation are in fact more similar to findings from pain-free individuals that showed no difference in the rated valence of pain stimuli between catastrophizers and non-catastrophizers (Van Damme et al., 2004). Thus, affective ratings may be contextually based, such that the valence of pain is a function of prior experience with that pain. Incorporating Beck’s cognitive model (1979), pain appraisals over time may form and perpetuate a depressive or negative affective schema. Once a negative pain schema is established, ensuing appraisals and ratings of pain become emotionally laden in a negative manner. Thus, acute pain that is unrelated to an individual’s chronic pain condition may not have negative affective ratings, but depressive schema from a history ongoing pain may result in more negative affective ratings of the pain associated with that condition. Indeed, chronic pain patients who
catastrophize show greater affective pain ratings relative to their chronic pain (Geisser et al., 1994; Sullivan et al., 2005).

Acceptance, Emotional Functioning and Pain Ratings

Self Reports of Depressive Symptoms

In the present study, a negative correlation was found between acceptance and depressive symptoms but no effect emerged when acceptance was entered simultaneously in the regression analyses predicting depressive symptoms. These results are different from prior investigations utilizing multiple regression analysis that showed greater levels of acceptance to be predictive of less depressive symptomatology (McCracken, 2007; McCracken & Eccleston, 2005). Unlike the current investigation, these earlier studies did not include catastrophizing, or other negative coping constructs for that matter, in the analyses. One study did allow for concurrent entry of levels of catastrophizing and two subscales of the CPAQ (Nicholas & Asghari, 2006). These researchers found that catastrophizing significantly predicted self-reported depressive symptoms but that only the CPAQ items reflecting the degree of activity engagement showed a significant inverse effect on this same criterion. In conjunction with the results of the current investigation, it would appear that acceptance, at least as it is measured by the CPAQ in its entirety, does not contribute significantly to depression when catastrophizing is simultaneously accounted for.
Ratings of Laboratory Induced Pain

Similar to the current findings of acceptance and self-reported depressive symptoms, acceptance was correlated with SF-MPQ Affective ratings of pain, such that greater acceptance was associated with lower use of affective verbal descriptors of experimentally induced ischemic pain. When demographics, baseline pain severity, and catastrophizing were taken into consideration, this significance dissolved. This remained true for the SF-MPQ Sensory but not the general pain intensity (SF-MPQ PPI) of the induced pain which did not show a relationship in even simple correlation analysis. At least one laboratory-based study was found examining the effects of acceptance on pain severity levels in chronic low back pain (Vowles, McNeil et al. 2007). These researchers provided acceptance-based instruction and guidance to chronic low back pain patients and measured pain severity in a subsequent physical functioning task. As alluded to previously, this study’s methodological design assumed an increase in acceptance from the treatment and did not verify this assumption with direct measurement of this construct following intervention. Nonetheless, Vowles and colleagues (2007) found no difference in pain severity ratings among those who were guided to focus on activity and not the associated pain.

Clearly, there is a paucity of data available to explain the effects of acceptance, or lack thereof, on perceived pain severity. Nonetheless, the present findings, along with those of Vowles, McNeil et al. (2007), suggest that acceptance of one’s pain does not necessarily require that the pain be less severe in nature. The possible exclusivity of acceptance of one’s pain and pain severity would still parallel the conceptualization by
McCracken and colleagues (2004, 2005) in that acceptance is the belief that pain, regardless of severity, does not need to interfere with one’s goals or activities.

Corroborating Self-Report with Observed Pain Interference

A major gap in the literature has been the bridging of laboratory based and subjective report data in the context of pain and daily functioning. A predominant goal in most multidisciplinary chronic pain centers is not only the attenuation of a patient’s pain, but also maximizing functional activities. Appropriate goal-setting requires obtaining an accurate picture of a patient’s functioning in day-to-day life. Given the time constraints of clinical service delivery, brief self-report measures have become a preferred option for functional assessment. Such measures include the interference items from the BPI (Cleeland, 1989), the Oswestry Disability Questionnaire (Fairbank, Couper, Davies, & O’Brien, 1980), and the Roland and Morris Disability Questionnaire (Roland & Morris, 1983). It remains unclear, however, whether these self-report measures accurately reflect the patient’s actual interference in daily activities. In the present study, the degree of task interference during induced pain was found to be significantly associated, albeit in a weak to moderate manner, with the patient’s subjective report of interference in the “real-world” as measured by the seven interference items on the BPI.

Relationship Between Catastrophizing and Acceptance

Surprisingly, the literature offers little even in the realm of basic correlational analyses to clarify the relationship between catastrophizing and acceptance. Two studies found weak to moderate relationships between various ways of coping and levels of
acceptance although catastrophizing was excluded from these analyses (McCracken & Eccleston, 2003; McCracken & Eccleston, 2006). Only two studies were identified to have examined the correlation between acceptance and catastrophizing (Nicholas & Asghari, 2006; Flor et al., 1993). Results from these investigations showed catastrophizing and acceptance to be inversely related. In both cases, however, the questionnaires for assessing catastrophizing appear to be less familiar and not as widely used as other measures such as the PCS (Sullivan et al., 1995) and the CSQ (Rosenstiel & Keefe, 1983).

Similar to the literature base, results from the current study indicate that catastrophizing and acceptance are significantly associated with various outcomes among persons with chronic pain. One main difference with the present study and most previous investigations is that in the current investigation, these two constructs were examined concurrently. Two studies were found that have examined these two constructs simultaneously in analyses. One study indicated that changes in catastrophizing and acceptance across a multidisciplinary pain treatment program were comparable in predicting outcomes in emotional and physical functioning (Vowles, McCracken & Eccleston, 2007). In another study, researchers from Spain who utilized structural equation modeling found that the model with the best fit showed acceptance to better determine functional outcome, while catastrophizing significantly impacted pain severity and depression (Esteve, Ramírez-Maestre, & López-Martínez, 2007). Results from the current study extend these findings from Esteve et al. (2007). The present analyses showed that acceptance was a better predictor of both self-reported pain interference and task interference during induced ischemic pain when catastrophizing was also in the
model. Conversely, catastrophizing was a better predictor than acceptance when the outcome was self-reported depressive symptoms and rating of pain severity and intensity. Clearly, more research is needed to better clarify the specific outcomes to which these constructs contribute when investigated in a concurrent manner.

Acceptance as a Moderator

To date, little is known about how catastrophizing and acceptance work in tandem to affect functional outcomes in chronic pain populations. It has been postulated that catastrophizing and acceptance are “intrinsically linked” (McCracken & Eccleston, 2003, p. 202) by their definitional characteristics, such that increases in one may possibly result in reduction of another. At the most superficial level of interpretation, this indeed appears to be true through basic correlational analyses performed in prior studies (Nicholas & Asghari, 2006; Viane et al., 2003) and also in the current investigation.

Catastrophizing has been conceptualized as an erroneous automatic thought that may be activated by one’s pain (Thorn, 2004). Acceptance, on the other hand, could be characterized as a means by which one is able to pursue valued goals even in the presence of negative feelings, thoughts or beliefs (Hayes et al., 2006). Consideration of these conceptualizations together suggests that acceptance could be viewed as a “buffer” to the impact that catastrophic thoughts exert on functioning. In other words, acceptance serves as a moderator to the effects of catastrophizing. Indeed, the current investigation found acceptance to moderate the relationship between catastrophizing and task performance during induced pain. Interestingly, it was found that with high levels of acceptance, task performance improved even as levels of catastrophizing increased. The positive effects of
acceptance may not necessarily apply unless there is something negative present to accept. It has been suggested that when negative cognitions do arise, individuals may, in a sense, become “fused” with these negative cognitions in a way that governs behavior (Hayes, 2004; Hayes et al., 2006; Hayes & Wilson, 1995; Blackledge & Hayes, 2001). In the presence of catastrophizing then, acceptance may “defuse” the degree to which catastrophizing exerts influence on subsequent function. Moreover, in the absence of acceptance, task performance appears to be more susceptible to increasing levels of catastrophizing, such that as catastrophizing increases, task interference also increases (i.e., task performance worsens). Although this effect appeared to extend to the relationship between catastrophizing and self-reported day-to-day pain interference, a moderating effect of acceptance in the present analyses did not quite reach significance.

This moderation did not emerge in terms of pain ratings during induced ischemic pain and self-reported depressive symptoms. To the contrary, catastrophizing in the preliminary analyses was shown to be the key variable in these outcomes in final models. Although beyond the scope of the hypotheses and analyses currently presented, perhaps catastrophizing moderates or interacts with some other factor not accounted for here when depressive symptoms or perceived severity of pain is the outcome. Future mediational, moderational or structural equation modeling (SEM) analyses could perhaps clarify this issue. Utilizing SEM could examine if reciprocal paths among variables, rather than unidirectional relationships, would provide a clearer model. SEM is a more parsimonious technique as it can model regression equations simultaneously, and moreover, can account for measurement error among complex phenomena (Schumacker & Lomax, 2004). SEM was not utilized in the current study as substantially larger
samples sizes are needed in order to adequately validate a hypothesized model using this technique (for review, see Schumacker & Lomax, 2004, p. 49).

Clinical Implications and Future Directions

Chronic pain has often posed a clinical conundrum. Despite pharmacological, surgical and other technological advances, current medical treatment, at best, has only been able to reduce chronic pain by a modest amount (Curatolo & Bogduk, 2001; Turk, 2002a). As a result, many specialized pain clinics focus on the management of chronic pain when the search for a cure is no longer a viable option. A predominant goal for psychotherapeutic intervention in chronic pain, therefore, is to provide the patient with the skills necessary to maximize all aspects of functioning despite the presence of pain.

Cognitive-Behavioral Therapy (CBT) appears to be the most widely used psychotherapeutic approach in chronic pain populations (Turk, 2002b; Turk & Flor, 2006). The premise upon which its effectiveness is presumed is the notion that when erroneous cognitive patterns are identified and restructured, emotional and behavioral functioning can improve. In chronic pain, catastrophizing is seen as one such distorted thought or appraisal (Eimer & Freeman, 1998; Thorn, 2004; Turk, 2002b; Turk & Flor, 2006). More recently, evidence is increasing regarding the benefits of acceptance-based treatments in chronic pain management (McCracken & Eccleston, 2005; McCracken et al., 2005). The fundamental tenet of this approach is that the chronic pain patient may exert a great deal of effort in attempts to control private experiences or negative feelings regarding pain which, in turn, may inadvertently result in avoidance (Hayes, 2004; Hayes et al., 2006). Thus, acceptance based therapy aims to help patients learn how to
experience pain related sensations and emotions without attempting to avoid such experiences and to become aware of thoughts without feeling compelled to follow or believe such thoughts (Hayes et al., 2006).

Results from the present study indicate that exclusive focus should not be placed on either catastrophizing or acceptance; rather, both are constructs that contribute to important, but different, outcomes. These results indicate that individuals who catastrophize about their pain perceive evoked pain in a more severe and intense manner. Similarly, catastrophic thoughts about one’s pain condition were found to be adversely related to emotional well-being. Restructuring catastrophic thoughts via CBT may indeed promote more realistic appraisals of incoming pain sensations acutely and also enhance emotional functioning in the long term. Overt functioning (e.g., degree of interference), on the other hand, appears to be more strongly related to the degree to which one is accepting of their chronic pain condition and lends credence to the effectiveness of acceptance based treatments when the goal is to help chronic pain patients re-engage in various activities in life. However, if a clinician’s aim is to improve global functioning – physical, cognitive, and emotional – perhaps the optimal strategy would be to implement these psychotherapeutic approaches in a complementary manner. A broader armamentarium in which a clinician does not mechanistically apply techniques associated with a single theoretical framework would allow for mutual emphasis on reducing catastrophic thinking and promoting acceptance of one’s chronic pain condition. Future investigations are in order to determine any enhanced effectiveness from augmenting CBT with acceptance-based interventions.
The results from the current investigation also have heuristic value when conceptualizing theoretical models of overt pain interference. Specifically, it appears that acceptance may serve a strong role in the attentional model of interference from pain (Sullivan et al., 2001). This is especially apparent from the current results utilizing an established measure of cognitive attention. The proposed role of acceptance is not to the exclusion of catastrophizing per se; rather, acceptance appears to be a moderating factor in this equation, such that greater levels of acceptance are more likely to offset the negative impact of catastrophizing. Clearly, more data are needed to corroborate these findings.

Additionally, neuroimaging research may be of benefit in providing concrete evidence of the relationship between acceptance and one’s attention. The neural circuitry of pain includes areas associated with attention; namely, the anterior cingulate cortex (ACC) that may modulate behavioral responses (Price, 2000). It has been shown that induced pain modifies cortical activity during a cognitive task (Rémy, Frankenstein, Mincic, Tomanek, & Stroman, 2003). Among persons with chronic pain, greater levels of catastrophizing have been found to be associated with increased activity in ACC regions during painful experiences (Gracely et al., 2004). From the behavioral observations in the present study, it could be hypothesized that acceptance would be associated with activity changes in neural networks associated with pain and the allocation of attention. Future neuroimaging studies would aid in elucidating the potential modulatory effects of acceptance on neural mechanisms associated with cognitive-attentional processing.
There are several limitations to the current study that should be noted. First, participants were recruited from pain management clinics, and as such, most participants were on different pharmacological regimens which may have affected perceived severity of experimentally induced pain or cognitive performance. Moreover, because participants were specifically failed back surgery chronic pain patients recruited from specialized clinics, results cannot necessarily be generalized to other chronic pain patients or non-clinic patients. Lastly, self-report analyses were purely correlational in nature. Although one can infer a greater degree of causality in the laboratory based condition, the pain induced in this condition may not necessarily parallel pain experienced from one’s pain condition and the consequent “real-life” interference. Structural equation modeling using time-lapsed data would aid in bolstering causal inference and also the moderational effects observed with acceptance of chronic pain. Despite these limitations, results from the present study collectively highlight the importance of psychological constructs of catastrophizing and acceptance on functional outcome and further, offer important preliminary evidence regarding how these constructs mutually work in a model predicting pain interference among persons with chronic pain.
REFERENCES


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APPENDIX A

INSTITUTIONAL REVIEW BOARD APPROVAL FORM

The IRB reviewed and approved the above named project on 7/18/2007. The review was conducted in accordance with UAB's Assurance of Compliance approved by the Department of Health and Human Services. This Project will be subject to Annual continuing review as provided in that Assurance.

This project received FULL COMMITTEE review.

IRB Approval Date: 7/18/2007

Date IRB Approval Issued: 08/20/07

Identification Number: IRB00000726

Investigators please note:

The IRB approved consent form used in the study must contain the IRB approval date and expiration date.

IRB approval is given for one year unless otherwise noted. For projects subject to annual review research activities may not continue past the one year anniversary of the IRB approval date.

Any modifications in the study methodology, protocol and/or consent form must be submitted for review and approval to the IRB prior to implementation.

Adverse Events and/or unanticipated risks to subjects or others at UAB or other participating institutions must be reported promptly to the IRB.