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ATTENTION MEDIATES THE RELATION BETWEEN CATASTROPHIZING AND PAIN

by

Scott R. Bishop

Submitted in partial fulfillment of the requirements
for the degree of Ph.D.

at

Dalhousie University
Halifax, Nova Scotia
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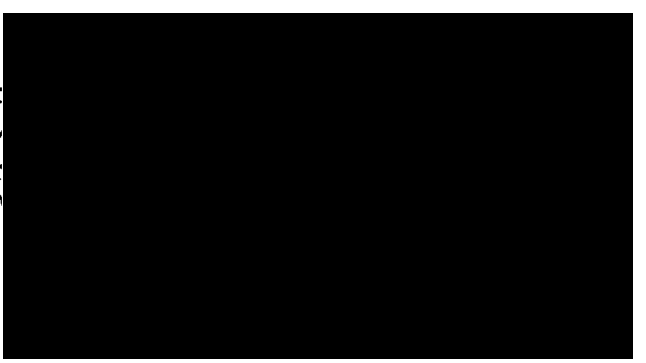

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DEDICATION

I would like to dedicate this paper to my partner and wife, Christy Gaetz. There were moments during this process in which I believed that I did not have the ability or the will to complete this project. Thank you for your encouragement and your faith in me.

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ABSTRACT

This paper describes the development and investigation of an attentional model of catastrophizing and perceived pain intensity. According to this model, catastrophizers have a propensity to direct their attentional focus toward their pain during aversive stimulation. The increase in attention to pain results in an increase in perceived pain intensity. The central assertion of this model is that the relation between catastrophizing and pain is mediated by an attentional process. In Study 1, catastrophizing was unrelated to the degree of selective attentional focus to pain-related stimuli prior to cold pressor stimulation, although catastrophizing was significantly correlated with subjects' estimates of the percentage of time that they attended to their pain during cold pressor stimulation. In Study 2, catastrophizing was significantly correlated with the degree of attentional focus to pain-related and social-threat related stimuli during cold pressor stimulation. The degree of attentional focus to pain-related stimuli was significantly correlated with reported pain intensity. In Study 3, catastrophizers who were provided with a distraction task reported less pain than catastrophizers who were not provided with a task. Further, catastrophizers who were provided with a distraction task did not differ from non-catastrophizers in reported pain. There was also evidence suggesting that catastrophizers focused on the threatening and emotional value of painful sensations, while non-catastrophizers focused on the concrete sensory aspects of painful sensations during pain. The results of this research are discussed within the context of an attentional model of catastrophizing and pain.

LIST OF ABBREVIATIONS

1. M	=	*mean*
2. Sd	=	*standard deviation*
3. Msec	=	*milliseconds*
4. PCS	=	*Pain Catastrophizing Scale*

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INTRODUCTION

Until very recently, pain research was thought to be primarily the concern of the physiologist and anatomist, and the treatment of pain was almost exclusively the task of the neurosurgeon and neurologist (cf. Melzack, 1986). The last 40 years, however, have yielded a vast amount of research and theory that has dramatically changed our views on the problem of pain and resulted in the development of new treatments for pain. The most significant change has been the recognition that physiological processes operative in pain interact with psychological processes (Melzack & Wall, 1965). In recent years, pain research and treatment have increasingly become the concern of the psychologist and psychological methods have become essential in advancing our understanding of the nature of pain.

The traditional Western biomedical view of pain dates back to 16th century European scholars who, concerned with the relationship between mind and body, proposed the first formal models of psychophysics and related views on the nature of pain. Early conceptualizations of pain and other sensations proposed by Descartes (1596-1650), Liebnitz (1646-1716) and Kant (1724-1804) provided the philosophical foundation for 19th and 20th century physiological theories of pain based on physical reductionism (Schneider & Karoly, 1983). Descartes conceptualized pain as a purely sensory event that can be understood through physiological and anatomical mechanisms, and Liebnitz and Kant emphasized that there is a linear one to one relationship between the physical and mental aspects of perception. Thus, the extent of pain severity was thought to be directly proportionate to the amount of stimulation or the degree of tissue damage. Despite the advances in anatomy and physiology

that would take place over the next 300 years, these basic assumptions dominated modern conceptualizations of pain within 19th and 20th century medicine.

By the 1960's, extensive laboratory evidence had accumulated which did not support these assumptions. First, advances in neurophysiology revealed that the transmission of sensory information is not a straight-through process. Sensory information from the peripheral nervous system travels along a complex array of pathways that receive several spatial and temporal modifications from the periphery and central systems so that neural activity is significantly altered by the time it has reached the cortex (for a review, see Melzack, 1986). Secondly, a substantial body of evidence did not support the assumption that there was a one to one correlation between the physical dimensions of stimulation and the experience of pain. Considerable laboratory and clinical evidence had accumulated that documented a variety of cutaneous sensations that were larger or smaller than could be accounted for based on neurophysiology alone (Melzack, 1986). This gave rise to extensive evidence that cognitive and emotional factors could influence the quality and intensity of pain (for a review, see Schneider & Karoly, 1983). This led to the conceptualization of pain as a multidimensional experience with sensory, affective and cognitive components, each interacting to contribute to the perceptual experience of pain (Melzack & Wall, 1965). These findings led to the rejection of straight-through sensory processing models of pain, and the espousal of the view of pain as a complex perceptual experience varying in quality as well and intensity across individuals.

With the recognition of the highly personal nature of pain, there has been an increase in interest in identifying markers for individual differences in pain perception, as well as processes

mediating individual difference variables (e.g., Chaves & Brown, 1978, 1987; McNeil, Rainwater, & Aljazireh, 1986; Pennebaker, 1982; Rosensteil & Keefe, 1983; Sullivan, Bishop, & Pivik, 1995). In recent years, the role of catastrophizing in mediating the experience of pain has received considerable attention. Catastrophizing has been described as an exaggerated response to aversive situations, and is characterized by excessive negativity, rumination, and perceived helplessness (Sullivan et al., 1995). Catastrophizing has been identified as an individual difference variable that contributes to increased pain and emotional distress in the context of clinical acute and chronic pain, as well as experimentally induced pain (Jensen, Turner, Romano & Karoly, 1991; Keefe, Brown, Wallston, & Caldwell, 1989; Spanos et al., 1979; Sullivan et al., 1995). While the relation between catastrophizing and pain has been well documented in the literature, the processes underlying this relation are not well understood.

This paper describes three studies that provide evidence that attention may be one of the mediating mechanisms by which catastrophizing influences perceived pain. Using experimental pain induction procedures, this research shows that catastrophizing is associated with a tendency to focus on pain-related stimuli during aversive stimulation, and provides evidence to suggest that a tendency to focus attention to aspects of painful stimulation mediates the relation between catastrophizing and heightened pain intensity. The results of these studies are discussed in terms of current theories of pain perception. As well, implications for future research and clinical intervention are addressed.

Literature Review and Theoretical Background

Chaves and Brown (1978; 1987) provided one of the earliest empirical reports on the relation between catastrophizing and the experience of pain. Patients undergoing a stressful dental procedure were asked to report the thoughts, images and strategies that they engaged in during the procedure. Based on responses to a structured interview, subjects were classified as catastrophizers (37%), copers (44%) or deniers (19%) according to their dominant cognitive activity during the dental procedure. Patients classified as catastrophizers reported higher levels of trait anxiety, and a more external locus of control, than patients classified as copers or deniers. Catastrophizers did not differ from copers in reported pain intensity, but they reported that the procedure was more stressful.[1]

Since the work of Chaves & Brown (1978, 1987), questions concerning the role of catastrophizing in mediating physical and emotional distress have been addressed in the context of chronic pain, and experimentally induced pain. In both experimental and chronic pain studies, issues concerning the relation between catastrophizing, pain, emotional distress and functional disability have been addressed. In experimental research, there has also been some focus on identifying mechanisms mediating the relation between catastrophizing and distress reactions. A review of this work is presented below, beginning with research examining the relations between catastrophizing, pain and emotional distress. This is followed by a discussion of the various theoretical models proposed to account for these relations.

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[1] In the study by Chaves and Brown (1978; 1987), all subjects undergoing the dental procedure had received an anesthetic thus reducing the probability that a relation between catastrophizing and pain would be observed.

Catastrophizing and Experimental Pain

Because of the ability to control extraneous factors and to introduce manipulations to a pain-stress situation, the laboratory provides a setting that is well suited to examining underlying processes that may mediate the relation between catastrophizing, pain and emotional distress. Typically, pain is induced for a brief period of time, and the experimenter assesses its impact on subjective pain report, cognitions, and affect. The most commonly used pain induction procedure used in studies of catastrophizing in experimental pain research involves immersing a subject's hand and forearm in ice water maintained at a constant temperature (e.g., 2 degrees Celsius). Referred to as the "cold pressor task" it produces rapidly accelerating noxious sensations. Subjects typically describe the experience as changing over time from initially cold discomfort to moderate or extreme pain characterized by stinging, burning and cramping sensations. Cold-pressor pain does not result in physical injury, and has been described as similar to the quality, duration and urgency of many types of acute clinical pain (cf. Turk, Meichenbaum & Genest, 1983).

Spanos, Radtke-Bodorik, Ferguson & Jones (1979) conducted the pioneering work in catastrophizing using experimental pain induction procedures. Subjects were subjected to two one-minute trials of cold pressor pain. The first trial served as a baseline, and the second trial was preceded by a suggestion for analgesia. Pain ratings were elicited at 20 second intervals during each trial. At the end of the second trial, subjects participated in a standardized interview consisting of ten questions designed to elicit the subject's cognitive activity during the post-treatment immersion. The transcribed testimony relating to the second immersion trial

was coded for the subject's use of cognitive coping strategies (distraction, imagery, and relaxation) and for catastrophizing ideation (thoughts and images reflecting worry, fear, and the inability to divert attention away from the painful stimulation). During the baseline immersion, catastrophizers did not differ in reported levels of pain intensity from non-catastrophizers. However, catastrophizers reported significantly more pain than non-catastrophizers during the post-treatment immersion. Non-catastrophizers reported a reduction in pain from baseline to post-treatment that increased as a function of the number of cognitive coping strategies employed during the second immersion. Catastrophizers did not report a reduction in pain regardless of the number of cognitive coping strategies they used.

Spanos, Brown, Jones & Horner (1981) noted that Spanos et al. (1979) did not examine cognitive activity during the baseline trial. They suggested that it is unclear from this initial study whether subjects who were identified as catastrophizers during the post-treatment immersion were also catastrophizers during the baseline immersion. The provision of cognitive coping strategies may have transformed some baseline catastrophizers into post-treatment non-catastrophizers. Secondly, although catastrophizers reported more pain than non-catastrophizers during the post-treatment immersion, it is unclear whether catastrophizers also experienced more pain than non-catastrophizers during the baseline immersion (in the absence of a treatment manipulation).

In order to address these issues, Spanos et al. (1981) replicated the study by Spanos et al. (1979). Subjects were subjected to two one minute cold-pressor immersions; the post-treatment trial was preceded by a suggestion for analgesia. Cognitive activity during each trial

was elicited by written responses to brief open-ended questions. Subjects were classified as catastrophizers or copers based on their predominant cognitive activity during each of the two immersions. During the baseline immersion, catastrophizers reported more pain and less tolerance for pain than copers. When provided with a pain reduction strategy (suggestion for analgesia), approximately 75% of subjects who catastrophized during the baseline immersion were classified as copers during the post-treatment immersion. Subjects who coped during both immersions, and subjects who catastrophized during the baseline immersion, but coped during the post-treatment immersion, reported a reduction in pain from baseline to post-treatment. Subjects who catastrophized during both immersions did not report a reduction in pain.

Similar findings were reported by Spanos, Stam & Brazil (1981). Subjects provided pain ratings during a baseline and post-treatment trial. Prior to the post-treatment trial, subjects were either provided with a suggestion for analgesia, a distraction task, or served as a control. Consistent with Spanos et al. (1979) catastrophizers did not differ from non-catastrophizers in reported pain during the baseline trial. However, approximately 75% of subjects classified as catastrophizers during the baseline and who were provided the analgesic suggestion, were classified as non-catastrophizers during the post-treatment trial. These subjects reported reductions in pain from the baseline to post-treatment immersion. Similarly, non-catastrophizers also reported a reduction in pain from baseline to the post-treatment trial when provided with a suggestion for analgesia. Subjects classified as catastrophizers during both immersions did not report a reduction in pain.

Spanos, Jones, Brown & Horner (1983) examined pain intensity and rate of pain increase during two trials of cold-pressor pain. The post-treatment trial was preceded by an analgesic suggestion. Subjects were classified as catastrophizers and copers based on written testimony to a questionnaire administered following the cold pressor procedure. During baseline, nine subjects were classified as copers, and eighteen subjects were classified as catastrophizers. Copers and catastrophizers did not differ with respect to baseline pain intensity or rate of pain increase. During the post-treatment immersion, twenty-seven subjects were classified as copers and only six subjects were classified as catastrophizers. Catastrophizers reported significantly greater pain intensity and a quicker rate of increase in pain.

The work of Spanos and his colleagues suggests that catastrophizing may interfere with the efficacy of cognitive coping strategies for the reduction of pain. They have consistently demonstrated that individuals identified as non-catastrophizers during a baseline immersion report a reduction in pain following interventions that foster the use of coping strategies. For this group, the number of coping strategies was directly related to the reductions in pain. Non-catastrophizers who reported a greater number of cognitive coping strategies reported the greatest decreases in pain. In contrast, individuals identified as catastrophizers during a baseline immersion, and who remained catastrophizers following interventions that foster the use of coping strategies, failed to report reductions in pain regardless of the number of cognitive coping strategies that they reported using.

Their research further suggests that catastrophizing can be reduced or eliminated by interventions that foster the use of cognitive coping strategies. Across these studies, approximately 75% of individuals identified as catastrophizers during a baseline immersion became non-catastrophizers following interventions that foster the use of cognitive coping strategies. However, the provision of a coping strategy for the reduction of pain failed to eliminate catastrophizing during the second immersion in approximately 25% of individuals who catastrophized during a baseline immersion. This suggests that catastrophizing may be relatively stable for a substantial group of individuals.

Although important as catalysts for further research, these early studies were designed to study the effects and parameters of hypnotic and non-hypnotic analgesic suggestions for pain reduction. Subjects were not selected based on their dominate cognitive activity during pain, rather group assignment was post hoc. Except for Spanos et al. (1981a), subjects were selected for level of susceptibility to hypnotic induction procedures. The interpretation and generalizability of findings are therefore questionable beyond the context of this limited population (Blaney, 1986). A number of studies have since been conducted within the general population using similar methodologies.

Sullivan, Bishop & Pivik (1995) examined the relation between catastrophizing, pain and emotional distress within the context of a series of studies describing the development, validation and psychometric properties of the Pain Catastrophizing Scale (PCS). The PCS is a 13 item self-report instrument that measures the degree to which individuals characteristically engage in catastrophic ideation during painful stimulation. In Study 2, subjects scoring in the

top and bottom third of a distribution of catastrophizing scores on the PCS obtained during a screening procedure approximately six weeks prior to testing and on the day of testing were classified as catastrophizers and non-catastrophizers, respectively. Subjects were subjected to a single trial of cold pressor pain for a one minute duration. Pain ratings were elicited at 20 second intervals during the immersion and for one minute following the immersion. Catastrophizers reported significantly more pain than non-catastrophizers during the one minute immersion and during the one minute following the immersion. Catastrophizers also reported that they experienced more emotional distress than non-catastrophizers during the ice water immersion. PCS scores obtained during the screening procedure six weeks prior to testing were highly correlated with PCS scores obtained on the day of testing, $r = .75$, suggesting that in the absence of intervention, catastrophizing is stable over time.

Sullivan et al. (1995) argued that while catastrophizing was associated with increased pain and emotional distress during the cold pressor procedure in Study 2, it was not possible to rule out the possibility that catastrophizers' reports reflect a response bias. They further argued that while the results suggest that catastrophizing is relatively stable over time, it is possible that the high test-retest correlations may have been inflated as a result of selecting subjects from the upper and lower thirds of the distribution of scores. They addressed these questions in Study 4 using an unselected group of subjects. The procedure for this study was identical to that described in Study 2 except that the cold pressor procedure was preceded by a trial in which subjects immersed their arm in room temperature water and provided pain ratings. In addition

to the PCS, subjects also completed measures of depression, trait anxiety, negative affectivity and fear of pain.

Sullivan et al. (1995; Study 4) reported that catastrophizing was significantly and highly correlated, $r = .46$, with pain intensity ratings during the cold pressor procedure. The relation between catastrophizing and pain remained significant even when controlling for ratings of discomfort during the room temperature immersion. This suggests that the relation between catastrophizing and pain cannot be explained on the basis of a response bias. Further, although catastrophizing was significantly correlated with depression, trait anxiety, negative affectivity and fear of pain, only catastrophizing contributed significant unique variance to the prediction of pain intensity during the cold pressor procedure. This finding supports the conceptual distinctiveness of the catastrophizing construct. Finally, PCS scores obtained 10 weeks prior to testing were significantly correlated with those obtained on the day of testing, $r = .70$, showing that catastrophizing is highly stable over time.

Sullivan, Rouse, Johnston & Bishop (1997) examined the role of thought intrusions in the relation between catastrophizing and pain. Catastrophizers and non-catastrophizers were asked to either suppress thoughts related to an upcoming cold pressor procedure or given no instructions to suppress, and then write their ongoing thoughts on paper for a nine-minute period. Subjects then participated in a cold pressor procedure. Consistent with Sullivan et al. (1995), catastrophizers reported significantly more pain than non-catastrophizers during the ice water immersion. In the thought suppression condition, catastrophizers reported a greater frequency of pain-related intrusions during the nine-minute period than non-catastrophizers.

Further, there was some evidence that catastrophizers engaged in persistent efforts to suppress pain-related thoughts in the no suppression condition as reflected in less thematic consistency of thoughts during the nine minute period. This finding is consistent with previous research demonstrating a relation between effort to suppress ideation and lower thematic consistency in the flow of thoughts (Wegner, Schneider, Carter & White, 1987). The main effect due to level of catastrophizing remained significant when controlling for frequency of pain-related intrusions.

Sullivan and his colleagues have reliably demonstrated that catastrophizers reported more pain during the cold pressor procedure than non-catastrophizers.[2] These findings are not entirely consistent with those reported by Spanos and his colleagues. In Spanos' studies, catastrophizers and non-catastrophizers did not differ in reported pain intensity during a baseline immersion (Spanos et al., 1979; 1981b; 1983). Instead, they found that catastrophizers were unable to reduce their pain during a subsequent immersion when provided with coping strategies.

The discrepancy in findings may be attributed to differences in sample populations from which subjects were selected. Sullivan and his colleagues selected subjects from a population of university students. Spanos and his colleagues selected subjects from a population of university students who obtained high scores on measures of susceptibility to hypnotic induction procedures. The findings in Spanos' studies may therefore not be generalized beyond

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[2] In addition to those reported in the literature, we have recently completed a series of studies in our laboratory examining the relation between catastrophizing and pain behaviour. In both studies, catastrophizing was associated with increased pain and emotional distress during the cold pressor procedure (Sullivan, Bishop, Degagne & Johnson, unpublished manuscript).

this population. It is noteworthy that in the Spanos et al. (1981a) study, subjects were not selected for susceptibility to hypnotic induction but rather were drawn from the general university population and they found that catastrophizers reported more pain than non-catastrophizers during the baseline immersion.

The results of Sullivan and his colleagues also suggest that in the absence of intervention, catastrophizing has a high degree of stability over time. Spanos and his colleagues report findings that suggest that interventions which foster the use of cognitive coping strategies fail to adequately modify level of catastrophizing for a significant number of individuals (Spanos et al., 1979, 1981a, 1981b, 1983). Other investigators have since reported similar findings (Heyneman, Frewmouw, Gano, Kirkland & Heiden, 1990; Vallis, 1984).

Finally, Sullivan et al. (1997) provided data suggesting that catastrophizers may be impaired in their ability to suppress pain-related ideation. Instead, catastrophizers appear to experience an increase in pain-related intrusions when asked to suppress pain-related thoughts. It is not yet clear if pain-related thought intrusions play a mediating role in the relationship between catastrophizing and pain. While they found that the relation between catastrophizing and pain remained significant when statistically controlling for pain-related thought intrusions, the thought suppression task preceded aversive stimulation. A different pattern of findings may have emerged if the relation between catastrophizing and thought suppression had been examined during rather than prior to experiencing pain.

In summary, experimental pain induction studies have not demonstrated a consistent relationship between catastrophizing and heightened levels of pain during aversive stimulation.

However, differences in the populations from which subjects have been selected may account for the discrepancies. When using subjects from the general population, a consistent relation between catastrophizing and heightened levels of pain intensity emerges (Spanos et al., 1981a; Sullivan et al., 1995; 1997). Sullivan and his colleagues have also reported a consistent relation between catastrophizing and heightened levels of emotional distress (Sullivan et al., 1995; 1997). The results of experimental pain research also support the conceptual distinctiveness of the catastrophizing construct and indicates that it is relatively stable over time.

Catastrophizing and Chronic Pain

Chronic pain typically refers to pain that has persisted for more than six months duration and has been refractory to traditional therapeutic intervention (Bonica, 1980). Chronic pain differs substantially from acute pain, both qualitatively and quantitatively (Melzack, 1986; Sternbach, 1976). Acute pain is typically associated with a well-defined cause and characteristic time course in which the pain disappears with healing. Chronic pain, however, persists beyond the time expected for the injury to heal and often despite observable evidence that healing has occurred (Bonica, 1990). This has lead to the suggestion that while acute pain exerts itself peripherally, chronic pain may be due to long-term changes in central neural pathways (Melzack, 1986).

The relation between catastrophizing and chronic pain has been examined primarily with the Coping Strategies Questionnaire (CSQ; Rosensteil & Keefe, 1983). The CSQ is a 42 item self-report instrument that measures different ways in which individuals attempt to cope with chronic pain. It includes seven subscales that assess different ways of coping with pain:

diverting attention, reinterpreting pain sensations, ignoring pain sensations, coping self-statements, praying or hoping, increasing behavioral activity, and catastrophizing. Two additional items ask patients to rate their ability to control and decrease their pain. The catastrophizing subscale of the CSQ contains six items indicative of excessive worry (e.g., I worry all the time about whether the pain will end), inability to cope (e.g., It's awful and I feel that it overwhelms me), and hopelessness (e.g., It's terrible and I feel that it's never going to get any better). In chronic pain samples, the role of catastrophizing has been addressed either in the context of various factor analytic components derived for the CSQ, or correlations between specific CSQ subscales and measures of adjustment to chronic pain.

Rosenstiel & Keefe (1983) were the first to use the CSQ to examine the relation between coping strategies and adjustment to chronic pain. Using principle component analysis on a sample of 61 chronic low back pain patients, they found that the subscales on the CSQ loaded onto three factors that they labelled (1) cognitive coping and suppression, (2) diverting attention and praying, and (3) helplessness. The helplessness factor contained the catastrophizing subscale items and the two questions concerning the individual's ability to control or decrease their pain. Regression analysis revealed that the three factors accounted for 37% of the variance in average pain ratings, 61% of the variance in state anxiety ratings, 23% of the variance in depression scores, and 19% of the variance in functional capacity. The helplessness factor (containing catastrophizing items) was the best predictor of anxiety and depression, but did not predict level of pain. The diverting attention and praying factor was the best predictor of pain.

Turner and Clancy (1986) examined the relation between coping strategies and adjustment to chronic pain in a sample of 74 chronic low back pain patients both prior to and following a cognitive-behavioral pain management program. A principle component analysis of the CSQ yielded three components that they labelled (1) denial of pain, (2) diverting attention and praying, and (3) helplessness. The helplessness factor contained the catastrophizing subscale and the two questions concerning the individual's ability to control or decrease their pain. Prior to treatment, the three factors accounted for 29% of the variance in depression scores, 27% of the variance for disability and psychosocial impairment, and 16% of the variance for downtime. The helplessness factor (containing catastrophizing items) was the best predictor of depression and impairment in physical and psychosocial functioning. Following treatment, reduction in catastrophizing was significantly correlated with reductions in pain intensity, as well as a decrease in physical and psychosocial disability.

Spinhoven, Kuile, Linssen & Gazendam (1989) examined the relation between the CSQ and measurements of behavioral and emotional adjustment in 108 chronic low back pain patients. Principle component analysis yielded three components labelled (1) active coping, (2) perceived control and (3) helplessness. The helplessness factor contained the catastrophizing subscale, as well as the active coping subscale. Regression analysis revealed that the three factors accounted for 40% of the variance in pain intensity ratings, 33% of the variance in functional impairment ratings, 25% of the variance in depression scores, and 18% of the variance in anxiety scores. The helplessness factor (containing catastrophizing items) was the

best predictor of adjustment overall, and was associated with higher levels of reported pain, anxiety, depression, and functional impairment.

The results of these studies suggest that catastrophizing may be associated with poor adjustment to chronic pain. There is a fairly consistent relation between the factor component containing catastrophizing items, emotional distress, and functional disability. In contrast, only Spinhoven et al. (1989) found a relation between the factor containing catastrophizing items and reported pain intensity. Turner & Clancy (1986) report a relation between decreased endorsement of catastrophizing items and reductions in pain intensity following psychological intervention in chronic pain patients, but the factor component containing catastrophizing items was unrelated to average pain prior to treatment. It is important to note, however, that there was considerable variability in the factor structure derived for the CSQ across the three studies. This variability may account for inconsistencies in findings.

The interpretation of these studies is further limited by the statistical procedures selected to examine the relation between coping strategies and adjustment to chronic pain. Since the analyses were confined to the factor components obtained for the CSQ, the relation between individual CSQ subscales and measures of adjustment to chronic pain cannot be adequately addressed. It is not possible to make strong statements regarding the relation between any of the subscales on the CSQ and adjustment to chronic pain based on these analyses. For example, it is unclear if the observed relation between the factor containing the catastrophizing subscale items (e.g., helplessness) and indices of adjustment to chronic pain (e.g., depression) is a function of level of catastrophizing, or other cognitive activity tapped by

the CSQ items within the same factor component. The factors containing the catastrophizing subscale items in these studies also contained CSQ items reflecting low perceived efficacy for coping and infrequent use of cognitive coping strategies. Previous studies have shown these variables may contribute to the chronic pain experience independent of level of catastrophizing (for a review, see Jensen et al., 1991).

Lawson, Reesor, Keefe & Turner (1990) have further criticized previous work on the CSQ as being hampered by limited sample sizes and lack of cross-validation on different patient groups. They also argued that the use of principle component analysis has too many statistical limitations in order to adequately derive the components of the CSQ. They suggested that confirmatory factor analysis, which allows for comparisons between different theoretically derived factor models, may provide a more accurate estimate of the components of the CSQ. Using confirmatory factor analysis, they examined the content and number of dimensions of the CSQ in 620 patients from five different chronic pain patient samples. They found that a three component model of the CSQ provided the best fit to the structure of the measure across samples. They labelled the three components (1) conscious cognitive coping, (2) self-efficacy beliefs and (3) pain avoidance. Unlike previous studies, the catastrophizing subscale did not load on any of the factors across samples. Lawson et al. (1990) suggested that catastrophizing may be conceptually and empirically distinct from cognitive coping activity, and recommended that in studies that use the CSQ, the role of catastrophizing should be examined independently of coping strategy use.

Keefe et al. (1989) were the first to specifically examine the relation between the CSQ catastrophizing subscales and adjustment to chronic pain. In a sample of 223 rheumatoid arthritis patients, they reported that the CSQ catastrophizing subscale scores significantly predicted average pain, depression and functional impairment six months later, accounting for 16%, 36% and 25% of the variance, respectively. Patients who scored high on the CSQ catastrophizing subscale rated their average pain as more intense, and obtained higher scores on measures of depression and functional impairment. The predictive relation between initial catastrophizing scores and later pain and functional impairment remained significant even when controlling for initial scores on these outcome measures. Other than patients' initial scores on the depression measure, catastrophizing was the only significant predictor of depression over the six month period.

Sullivan & D'Eon (1990) also examined the relation between catastrophizing, pain and depression in a sample of 125 chronic low back pain patients. They reported that CSQ catastrophizing subscale scores were significantly correlated with patients current level of pain (r = .27) and scores on a self-report measure of depression (r = .42). Regression analysis revealed that the catastrophizing subscale was the only CSQ subscale significantly related to pain intensity.

In summary, five studies have examined the relation between catastrophizing and adjustment to chronic pain. The results of this research generally indicate that catastrophizing is associated with poor adjustment in this population. A consistent relation between catastrophizing and emotional distress has been demonstrated across studies. Studies

examining the factor structure of CSQ suggest that individuals who report frequent catastrophizing cognitions are more anxious and depressed than individuals who report few catastrophizing cognitions, and that they are more impaired on measures of physical and psychosocial disability (Rosensteil & Keefe, 1983; Spinhoven et al., 1989; Turner & Clancy, 1986). More specifically, the CSQ catastrophizing subscale scores have been significantly correlated with self-report measures of depression (Keefe et al., 1989; Sullivan & D'Eon, 1990). Although not entirely consistent, catastrophizing has also been associated with increased pain intensity among chronic pain patients. Both studies that examined the relation between the CSQ catastrophizing subscale and reported pain intensity in chronic pain samples reported a significant relation (Keefe et al., 1989; Sullivan & D'Eon, 1990). Conversely, only one of three factor analytic studies report a relation between frequent catastrophizing cognitions and reported pain intensity (Spinhoven et al., 1989). As mentioned earlier, differences in the factor components derived across studies may account for this discrepancy.

The CSQ has been a useful tool in chronic pain populations for examining the correlates of catastrophizing. However, the CSQ may be too narrow in its definition of catastrophizing. The CSQ was developed based on a conceptualization of catastrophizing primarily in terms of helplessness (Rosensteil & Keefe, 1983). Recent research has provided data which supports catastrophizing as a broader multi-dimensional construct consisting of conceptually interrelated components reflecting rumination, magnification and helplessness (Sullivan et al., 1995). Further, there has been concern that the CSQ catastrophizing subscale may be confounded with measures of depression (Sullivan & D'Eon, 1990). Finally, the

psychometric properties of the CSQ have only been investigated within chronic pain patient populations. Because of the ability to control extraneous factors and introduce manipulations to a pain-stress situation, the laboratory may provide a better setting to address questions related to hypothesized mechanisms thought to mediate the relation between catastrophizing and pain. It is unclear if the CSQ is a valid measure of catastrophizing within an experimental (i.e., non-clinical) pain setting.

The Relation Between Catastrophizing and Pain: Summary and Conclusions

Despite differences in methodology and measurement procedures, as well as phenomenological differences between clinical chronic pain, and experimentally induced acute pain, a review of this literature reveals a very similar pattern of findings. While catastrophizing has consistently been associated with heightened levels of emotional distress in both populations, the relationship between catastrophizing and pain has been less consistent.

Eight studies have examined the relation between catastrophizing and pain in the context of experimental pain induction procedures. Five of these studies have shown that catastrophizing was associated with heightened pain intensity during aversive stimulation (Spanos et al., 1981a; Sullivan et al., 1995, 1997, unpublished manuscript). Three studies have shown that while catastrophizers reported more pain than non-catastrophizers following an intervention fostering the use of cognitive coping strategies, the two groups did not differ with respect to baseline levels of pain (Spanos et al, 1979; 1981b, 1983). However, as argued previously, the selection of subjects from a population of highly hypnotizable individuals likely limits the interpretation and generalizability of findings of the later studies. Five studies have

examined the relation between catastrophizing and chronic pain. Three of these studies report that catastrophizing was associated with increased pain intensity (Keefe et al., 1989; Spinhoven et al., 1989; Sullivan & D'Eon, 1990). Two studies did not find a relationship between catastrophizing and pain intensity (Rosensteil & Keefe, 1983; Turner & Clancy, 1986). It has been argued that differences in factor structures derived for the CSQ, as well as chronic pain samples, may account for this discrepancy. Although there have been some inconsistencies, the majority of studies suggest that catastrophizing is associated with increased pain intensity during aversive stimulation.

Theoretical Models of Catastrophizing and Pain

Research examining the relation between catastrophizing and pain has proceeded in the absence of a unified theoretical model. Two major perspectives have been advanced to account for the relation between catastrophizing and increased pain and emotional distress: (1) appraisal processes, and (2) coping interference. However, these theoretical positions have generally been undeveloped and untested. A discussion of each of these theoretical positions is presented below.

(1) *Catastrophizing as Negative Appraisals.* Several investigators have suggested that catastrophizing ideation reflects negative appraisals of pain (Jensen et al., 1991; Keefe et al., 1989; Turk & Rudy, 1992). Catastrophizers are thought to possess enduring cognitive structures or "schemata" that give rise to negative appraisals of painful situations. Schemata can be described as an active organization of past experiences and reactions into knowledge structures that guide the interpretation and lend meaning to similar future experiences (Bartlett,

1932; Markus 1977; Neisser, 1976). Pain-related schemata are therefore thought to contain information about past pain experiences, and are hypothesized to guide the interpretation and give meaning to current pain experiences (Turk & Rudy, 1992).

Appraisal processes have generally been proposed to account for the observed relation between catastrophizing and increased pain and emotional distress within chronic pain populations (Jensen et al., 1991; Keefe et al., 1989; Turk & Rudy, 1992). An examination of the content on self-report measures (Rosensteil & Keefe, 1983; Sullivan et al., 1995), and verbal or written testimony following aversive stimulation (Chaves & Brown, 1987; Spanos et al., 1979) is consistent with an appraisal model. Catastrophizing cognitions reflect negative expectancies about pain (e.g., "I worry that the pain will get worse"), negative beliefs about pain (e.g., "Something serious will happen), and a perceived inability to cope with pain (e.g., " I can't stand it"). While these observations support the position that catastrophizing ideation reflects negative appraisals, there has been little theoretical development to explain how appraisals are thought to mediate the relation between catastrophizing and pain.

In the general pain literature, appraisal processes have been hypothesized to impact on the pain experience in three ways. First, negative appraisals that emphasize or exaggerate the threat of a situation or lead to a perception of inability to control the consequences of the situation, are thought to result in heightened levels of emotional distress (Jensen et al., 1991; Turk & Rudy, 1992). This notion is consistent with cognitive theories of emotion, where negative evaluations of events or situations are thought to precipitate distress reactions (Beck, 1967; Ellis, 1962; Lazarus & Folkman, 1984). Secondly, appraisals that emphasize threat and

inability to effectively manage or cope with the stimulus have been associated with increased pain intensity (Jensen et al., 1991; Turk & Rudy, 1992). Negative appraisals are thought to bias the processing of incoming sensory information at a higher level of the cognitive system resulting in the perception of heightened pain intensity (Cioffi, 1991; Leventhal, 1993; Turk & Rudy, 1992). Finally, appraisals are thought to impact on the pain experience indirectly by influencing the amount of effort that is expended on the use of coping strategies for the reduction of pain. Individuals are more likely to engage in coping activity if they believe that they will be successful in reducing their pain (Bandura, 1977; Lazarus & Folkman, 1984).

The notion that catastrophizers' negative appraisals of pain contribute to heightened levels of emotional distress is consistent with a substantive body of mood research demonstrating the relation between negative appraisals and distress reactions (for a review, see Tararyn, Nadel, & Jacobs, 1989). This is also consistent with research demonstrating that interventions that alter the interpretation of painful stimuli are effective in reducing the level of emotional distress (Turk & Rudy, 1992). Thus, an appraisal model may adequately account for the relation between catastrophizing and heightened levels of emotional distress during painful stimulation. This position can be tested by manipulating aspects of the appraisal process (e.g., expectancies, perceived control), and assessing its impact on affect. Further investigation is clearly warranted.

The role of appraisal processes in mediating the relation between catastrophizing and perceived pain intensity is less clear. There has not been any research that has examined the relation between catastrophizing, appraisal processes and pain. It is possible that appraisal

processes associated with catastrophizing biases the processing of somatic sensations resulting in a perception of increased pain intensity (Cioffi, 1991; Leventhal, 1993; Turk & Rudy, 1992). However, an attentional process may also play a role. Cioffi (1991) suggests that negative appraisals are most likely to result in increased pain intensity if they become the focus of attention. She cites research showing that attention to the interpretations and cognitive elaborations of noxious sensations produces greater intensity of perceived pain than attention to the concrete properties of the physical sensations (see also, Leventhal, 1993). She suggests that attending to the interpretations and cognitive elaborations of painful sensations add information about the sensations that changes the perception of them. Within this conceptualization, catastrophizing may not only reflect negative appraisals of pain, but also a tendency to focus excessively on their interpretations of the painful sensations.

Appraisals are also thought to impact on the pain experience indirectly by influencing the amount of effort that is expended on the use of coping strategies for the reduction of pain (Bandura, 1977; Lazarus & Folkman, 1984). Catastrophizers may be less likely to use cognitive coping strategies because they do not believe that they can effectively reduce their pain. This position has been addressed primarily within the context of experimental pain induction procedures. Spanos et al. (1979, 1981a) reported that although catastrophizers and non-catastrophizers did not differ in the number of coping strategies that they used, only non-catastrophizers were effective in reducing their pain from a baseline to post-intervention immersion. Sullivan et al. (1995) also reported that catastrophizers and non-catastrophizers did not differ in the number of cognitive coping strategies that they employed but that

catastrophizers reported more pain. Thus, the position that catastrophizers may be less likely to use cognitive coping strategies for the reduction of pain has not been supported.

(2) *Catastrophizing and Coping Interference.* Other investigators have suggested that catastrophizing interferes with the effective use of cognitive coping strategies for the reduction of pain. According to Spanos and his colleagues (Spanos et al., 1979; 1981a), catastrophizers do not benefit from the use of cognitive coping strategies because they do not sustain attention to them. They noted that cognitive coping strategies may be effective to the extent that they direct attention away from the painful stimulus. This position is consistent with recent research that suggests that cognitive coping strategies are effective to the extent that they impose demands on attentional capacity; cognitive coping strategies that require considerable attentional resources are the most effective in reducing perceived pain intensity (see Fernandez & Turk, 1989). Although catastrophizers report that they use cognitive coping strategies as frequently as non-catastrophizers (Spanos et al., 1979, 1981; Sullivan et al. 1995), they also report that they focus excessively on their pain. This excessive focus would be expected to render cognitive coping strategies ineffective.

Sullivan et al. (1997) provided data that suggests one mechanism by which catastrophizing may interfere with attempts to reduce pain using cognitive coping strategies. They found that when asked to suppress pain-related ideation prior to an upcoming cold pressor procedure, catastrophizers reported a greater frequency of pain-related thought intrusions than non-catastrophizers. They suggested that catastrophizers may be unable to control the flow of pain-related thoughts into consciousness. Cognitive coping strategies that

involve distraction require the individual to keep attentional focus away from pain-related ideation (Fernandez & Turk, 1989). An increase in pain-related ideation associated with catastrophizing would be expected to render cognitive coping strategies for pain reduction ineffective.

Sullivan et al. (1996) reasoned that the frequency of pain-related thought intrusions would be inversely proportional to the amount of time that subjects attended to their cognitive coping strategies. They therefore predicted that frequency of pain-related thought intrusions would mediate the relation between catastrophizing and pain. Their results did not support this prediction; catastrophizers reported more pain than non-catastrophizers when statistically controlling for the frequency of pain-related thought intrusions. However, the thought suppression task preceded the aversive stimulation. A different pattern of findings may have emerged if the relation between catastrophizing and pain had been examined during the pain experience. A thought suppression procedure concurrent with aversive stimulation would provide a more adequate examination of the role of thought intrusions in mediating the relation between catastrophizing and pain. However, the results of this study do suggest that catastrophizers may be unable to direct attention away from pain-related ideation.

Theoretical Models of Catastrophizing: Current Status

The various theoretical positions presented in the literature have not been well developed and there has been a paucity of research addressing hypothesized mediating mechanisms. Except for Sullivan et al. (1997), the various theoretical positions have been

advanced as post-hoc explanations of findings, rather than a priori tests of hypotheses. Well designed studies that adequately test the theoretical positions and rule out alternate models are clearly needed. Despite the limitations of theoretically relevant studies currently available in the literature, some general conclusions can be drawn.

First, there is sufficient evidence to posit the role of appraisal processes in mediating the relation between catastrophizing and emotional distress. The content of catastrophizing cognitions reflects negative beliefs, expectancies, and inability to cope with painful stimuli. This content may be interpreted as appraisals of the painful situation, and/or underlying beliefs about pain that guide the appraisal process. Further, there is a substantive body of theory and research demonstrating a relation between negative appraisal processes and heightened levels of emotional distress (Beck, 1967; Ellis, 1962; Lazarus & Folkman, 1984; Tararyn et al., 1989). As discussed, this position holds promise and warrants further investigation.

Secondly, it does not appear that negative appraisal processes associated with catastrophizing inhibit the employment of cognitive coping strategies for the reduction of pain. While catastrophizers appear to have less confidence in their ability to effectively manage their pain, they report using as many cognitive coping strategies as non-catastrophizers (Spanos et al., 1979; 1981a; Sullivan et al., 1995). Instead, catastrophizers likely do not benefit from cognitive coping strategies. There is some evidence that catastrophizers are unable to direct attention away from pain-related ideation (Sullivan et al., 1997). Increased attention to painful sensations associated with catastrophizing may interfere with the effectiveness of cognitive coping strategies (Fernandez & Turk, 1989; Spanos et al., 1979; 1981a). Conversely,

increased attention toward the interpretation and cognitive elaboration of painful sensations may bias the interpretation toward a perception of increased pain intensity (Cioffi, 1991). The available evidence favours a model that posits the role of attentional focus in mediating the relation between catastrophizing and perceived pain intensity. An attentional model of catastrophizing and pain intensity is presented below.

An Attentional Model of Catastrophizing and Pain

There is substantial evidence within the general pain literature suggesting that attentional processes influence pain perception. Experimental studies that manipulate attention have shown that subjects give lower pain ratings when they direct attention away from their pain, and higher pain ratings when they attend to their pain (Arntz, Dreessen & Merckelbach, 1991; Beers & Karoly, 1979; Brewer & Karoly, 1989; McCaul & Haugtvedt, 1982; Miron, Duncan, & Bushnell, 1989; Williams & Kinney, 1991). Further, there is considerable evidence that attentional processes play a central role in the effectiveness of cognitive coping strategies. A recent meta-analytic study by Fernandez & Turk (1989) suggests that cognitive coping strategies are effective to the extent that they impose demands on attentional capacity. Cognitive coping strategies that require considerable attentional resources were generally found to be the most effective in reducing perceived pain intensity.

Interpretations of these findings have focused on limited capacity models of attention (Broadbent, 1958; Treisman, 1964). According to these models, attention is finite in capacity. With the presence of two stimuli, attention becomes selective by filtering out some of the incoming information. Therefore, each stimulus present can be seen as impinging on the amount of attentional resources available for the other stimulus. The selection or filtering of stimuli by attention is thought to occur automatically, at a preconscious stage of processing (Hasher & Zacks, 1978; Shiffrin & Schneider, 1977). Only the information that is selected by the attentional system for further processing will be experienced at a conscious level. Cognitive coping strategies that require considerable attentional capacity (e.g., distraction tasks) are

hypothesized to reduce the amount of attentional resources available to process nociceptive activity (a competing stimulus), thereby attenuating perceived pain (Fernandez & Turk, 1989). Conversely, it was assumed that attending to painful sensations would maximize the processing of nociceptive information resulting in heightened levels of pain. However, there is some evidence that the relation between attention and pain may not be as straight-forward as suggested by theoretical positions based on limited capacity models of attention.

While some studies have reported that attending to painful stimuli results in a perception of increased pain intensity (Arntz et al., 1991; Beers & Karoly, 1979; Brewer & Karoly, 1989; McCaul & Haugtvedt, 1982; Miron et al., 1989; Williams & Kinney, 1991), other studies have reported that attending to painful stimuli decreases perceived pain intensity (Ahles, Blanchard & Leventhal, 1983; Leventhal, Schacham & Engquist, 1979). Recent reviews of the literature indicate that attention to certain aspects of painful sensations may yield different effects on perceived pain intensity (Cioffi, 1991; Leventhal, 1993). Potentially uncomfortable events can be processed for their concrete sensory information, and their threatening and emotional value (Ahles et al., 1983; Leventhal & Mosbach, 1983; Leventhal et al., 1979; Melzack & Wall, 1982). There is some evidence to suggest that pain is perceived as less intense when attention is focused on the concrete sensory aspects of the nociceptive stimulus, and more intense when attention is focused on the emotional and threatening value of the sensations (Ahles et al., 1983; Leventhal & Mosbach, 1983; Leventhal et al., 1989). Cioffi (1991) suggests that attending to the threatening value of sensory stimuli, as well as their

concomitant emotional reactions, adds information about the sensations that biases the perception of painful sensations toward increased pain intensity.

There is evidence within the catastrophizing and pain literature suggesting that catastrophizing is associated with an increase in attention to pain-related stimuli. First, when interviewed following cold-pressor pain, catastrophizers report that they spend considerably more time thinking about the painful stimulus than non-catastrophizers (Chaves & Brown, 1987; Spanos et al., 1979; Sullivan et al., 1995). Secondly, an examination of the item content on self-report measures suggests that catastrophizing is associated with considerable negative focus on aspects of the painful situation (Rosenstiel & Keefe, 1983; Sullivan et al., 1995). Indeed, Sullivan et al. (1995) reported that pain-related ruminations accounted for the largest proportion of variance in catastrophizing scores on the Pain Catastrophizing Scale. Finally, catastrophizers report a greater frequency of pain-related thought intrusions during thought suppression procedures than non-catastrophizers suggesting that catastrophizing may be associated with an inability to direct attention away from pain-related stimuli (Sullivan et al., 1996).

Attentional processes may play a role in mediating the relation between catastrophizing and perceived pain intensity. Consistent with theoretical positions based on limited capacity models of attention (Fernandez & Turk, 1989), increased attention to painful sensations associated with catastrophizing might be expected to maximize the processing of nociceptive stimuli and possibly interfere with the use of cognitive coping strategies for pain reduction (Spanos et al., 1979; 1981a). In contrast, catastrophizers may direct attention in a way that is

less focused on the concrete sensory aspects of the sensations, and more on their interpretations and cognitive elaborations of painful sensations. This would be expected to bias the processing of somatic sensations toward a perception of increased pain intensity (Cioffi, 1991).

The process by which catastrophizers focus on pain-related stimuli may be similar to that discussed in the anxiety literature. Studies have been consistent in showing that anxiety is associated with a selective focus of attention to environmental threat cues (Dalgleish & Watts, 1990). The presence of the feared stimulus in the environment is thought to prompt anxious individuals to direct their attention to the stimulus. For example, individuals with a phobia for spiders have been found to selectively attend to spider-related cues in the environment (Watts, McKenna, Sharrock, & Trezise, 1986). This process of selective attention has been referred to as an "attentional bias".

There have generally been three methodologies employed to measure attentional focus in the mood literature. In early studies, investigators used a dichotic listening task (Broadbent, 1958) to measure attentional focus. In this task, subjects were typically presented with two prose passages or stories, one to each ear, and asked to attend to one passage at the exclusion of the other. Subjects were asked to indicate the presence of a target word, regardless of whether it occurred in the attended or unattended passage. Studies using this methodology have been consistent in showing that clinically anxious subjects detected more fear-relevant targets in the unattended passage than non-anxious subjects, but did not differ in the detection

of neutral targets (Burgess, Jones, Robertson, Radcliffe & Emerson, 1981; Parkinson & Rachman, 1981; Mathews and MacLeod, 1986).

MacLeod, Mathews and Tata (1986) used a probe detection paradigm to examine the allocation of attentional resources to threat-related words. Subjects were presented with pairs of words one above the other on a visual display unit. The distribution of visual attention was determined by measuring reaction times for the detection of a small dot that could replace either of the two words. The word pairs contained either two neutral words, or one threat-related word (e.g., rejection, accident) matched with a neutral word. The results demonstrated that subjects diagnosed with generalized anxiety disorder had faster reaction times in detecting the probe when it replaced a threat-relevant word compared to non-anxious controls, and slower reaction times to the probe when it replaced a neutral word opposite a fear-relevant word. Similar results were obtained by MacLeod and Mathews (1988).

Other studies have employed a modified version of Stroop's colour interference task (Stroop, 1935). In this task, subjects named the colours in which a set of words was printed. Attending to the meaning of the words produces interference in naming the colour of the word, as reflected in longer colour naming latencies. In several studies, anxious subjects had longer colour naming latencies for threat-related words than non-anxious subjects, but did not differ in naming the colours of neutral words (Mathews & MacLeod, 1985; Watts et al., 1986).

There has been a consistent relation between anxiety and an attentional bias for environmental threat cues. The results of these findings have been interpreted within the context of schematic models of information processing (Bartlett, 1932; Beck, 1976; Beck,

Emery & Greenberg, 1985; Bower, 1981; Clark & Teasdale, 1982; Derry & Kuiper, 1981; Markus 1977; Neisser, 1976). Schematic processes are thought to play an integral role in the pre-conscious selection and integration of environmental stimuli to be processed by the cognitive system (Hastie, 1980; Rumelhart, 1980). Only environmental stimuli that have some value for the organism are selected for further processing. According to Beck et al. (1985), individuals vulnerable to anxiety states may possess schemata that lead them to interpret various stimuli as threats to their well-being. When these structures are activated by the presence of a feared stimulus, the processing of incoming information is guided towards the schema-congruent, threat-related elements in the environment. According to Mathews & MacLeod (1986), the presence of the feared stimulus activates the threat-related schemata resulting in the allocation of attentional resources to environmental threat cues.

A similar process may underlie an attentional bias for pain-related stimuli associated with catastrophizing. It has been suggested that catastrophizers possess enduring pain-related schemata that guide the processing of pain-related information (Jensen et al., 1991; Turk & Rudy, 1992). Catastrophizers may have a learning history characterized by excessive exposure to painful stimulation or exposure to others' catastrophic reactions of pain, and therefore develop enduring beliefs about the high threat value of painful stimuli (Sullivan et al., 1995; Turk & Rudy, 1992). Painful stimulation may activate these schemata, resulting in the allocation of attentional resources to aspects of the painful situation. Increased attention to painful sensations may increase the processing of nociceptive stimuli (Fernandez & Turk, 1989), or the cognitive elaboration of the sensations (Cioffi, 1991).

Purpose of the Current Research and Predictions

The primary purpose of this research was to investigate the tenability of the attentional model of catastrophizing and pain perception discussed above. The central assertion of this model is that the relation between catastrophizing and perceived pain intensity is mediated, at least in part, by the degree of selective attentional focus to aspects of painful sensations. Three studies were conducted to examine the model.

In all three studies, painful stimulation was provided using a cold pressor procedure involving a single one-minute limb immersion in ice water. This procedure produces rapidly accelerating sensations that subjects typically describe as stinging, burning, aching and cramping of their limb. Exposure of the limb to ice water is thought to result in the activation of cutaneous c-fibre mechano-heat nociceptors, a group of unmyelenated peripheral fibres which respond to both pressure and extremes in temperature (Meyer, Campbell, & Raja, 1994; Lynn, 1984; Ochoa, 1984; Perl, 1984). There has been some speculation that their activation by the ice water may account for the stinging and burning sensations experienced during the cold pressor procedure. As well, it has been suggested that reductions in cutaneous temperature may result in vasoconstriction thereby activating both a-fibre mechanoreceptors (myelenated, pressure-sensitive nociceptive fibres) and c-fibre mechano-heat receptors within the vascular system. The latter may account for the aching and cramping sensations experienced by many subjects during cold pressor pain (Meyer et al., 1994). The cold pressor procedure was selected because it produces painful sensations without resulting in physical

injury, is simple to employ, and is similar to the quality, duration and urgency of many kinds of clinical acute pain (Turk et al., 1983).

Study 1 and Study 2 were designed to test the hypothesis that catastrophizing is associated with a tendency to direct attentional resources toward pain-related sensations by using a behavioral task that could provide an estimate of the degree to which subjects are attending to pain-related stimuli. An estimate of attention to pain-related stimuli was obtained using a modified version of Stroop's colour interference task (Stroop, 1935). In this task, subjects were asked to name the colour of a series of words that were either pain-relevant (e.g., torture, hurt, scalpel), or neutral (e.g., car, make, boat). Attending to the words produces interference in colour naming, and is reflected in longer colour naming latencies.

It was predicted that catastrophizers would show greater interference in the colour-naming of pain-relevant words on the Stroop task than the colour-naming of neutral words. The differences in response latencies between pain-relevant words and neutral words would reflect the degree of attentional bias towards pain-relevant stimuli. Non-catastrophizers should not differ significantly in the amount of interference produced by the colour-naming of pain-relevant and neutral words. Therefore, catastrophizers were expected to show an attentional bias towards pain-relevant stimuli while non-catastrophizers were not. Using a full range of catastrophizing scores and multiple regression procedures, the expected results would be reflected in a positive correlation between level of catastrophizing and degree of attentional bias for pain-relevant stimuli.

Catastrophizers are thought to differ from non-catastrophizers primarily in the way in which they process pain-relevant information. One would not expect catastrophizers and non-catastrophizers to differ in the processing of environmental threat cues which are pain-irrelevant. To test this hypothesis, an additional set of socially threatening words (e.g., rejection, criticize) were presented during the Stroop task in Study 1 and Study 2. It was predicted that catastrophizing would not be correlated with the degree of attentional bias for pain-irrelevant threat-related stimuli.

According to the attentional model, increased attentional focus to aspects of painful sensations is expected to be associated with increased pain intensity. This position would be supported if attention to pain-related stimuli on the Stroop task is positively correlated with reported pain intensity during the cold pressor procedure. If the relation between catastrophizing and pain is mediated by attentional processes, then the correlation between catastrophizing and pain would be significantly reduced when controlling for the degree of attentional bias for pain-related stimuli on the Stroop task.

A central assertion of the attentional model is that increased attentional focus to painful sensations results in heightened pain intensity. However, there has been recent evidence that suggests that high levels of pain can result in an increase in attention to painful stimulation (Eccleston, 1994). While catastrophizers may evidence an attentional bias for pain-related stimuli, the increase in attention may be the result of, not the cause of, heightened levels of pain. If the attentional bias associated with catastrophizing is the result of heightened pain intensity, then the relation between pain intensity and the attentional bias for pain-related stimuli

on the Stroop task would be independent of level of catastrophizing. If the relation between pain intensity and the attentional bias for pain-related stimuli is not independent of level of catastrophizing, then it is more parsimonious to conclude that there is something about catastrophizing that results in the attentional bias for pain-related stimuli. Such findings would be consistent with the notion that schematic processes associated with catastrophizing direct attention to pain-related stimuli, and strengthens the argument that attention plays a mediating role in heightened pain intensity.

While Study 1 and Study 2 may be able to provide behavioral evidence to support the notion that catastrophizing is associated with increased attention to painful sensations, they may be limited in their ability to examine questions related to the role of attention in mediating the relation between catastrophizing and pain. The Stoop task used in these studies measures the degree to which subjects are attending to pain-relevant words, not the degree to which they attend to their pain. While an inference can be made that the degree to which subjects attend to pain-relevant words on the Stroop task correspond to the degree to which they attend to their pain during aversive stimulation, pain-relevant words are not expected to have the same degree of saliency as painful sensations. Thus, the degree to which subjects attend to pain-relevant words on the Stroop task was expected to underestimate the amount of variance that attention contributes to the relation between catastrophizing and pain intensity.

Study 3 was designed specifically to address questions regarding the mediating role of attentional processes in the relation between catastrophizing and pain intensity. According to the attentional model, catastrophizers experience greater pain intensity because they excessively

focus on their painful sensations. It may therefore be possible to decrease the perceived pain intensity of catastrophizers by giving them a task that reduces the amount of available attentional resources to allocate to painful sensations. It may also be possible to increase the perceived pain intensity of non-catastrophizers by giving them a task that fosters attentional focus to painful sensations. In this study, subjects participated in the cold pressor procedure and either diverted their attention away from their painful sensations by counting serial 7's backwards from 500 or focused their attention to their painful sensations. A third group did not complete a task during the cold pressor procedure, but served as a comparison. The attentional model would be supported if catastrophizers in the attention diversion condition report less pain than catastrophizers in the control condition. The model would also be supported if non-catastrophizers who focused their attention to painful sensations during a cold pressor procedure report greater pain intensity than non-catastrophizers in the control condition.

The effect of attentional focus to painful sensations may be dependent on the aspects of the stimuli to which the subject attends (Cioffi, 1991). It is possible that by asking catastrophizers to focus on their painful sensations they may be less likely to attend to the concrete sensory aspects of the nociceptive stimuli, and more likely to attend to the threatening and emotional value of the sensations. Conversely, by asking non-catastrophizers to focus their attention to their painful sensations, they may be more likely to attend to the concrete sensory aspects of the nociceptive stimulus. The frequency of cognitive or emotional elaborations of sensory stimuli would be expected to be positively correlated with reported pain intensity, while the degree of concrete sensory focus would be expected to be negatively correlated with

reported pain intensity (Cioffi, 1991; Leventhal, 1993). Therefore, it may not be possible to increase pain intensity levels for non-catastrophizers by asking them to focus on their pain. Asking non-catastrophizers to focus their attention to their pain may result in lower levels of pain relative to non-catastrophizers in the control condition. In the attentional focus condition, subjects were asked to describe their sensations aloud during the cold pressor procedure in order to examine this hypotheses.

Further, it has been shown that catastrophizers may be unable to reduce their pain using attention diversion strategies (Heyneman et al., 1991), and there is evidence that this may be due to an inability to control the flow of pain-related ideation into consciousness (Sullivan et al., 1996). Thus, catastrophizers in an attention diversion condition may not differ in reported pain intensity from catastrophizers in the control condition because they are unable to divert attention away from their pain. An increase in attention to painful sensations would interfere with the attention diversion task and would be reflected in a greater number of errors on the task. If catastrophizers in an attention diversion condition attend excessively to their pain, there would be a positive correlation between level of catastrophizing and number of errors during the attention diversion task. Again, subjects in the attention diversion condition were asked to perform the task aloud in order to examine this hypothesis.

In the general pain literature, there are two competing attentional models of pain perception. According to limited capacity models of attention and pain, distraction strategies are thought to reduce the amount of attentional resources available to process nociceptive stimuli, and should therefore result in a decrease in perceived pain intensity (Fernandez & Turk,

1989). Conversely, attending to painful sensations is expected to maximize the processing of nociceptive activity resulting in an increase in perceived pain intensity. According to Cioffi (1991) and Leventhal (1993), the *content* of attention is also important in determining pain responses. Focusing attention to the concrete sensory aspects of pain is expected to produce less pain intensity than focusing on the cognitive elaborations of pain sensations. Thus, the attention manipulations in Study 3 may yield different findings that would support the attentional model of catastrophizing and pain.

In summary, three studies were conducted to examine the tenability of an attentional model of catastrophizing and pain. This model yields two major predictions: (1) that catastrophizing would be associated with an increase in attentional focus to aspects of painful sensations, and (2) that attentional focus to aspects of painful sensations would mediate the relation between catastrophizing and perceived pain intensity.

This research also examined two competing hypotheses regarding the specifics of the attentional process: (1) that an increase in attention to painful *sensations* mediates the relation between catastrophizing and perceived pain intensity, or (2) that an increase in attention to the *interpretations and cognitive and affective elaborations* of painful sensations mediates the relation between catastrophizing and perceived pain intensity. A description of these studies and their results is presented below.

STUDY 1

In Study 1, subjects were asked to name the colour of pain-related words, social-threat words, and neutral words prior to a cold pressor procedure. It was predicted that catastrophizing would be significantly correlated with colour naming latencies for pain-relevant stimuli relative to neutral stimuli on Stroop's colour interference task, so that greater levels of catastrophizing would be associated with increased attentional bias for pain-relevant words. The degree of attentional bias for pain-relevant stimuli was expected to predict pain intensity ratings during the subsequent cold pressor procedure, so that increased attentional bias for pain-relevant words would be associated with greater pain intensity. According to the attentional model, the relation between catastrophizing and pain is mediated by attentional processes. Therefore, it was predicted that the correlation between catastrophizing and reported pain intensity would be significantly reduced when controlling for the degree of attentional bias for pain related stimuli on the Stroop task.

According to the attentional model, the activation of pain-related schemata is necessary to yield an increase in attention to pain-related stimuli. The predicted attentional bias associated with catastrophizing was based on the assumption that waiting for the upcoming pain-stress situation would be sufficiently salient to activate the pain-related schemata. One way to test whether the schemata have been activated is to look at subjects' predictions or expectancies for pain and emotional distress during the upcoming cold pressor procedure. Since schematic processes are thought to guide both attentional and appraisal processes, then

one would expect a positive correlation between level of catastrophizing and expectancies for pain and emotional distress prior to the cold pressor procedure if the schemata are activated.

Method

Subjects

Potential subjects considered for this study included all students at Dalhousie University who were registered in an Introductory Psychology course. A public advertisement describing the study was posted outside of the lecture theatres where the classes were taught. The advertisement provided information regarding the purpose and task requirements of the study. Interested students provided their name and telephone numbers, and were contacted by the investigator. Subjects were asked if they would be interested in participating in a study involving the relation between individual differences and reactions to pain. The nature of the pain procedure was described, as well as risks and benefits of the study. Subjects were also screened for physical or medical conditions that may have placed them at risk during the procedure. Subjects were not considered if they reported any of the following conditions; chronic pain, migraines, cardiovascular and circulation problems, high blood pressure, asthma, seizure disorders, pregnancy, previous frostbite or surgery to the arm or hand. Subjects who did not report any of the above conditions and who agreed to participate in the study were booked for an appointment. Sixty subjects were recruited for this study (30 males, 30 females). The mean age of the sample was 20.1 years, with a range of 18 and 27 years.

Subjects participated individually, and received one percentage point added to their final grade in Introductory Psychology.

Apparatus

Testing Environment. Subjects were tested individually in a testing room that contained a desk and chair, a microcomputer equipped for the Stroop colour interference task, a container of room temperature water, and a cold pressor apparatus. A Hitachi VT1000 camcorder was placed behind a one-way mirror in the testing room, and linked with a colour video monitor in an observation room. A microphone in the testing room provided the audio. The video equipment was used to monitor subjects during the cold pressor procedure. Instructions for the cold pressor procedure were provided from the observation room via an intercom system to the testing room.

Room Temperature Water. A plastic cooler, measuring 25cm by 38cm by 30cm, was filled with water. The water remained in the container for at least 24 hours prior to testing, and was maintained at room temperature (20 degrees Celsius) for the duration of the study.

Stroop Colour Interference Task. The allocation of attention was measured using a modified version of Stroop's colour interference task (Stroop, 1935). In this task, subjects were asked to name the colour of a series of stimulus words. The stimuli for this study consisted of 24 pain-relevant words, 24 social-threat words and 24 neutral words (Appendix A). The stimulus words were selected from various sources. The pain-relevant words were selected from the McGill Pain Questionnaire (Melzack, 1975), and Gage's Canadian Dictionary (1983). The social-threat words were selected from previous research on anxiety and

attentional bias (Mathews & MacLeod, 1985; 1986). Neutral words were selected from Gage's Canadian Dictionary (1983). The stimuli were matched for word frequency according to Carroll, Davies & Richman's (1971) norms.

A Zenith 386SX microcomputer with a 30cm by 30cm VGA 64 colour monitor was used to present the stimuli. A voice key triggered microphone input linked to the internal computer clock of the central processing unit recorded response latencies to colour naming. GWBASIC™ software was programmed to run the procedure. Each of the 72 stimulus words was presented individually in one of the following colours: blue, green, red, and yellow. Each word was 10 cm in height, and was presented in the middle of the monitor screen on a black background. The task was started by pressing a key on the keyboard. The subject was then presented with the first word, and after the subject made a response (i.e., named the colour), the computer automatically recorded the latency between word onset and response in milliseconds. The colour named by the subject was then entered into the computer by the experimenter by pressing one of four coded keys on the keyboard. After the experimenter had entered the subject's colour response, a new word, printed in a different colour, appeared on the monitor. The task proceeded until all 72 stimuli were presented.

Pain Induction Procedure. A cold pressor apparatus was used to provide painful stimulation. The apparatus was similar to that used by Sullivan et al. (1995; 1996) and Spanos et al. (1979; 1981a). The apparatus consisted of a plastic cooler measuring 30cm by 40cm by 30cm and divided into two compartments separated by a wire mesh. The entire cooler was filled with water, and one compartment was filled with ice. A moveable armrest was placed

over the compartment that contained only water, and was used to immerse the subject's arm in the ice water. Water temperature was maintained at 2-4 degrees Celsius. Because of the short duration of pain exposure the water was not curculated during the immersion.

Measures

Assessment of Pain Intensity. Prior to the cold pressor trial, subjects were familiarized with a pain rating scale taken from Sullivan et al. (1995). The scale ranged from (0) no pain to (10) extreme pain. The scale was placed on the wall, across from the cold pressor apparatus. Subjects were told that when their arm was immersed in the ice water, they would be asked to rate their current level of pain verbally during the procedure at 20, 40 and 60 seconds. These ratings were combined to yield a score reflecting average pain intensity during the procedure. Intercorrelations for these ratings were .65, .79, and .81, with an alpha of .88. An identical scale on a sheet of paper was also used to assess current pain and was completed during the time that subjects' arm was immersed in the room temperature water (Appendix B).

Assessment of Affect. Two identical 12-item measures of mood were used to assess the experience of emotion during the room temperature water immersion, and during the cold pressor procedure. These measures were derived and used by Sullivan et al., (1995). The adjectives were drawn from the Profile of Mood States (McNair, Lorr & Droppleman, 1971) and were combined to yield 4 separate subscales; 1) sadness (sad, discouraged, hopeless), 2) anxiety (anxious, afraid, worried), 3) anger (angry, hostile, irritable), and 4) happiness (happy, delighted, joyful). A rating scale for each item was provided and ranged from (0) not at all to

(10) extremely. Sullivan et al. (1996a) reported that the alpha coefficients were .75, .67, .77, and .89 for the sadness, anxiety, anger and happiness subscales, respectively. The first measure (Appendix C) asked subjects to rate their current mood and was given during the time that subjects' arm was immersed in the room temperature water, immediately prior to the ice water procedure. The second measure (Appendix D) asked subjects to rate the level of moods that they experienced during the time that their arm was immersed in the ice water, and was given immediately following the cold pressor procedure.

Expectancies for Level of Pain and Emotional Distress. Subjects' expectancies for pain were assessed by using a pain rating scale with endpoints (0) no pain and (10) extreme pain. The measure asked subjects to rate the intensity of pain that they expected to experience during the cold pressor procedure (Appendix E). Subjects' expectancies for emotional distress were assessed by using a 12 item measure of mood derived from the Profile of Mood States (McNair et al., 1971). This measure was identical to the two measures used to assess affect during the room temperature water immersion and cold pressor procedure. Subjects were asked to rate the intensity of each of the 12 adjectives (reflecting sadness, anxiety, anger, and happiness) to indicate their expected mood during the cold pressor procedure (Appendix F).

Estimate of Attention to Pain. Immediately after removing their arm from the ice water, subjects were asked to estimate the percentage of immersion time that they had thought about their pain by circling a number on a scale from 0% to 100% (Appendix G).

Catastrophizing. The Pain Catastrophizing Scale (PCS; Sullivan et al., 1995) was used as a measure of level of catastrophizing (Appendix H). The PCS consists of 13 items

describing different thoughts and feelings associated with catastrophizing. Subjects were asked to reflect on past painful episodes and to indicate the degree to which they typically experience each of the 13 thoughts and feelings during pain on a 5 point scale with endpoints (1) not at all and (4) all the time. Subjects' responses were summed to produce a single catastrophizing score. The PCS has been found to be internally consistent (alpha = .87) and has a high test-retest reliability (r = .70) over a 10 week period. The PCS has also been shown to predict frequency of catastrophizing ideation during both cold pressor pain, and clinical acute pain (Sullivan et al., 1995).

Procedure

Subjects were familiarized with the cold-pressor apparatus, and told that they would be placing their arm in the ice water for a one-minute period. Subjects were assured that the procedure would not cause any damage to their arm, but that the ice water would likely cause some physical discomfort. Subjects were made aware that they could discontinue the immersion at any time, and that they would receive course credit even if they did not complete the study.

Subjects were asked to place their non-dominant arm in the container of room temperature water for five minutes. Subjects were told that the purpose of the immersion was to regulate the temperature of their arm. During the immersion, subjects were provided with four questionnaires that asked them to rate a) the intensity of pain that they were experiencing at that moment, with their arm in the room temperature water, b) the intensity of different moods that they were experiencing at that moment, with their arm in the room temperature

water, c) the intensity of pain that they expected to experience during the upcoming cold pressor procedure, and d) the intensity of different moods that they expected to experience during the upcoming cold pressor procedure.

Subjects were then placed in front of a computer monitor, and positioned so that they were approximately 30 cm away from the microphone that rested on the desk directly in front of the monitor. Subjects were told that they would be presented with a series of words, and that their task was to name the colour of each word aloud, as quickly as they could. Subjects were then shown an example of each colour. Each example correctly displayed the name of that colour (e.g., the word "blue" was printed in the colour blue, etc.). Subjects were then told that, as a practice, two series of words from the dictionary would be presented, and their task was to say aloud the colour that the word was printed in. Two practice trials of ten words each were then presented. Subjects then completed the experimental trial during which time they were presented with the 72 test stimuli.

Subjects were then seated at the cold pressor apparatus and instructed to place their arm on the moveable arm rest. Subjects were shown the pain rating scale, which was placed on the wall in front of them, and instructed in its use. The experimenter then left the room, and provided the instructions over the intercom system from the observation room. The experimenter instructed subjects to immerse their arm in the ice water. At 20, 40 and 60 seconds, the experimenter instructed subjects to provide verbal ratings of their current pain using the category rating scale in front of them. After the final pain rating had been elicited, subjects were instructed to remove their arm from the ice water.

The experimenter returned to the room, and asked subjects to estimate the percentage of immersion time that they thought about their pain, to provide ratings of the level of pain and mood experienced during the time that their arm was immersed in the ice water, and to complete the PCS. Subjects were then debriefed, and thanked for their participation.

Results[3]

Ratings of Pain and Mood

Immediately prior to the cold pressor procedure, subjects immersed their arm in room temperature water for five minutes, and indicated their current level of pain and rated their current mood. This was followed by the cold pressor procedure in which subjects immersed their arm in ice water for one minute, and provided pain intensity ratings at 20, 40 and 60 seconds. Pain intensity ratings were highly inter-correlated (r's = .65, .79, .81, for ratings made at 20, 40 and 60 seconds, respectively) during the cold pressor procedure. Therefore a single score reflecting average pain intensity was calculated. Subjects' level of moods during the cold pressor procedure was assessed immediately following removal of their arm from the ice water. Table 1 presents the mean ratings for pain and mood during the room temperature water immersion, and during the cold pressor procedure. In order to present the data in table format, subjects scoring within the bottom, middle and top third of the distribution of PCS scores were classified as low, medium and high catastrophizers, respectively.

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[3]Descriptive statistics summarizing the raw data for the variables in this study are provided in Appendix I.

Table 1: Means and Standard Deviations for Pain and Mood Ratings During the Room Temperature Water Immersion and Cold Pressor Procedure in Study 1

	Room Temperature			Cold Pressor		
	Low	Medium	High	Low	Medium	High
Pain	2.08 (1.00)	3.00 (1.22)	3.15 (1.54)	6.67 (1.67)	7.64 (1.81)	8.70 (1.03)
Anxiety	4.00 (3.41)	6.96 (4.12)	10.60 (5.47)	4.75 (3.52)	9.61 (6.29)	15.05 (6.39)
Anger	.33 (.65)	1.68 (2.99)	4.20 (3.72)	1.67 (3.39)	6.71 (6.09)	12.00 (6.16)
Sadness	.33 (.78)	1.25 (1.71)	4.25 (4.93)	.17 (.58)	4.21 (6.24)	6.45 (5.53)
Happiness	12.00 (6.27)	13.96 (6.27)	8.95 (6.68)	5.17 (4.99)	4.71 (5.21)	3.15 (5.41)

Note: **Low:** Subjects scoring within the bottom third of the distribution of scores on the PCS; **Medium:** Subjects scoring within the middle third of the distribution of scores on the PCS; **High:** Subjects scoring within the top third of the distribution of scores on the PCS. **Pain:** Pain intensity ratings during the room temperature water immersion and cold pressor procedure (with endpoints '0' and '10'); **Anxiety:** Ratings of anxiety during the room temperature water immersion and cold pressor procedure (with endpoints '0' and '30'); **Anger:** Ratings of anger during the room temperature water immersion and cold pressor procedure (with endpoints '0' and '30'); **Sadness:** Ratings of sadness during the room temperature water immersion and cold pressor procedure (with endpoints '0' and '30'); **Happiness:** Ratings of happiness during the room temperature water immersion and cold pressor procedure (with endpoints '0' and '30').

Pearson correlation coefficients were computed to examine the relation between catastrophizing, pain and mood during limb immersion in room temperature water. Analyses revealed that PCS scores were unrelated to pain intensity ratings during limb immersion in room temperature water, $r = -.02$; ns. However, PCS scores were significantly correlated with subjects' ratings of anxiety, $r = .47$; $p < .001$, anger, $r = .40$; $p < .001$, and sadness, $r = .47$; $p < .001$, during the limb immersion to room temperature water. The results are presented in Table 2.

Table 2: Correlation Matrix for Pain and Mood During Room Temperature Water Immersion in Study 1

	Pain	Anxiety	Sadness	Anger	Happiness
PCS	-.02ns	.47**	.47**	.40**	-.21ns
Pain	–	.13ns	.04ns	-.05ns	.16ns
Anxiety	–	–	.38**	.33**	.03ns
Sadness	–	–	–	.55**	-.11ns
Anger	–	–	–	–	-.39**

Note: **PCS:** Pain Catastrophizing Scale composite score. **Pain:** Pain intensity ratings during the room temperature water immersion; **Anxiety:** Ratings of anxiety during the room temperature water immersion; **Sadness:** Ratings of sadness during the room temperature water immersion; **Anger:** Ratings of anger during the room temperature water immersion; **Happiness:** Ratings of happiness during the room temperature water immersion.

* $p < .05$

** $p < .001$

ns=nonsignificant

Pearson correlation coefficients were computed to examine the relation between catastrophizing, pain and mood during the time that subjects' arms were immersed in the ice water. Analyses revealed that PCS scores were significantly correlated with pain intensity ratings during the cold pressor procedure, $r = .46$; $p < .001$. PCS scores were also significantly correlated with subjects' ratings of anxiety, $r = .61$; $p < .001$, anger, $r = .50$; $p < .001$ and sadness, $r = .48$; $p < .001$. The results are presented in Table 3.

Table 3: Correlation Matrix for Pain and Mood During the Cold Pressor Procedure in Study 1

	Pain	Anxiety	Sadness	Anger	Happiness
PCS	.46**	.61**	.48**	.50**	-.23ns
Pain	–	.56**	.37**	.43**	-.31*
Anxiety	–	–	.56**	.51**	-.46**
Sadness	–	–	–	.58**	-.25ns
Anger	–	–	–	–	-.33*

Note: **PCS:** Pain Catastrophizing Scale composite score. **Pain:** Mean pain intensity ratings during the cold pressor procedure; **Anxiety:** Ratings of anxiety during the cold pressor procedure; **Sadness:** Ratings of sadness during the cold pressor procedure; **Anger:** Ratings of anger during the cold pressor procedure; **Happiness:** Ratings of happiness during the cold pressor procedure.
* $p < .05$
** $p < .001$
ns=nonsignificant

Expectancies for Pain and Mood

Prior to the cold pressor procedure, subjects provided an estimate of the level of pain and intensity of different moods that they expected to experience during the time that their arm was to be immersed in the ice water. Pearson correlation coefficients were computed to examine the relation between PCS scores and these measures. Analyses revealed that catastrophizing was significantly and positively correlated with expectancies for anxiety, $r = .44$, $p < .001$, sadness, $r = .47$, $p < .001$ and anger, $r = .40$, $p < .05$. However, catastrophizing was not significantly correlated with expectancies for pain, $r = -.02$, ns. The results are presented in Table 4.

Table 4: Correlation Matrix for Pain and Mood Expected During the Cold Pressor Procedure in Study 1

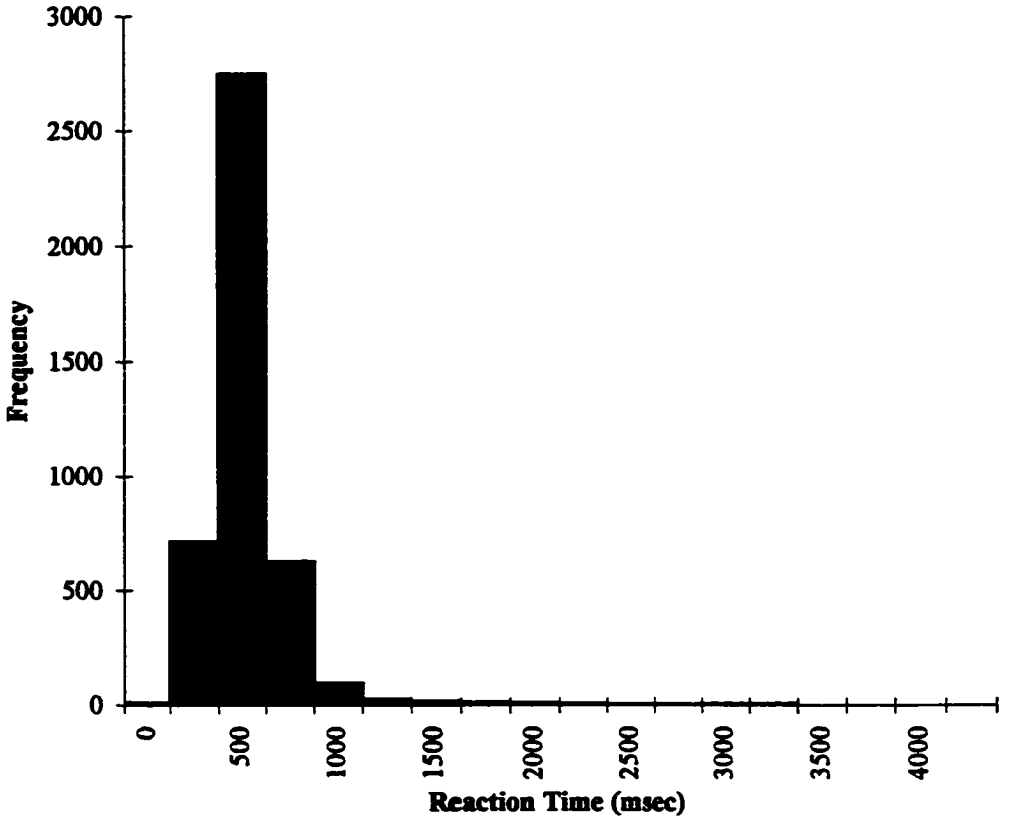
	Pain	Anxiety	Sadness	Anger	Happiness
PCS	-.02ns	.44**	.47**	.40*	.21ns
Pain	–	.11ns	.35*	.07ns	-.02ns
Anxiety	–	–	.42*	.41**	-.31*
Sadness	–	–	–	.66**	.21ns
Anger	–	–	–	–	-.43*

Note: **PCS:** Pain Catastrophizing Scale composite score. **Pain:** Pain intensity expected during the cold pressor procedure; **Anxiety:** Ratings of anxiety expected during the cold pressor procedure; **Sadness:** Ratings of sadness expected during the cold pressor procedure; **Anger:** Ratings of anger expected during the cold pressor procedure; **Happiness:** Ratings of happiness expected during the cold pressor procedure.
* $p < .05$
** $p < .001$
ns=nonsignificant

Analysis of Stroop Performance

A frequency distribution of reaction times during the Stroop colour interference task pooled across subjects was computed. The frequency distribution is shown in Figure 1. Mean reaction times on the task across subjects was 650.10msec with a standard deviation of 262.66msec.

Figure 1: Frequency distribution of reaction times during the Stroop colour interference task pooled across subjects in Study 1 before exclusion of extreme reaction times.



Reaction times less than 300msec were designated as missing values and were therefore not included in the analyses of the data. This decision was based on literature that suggests that it takes about 300msec to register and name the colour of words on the Stroop task (see Yee & Hunt, 1991). With the apparatus used in this study, any sound could have triggered the microphone linked to the internal computer clock. If a subject made a sound (e.g., coughed or

hit the table on which the microphone rested) around the time that a stimulus word was presented by the computer, a low reaction time would have occurred. Reaction times below 300msec were therefore thought to reflect response errors. Subjects on average made less than one response below 300msec (M = .22; Sd = .72; range = 0 to 5). These were excluded from the analyses. Reaction times that were more than 3 standard deviations above the mean, or 1400msec, were also designated as missing values and were therefore not included in the analyses of the data. This decision was made in order to exclude reaction times that might reflect times in which the subject was not attending to the task. Subjects on average made one response above 1400msec (M = 1.13; Sd = 1.73; range = 0-8).[4]

Table 5 shows the mean reaction times for pain-related, social-threat related and neutral words on the Stroop colour interference task. In order to present the data in table format, subjects scoring within the bottom, middle and top third of the distribution of PCS scores were classified as low, medium and high catastrophizers, respectively. Only correct trials were included in the subsequent analysis. The error rates were approximately 4% in each of the three conditions. An examination of the means indicates that subjects were generally slower in colour-naming the pain-relevant and social-threat related words than the neutral words.

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[4] Level of catastrophizing was unrelated to the number of responses below 300msec, r = -.02; ns, and above 1400msec, r = .-08. Catastrophizing was also unrelated to the total number of response errors (the number of responses below 300msec plus the number of responses above 1400msec), r = -.09, ns.

Table 5: Means and Standard Deviations for Reaction Times (msec) for Stimulus Words in Study1

	Low	Medium	High
Pain Words	600.11 (40.39)	630.52 (72.41)	662.22 (91.30)
Social Words	608.78 (47.87)	613.70 (75.24)	651.63 (95.85)
Neutral Words	593.67 (30.73)	619.48 (66.72)	638.83 (87.57)

Note: **Low:** Subjects scoring within the bottom third of the distribution of scores on the Pain Catastrophizing Scale; **Medium:** Subjects scoring within the middle third of the distribution of scores on the Pain Catastrophizing Scale; **High:** Subjects scoring within the top third of the distribution of scores on the Pain Catastrophizing Scale. **Pain Words:** Mean and standard deviation for reaction times for pain-related words; **Social Words:** Mean and standard deviation for reaction times for social-threat related words; **Neutral Words:** Mean and standard deviation for reaction times for neutral words.

For each subject, the amount of attentional bias for each threat type was calculated by subtracting the mean colour naming latencies observed for neutral words from the mean latencies observed for the pain-related and social-threat related words. Catastrophizing was expected to be associated with an attentional bias for pain-related words as reflected by a positive correlation between PCS scores and colour naming latencies for pain-related words relative to neutral words. The degree of attentional bias for pain-related words was expected to be positively correlated with reported pain intensity. Pearson correlation coefficients were computed to examine these hypotheses, and the results are shown in Table 6.

Table 6: Correlation Matrix for Stroop Performance for Study 1

	Pain	Pain Bias	Social Bias	Total Words	Estimated Attention	Gender
PCS	.46**	.16ns	.03ns	.23ns	.48**	.22ns
Pain Total	–	.05ns	-.03ns	.12ns	.65**	.22ns
Pain Bias	–	–	.51**+	.15ns	.13ns	-.08ns
Social Bias	–	–	–	.23ns	.03ns	-.14ns
Total Words	–	–	–	–	.19ns	-.04ns
Estimate Attention	–	–	–	–	–	.13ns

Note: **PCS:** Pain Catastrophizing Scale composite score; **Pain:** Mean pain intensity during the cold pressor procedure; **Pain Bias:** The degree of attentional bias for pain-related words (i.e., the difference in reaction times calculated by subtracting the response latencies for neutral words from pain-related words); **Social Bias:** The degree of attentional bias for social-threat related words (i.e., the difference in reaction times calculated by subtracting the response latencies for neutral words from social-threat related words); **Total Words:** Mean reaction times for all words on the Stroop task; **Estimated Attention:** Subjects' estimate of percentage of time attending to their pain during the cold pressor procedure (from 0% to 100%); **Gender:** Males were coded as '1' and females were coded as '2.'

* $p < .05$

** $p < .001$

+ This correlation is not meaningful as the two bias scores have a common component hence a significant correlation is expected for mathmatical reasons.

ns=nonsignificant

Analyses revealed that PCS scores were unrelated to colour naming latencies for the degree of attentional bias for pain-related words, $r = .16$; ns. Similarly, the degree of attentional bias for pain-related words was unrelated to reported pain, $r = .05$; ns.[5] A similar pattern was found for social threat words. Interestingly, PCS scores were correlated with overall colour-naming latencies on the Stroop colour interference task, $r = .23$, but this only approached statistical significance, $p = .07$. Overall response latencies were unrelated to pain intensity ratings during the cold pressor procedure, $r = .12$, ns. Gender was unrelated to any of these variables, all p's $> .05$.

Self-Report Measure of Attention

Immediately following the cold pressor procedure, subjects were asked to estimate the percentage of immersion time that they thought about their pain. Subjects' self-report estimates of attention to pain were consistent with the predictions of the attentional model. Correlational analysis revealed that PCS scores were significantly correlated with subjects' estimates of attention to pain during the cold pressor procedure, $r = 48$; $p < .001$. Additionally, subjects' estimates of attention to pain were significantly correlated with reported pain intensity during the cold pressor procedure, $r = .65$; $p < .001$.

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[5]Post-hoc examination of the set of stimulus words presented during the Stroop task indicated that some of the neutral words could potentially be associated with the cold pressor procedure or the painful stimulation produced by this procedure. It is possible that these words may have increased the mean reaction times for neutral words, and therefore decrease the degree of attentional bias for pain-related words. A second analysis of the the Stroop data was therefore performed. All potential cold-related neutral words were removed from the stimulus set (i.e., glacial, jacket, hibernation) and the degree of attentional bias for pain-related words was again calculated. Removal of these neutral words did not significantly change the magnitude and pattern of correlations presented in Table 5.

A regression analysis was performed in order to examine the relation between catastrophizing, self-report estimates of attention to pain, and reported pain intensity. Pain intensity served as the dependent variable. Subjects' self-report estimates of attention to pain were entered on the first step, followed by subjects' PCS scores on the second step. Subjects' estimates of attention to their pain accounted for approximately 43% of the variance in predicting pain intensity. The addition of PCS scores did not contribute any unique variance to the prediction of pain intensity. The results of the analysis are shown in Table 7.

Table 7: Results of Regression Analysis Predicting Pain Intensity Based on Self-Report Estimates of Attention

	Mutli R	R^2 change	F change	Signif.
Step 1: Est of Atten	.65	.43	43.52	.00001
Step 2: PCS.	.67	.03	2.94	.09

Note: **Est of Atten:** Subjects' self-report estimates of the percentage of time that they paid attention to their pain during the cold pressor procedure (0% to 100%); **PCS:** Pain Catastrophizing Scale total score.

Analysis of PCS Components

Previous research suggests that the PCS consists of three components reflecting rumination, magnification and helplessness (Sullivan et al., 1995). In order to examine the relative contribution of the PCS components to pain intensity ratings during the cold pressor procedure, a multiple regression analysis was performed, with the three factors entered together in a single step. An examination of the beta weights indicates that the helplessness

factor contributed the greatest proportion of variance to pain intensity ratings during the cold pressor procedure, followed by the rumination factor and magnification factor. None of these factors independently contributed unique variance to the prediction of pain intensity ratings. The results of this analysis are shown in Table 8.

Table 8: Results of the Direct Regression Analysis of PCS Components Predicting Reported Pain Intensity in Study 1

Factor	b	Beta	Correl	Part Cor.	Partial Cor.	Signif.
Rumination	.22	.17	.42	.10	.12	.18
Magnification	.12	.06	.32	.05	.06	.38
Helplessness	.34	.28	.45	.17	.19	.15

Note: **Correl:** correlation coefficient; **Part Corr:** part correlation coefficient; **Partial Cor:** partial correlation coefficient; **Signif:** significance level.

Discussion

The results of the current study replicate previous research in demonstrating that catastrophizing was associated with heightened levels of pain during aversive stimulation (Keefe et al., 1989; Spanos et al., 1979; 1981a; Sullivan et al., 1995; 1996; Sullivan & D'Eon, 1990). It is unlikely that heightened levels of pain during the cold pressor procedure reflected a response bias as catastrophizing was unrelated to reported pain during non-aversive stimulation (i.e., limb immersion in room temperature water). The results of the current study also replicate previous research in demonstrating that catastrophizing was associated with heightened levels of emotional distress during painful stimulation (Chaves & Brown, 1987;

Sullivan et al., 1995; 1996; Sullivan & D'Eon, 1990). Catastrophizing was significantly and positively correlated with levels of anxiety, anger and sadness both prior to and during the cold pressor procedure.

The current study failed to find a selective attentional bias for pain-related words on the Stroop colour interference task prior to the cold pressor procedure. According to the attentional model, catastrophizers possess schemata that, when activated, direct attentional resources towards pain-relevant stimuli. One of the assumptions implicit in the design of this study is that waiting for an upcoming pain-induction procedure would be sufficiently salient to activate the schemata. The failure to find evidence for an attentional bias for pain-related words associated with catastrophizing prior to the pain induction procedure could be interpreted as an indication that the situation was not sufficiently salient to activate the schemata.

However, catastrophizing was significantly and positively correlated with expectancies for emotional distress prior to the cold pressor procedure. This suggests that perhaps the schemata were active, at least at the level of appraisal processes. Several investigators have suggested that schemata may be active at one level of cognitive processing, but not others (Hastie, 1980; Neisser, 1976; Rumelhart, 1980). Although the schemata may have been active at the level of appraisal processes, it is possible for the schemata to be inactive at the level of stimulus selection. For example, prior to painful stimulation, the appraisal of the upcoming situation may be more important for the individual than stimulus selection. It is therefore

possible that pain is necessary for the schemata to become active at the level of stimulus selection.

Catastrophizing may have been associated with a global interference in colour naming on the Stroop colour interference task. Catastrophizing was positively correlated with overall colour-naming latencies on the Stroop task, although this did not reach statistical significance. One possibility is that catastrophizing may have interrupted task performance by directing attention away from the Stroop stimuli. For example, catastrophizers may have been ruminating about the possible outcomes of the upcoming cold pressor procedure, or focused on the high levels of emotional distress that they experienced prior to the procedure. A second possibility is that global slowing in colour-naming latencies associated with catastrophizing reflects psychomotor retardation. Several studies have indicated that catastrophizing is correlated with depression, and depression is frequently associated with psychomotor slowing (Beck et al., 1976; Keefe et al., 1989; Sullivan & D'Eon, 1990; Sullivan et al., 1995). The design of this study did not allow for an investigation of these hypotheses.

While an analysis of the Stroop data failed to find evidence that catastrophizing was associated with a selective attentional bias for pain-related stimuli prior to the cold pressor procedure, catastrophizing may have been associated with increased attention to pain during the cold pressor procedure. Catastrophizing was positively correlated with subjects' self-report estimates of attention to pain during the cold pressor procedure. This suggests that a high level of catastrophizing was associated with a high level of attentional focus to pain. Further, subjects' self-report estimates of attention to pain were positively correlated with subjects' ratings of pain intensity. The results of the regression analysis indicated that catastrophizing

did not contribute unique variance beyond subjects' self-report estimates of attention to pain. In other words, catastrophizing was not associated with increased pain intensity when subjects' self-report estimates of attention to pain were statistically controlled. These results are consistent with the predictions of the attentional model. However, strong statements regarding the role of attention in mediating the relation between catastrophizing and pain are precluded by the use of a self report measure. It is difficult to rule out the possibility that the high degree of self-reported attention to pain associated with catastrophizing reflects a reporting bias. The inclusion of a Stroop trial during the cold pressor procedure would provide a stronger test of whether catastrophizing is associated with an increase in attention to pain-related stimuli during painful stimulation.

STUDY 2

Study 1 failed to find evidence for a selective attentional bias for pain-related stimuli on the Stroop colour interference task prior to the cold pressor procedure. However, based on self report data, there was evidence that catastrophizing may have been associated with an increase in attention to pain-related stimuli during the cold pressor procedure. The pattern of findings suggests that painful stimulation may be necessary to evoke the attentional bias for pain-related stimuli thought to be associated with catastrophizing. To test this hypothesis, subjects in the current study participated in separate trials of the Stroop colour interference task both prior to and during the cold pressor procedure. It was predicted that catastrophizing would be associated with an attentional bias for pain-related words during the cold pressor procedure.

Although painful stimulation may be necessary to activate the attentional bias for pain-related stimuli, it is possible that it remains active following the cessation of painful stimulation. For example, catastrophizers may continue to direct attentional resources to painful stimuli for the purpose of monitoring tactile sensations, or they may ruminate about their experiences during the procedure. To test this hypothesis, subjects participated in a third trial on the Stroop colour interference task following the cold pressor procedure. If the attentional bias remains active following the cessation of painful stimulation, then one would expect to observe an attentional bias for pain-related words associated with catastrophizing during the Stroop trial following the cold pressor procedure. However, if the anticipated attentional bias disappears

with the alleviation of pain, then one would conclude that the attentional bias is limited to painful stimulation.

Catastrophizing may have been associated with general slowing on the Stroop colour interference task in Study 1. This finding may be interpreted as an indication that catastrophizers were not attending to the task, but rather were attending to ruminations or emotional distress related to the upcoming procedure. This finding suggests the possibility that pain-related stimuli may interfere with catastrophizers' ability to sustain attention to the Stroop task resulting in longer colour naming latencies regardless of word-type. Thus, catastrophizers may not evidence an attentional bias for pain-related words on the Stroop task because they are unable to sustain their attention to the task. The colour naming task may therefore act as a probe that indicates the degree to which the presence of pain-related stimuli places demands on attentional resources. With the onset of pain, one might expect even greater slowing in response latencies to colour naming as a function of catastrophizing, since painful stimulation would be expected to increase the saliency of the situation. The attentional model would be supported if it can be shown that the magnitude of correlation between PCS scores and overall colour naming latencies increases from the trial prior to the cold pressor procedure, to the trial during the procedure, and that overall response latencies during the cold pressor procedure are positively correlated with pain intensity.

Method

Subjects

Potential subjects considered for this study included all students at Dalhousie University who were registered in an Introductory Psychology course. The methods of recruitment, selection of subjects, and inclusion/exclusion criteria were identical to Study 1. Sixty-three subjects were recruited for this study (20 males, 43 females). The mean age of the sample was 21.3 years, with a range of 17 and 31 years. Subjects participated individually, and received one bonus percentage added to their final grade in Introductory Psychology.

Apparatus

The Stroop colour interference task used in Study 1 was modified for the purpose of the current study. Subjects were asked to name the colour of a series words prior to, during, and following exposure to cold pressor pain. Each trial consisted of a different set of 24 pain-relevant, social-threat and neutral words (Appendix J). The stimulus words consisted of the original 72 words selected from Study 1. The stimuli were matched for word frequency according to Carroll, Davies & Richman's (1971) norms and matched for word valance across trials and across word-types within each trial. For each trial, the 24 stimulus words were presented individually in one of the following colours: blue, green, red, and yellow. Each word was 10 cm in height, and was presented in the middle of the monitor screen on a black background.

The Stroop apparatus was modified so that subjects initiated each trial of words by pressing the space key on the computer keyboard. Once the trial was initiated, the subject was

presented with each word, and the computer automatically recorded the latency between word onset and the subject's response in milliseconds. A new word was presented after a three second delay, in a different colour. Each colour named by the subject was entered onto a coding sheet by the experimenter, who observed the subject's performance from the observation room. Each trial proceeded in this manner until all 24 words were presented. At the end of each trial, the computer presented instructions to stop, and to wait for the experimenter to return.

The testing environment was identical to that used in Study 1. The same plastic cooler containing room temperature water, and cold pressor apparatus described in Study 1 were utilized.

Measures

While the subjects' arm was immersed in the ice water during the cold pressor procedure, they concurrently completed a trial of the Stroop colour interference task. In order to avoid a disruption in the Stroop procedure, pain intensity was not assessed at intervals during the cold pressor procedure as in Study 1. Instead, level of pain intensity during the cold pressor procedure was assessed immediately following the removal of their arm from the ice water. Subjects were asked to rate the level of pain that they experienced on a rating scale with endpoints (0) no pain and (10) extreme pain. In Study 1 subjects' retrospective ratings of pain intensity were highly correlated, $r = .96$; $p < .001$, with pain intensity ratings during the cold pressor procedure. Current pain and mood during the room temperature immersion, expected pain and mood during the cold pressor procedure, and experienced pain, mood, and estimated

attention to pain were assessed using the measures described in Study 1. The PCS was used as a measure of level of catastrophizing.

Procedure

Subjects were familiarized with the cold-pressor apparatus, and told that they would be placing their arm in the ice water for a one-minute period. Subjects were assured that the procedure would not cause any damage to their arm, but that the ice water would likely cause some physical discomfort. Subjects were made aware that they could discontinue the immersion at any time, and that they would receive course credit even if they did not complete the study.

As in Study 1, subjects were asked to place their non-dominant arm in the container of room temperature water for five minutes, and told that the purpose of the immersion was to regulate the temperature of their arm. During the immersion, subjects were provided with the questionnaires that asked them to rate a) the intensity of pain that they were experiencing at that moment, with their arm in the room temperature water, b) the intensity of different moods that they were experiencing at that moment, with their arm in the room temperature water, c) the intensity of pain that they expected to experience during the cold pressor procedure, and d) the intensity of different moods that they expected to experience during the cold pressor procedure.

Subjects were then placed in front of the computer monitor, and positioned so that they were approximately 30 cm away from the microphone that rested on the desk directly in front of the monitor. They were told that they would be presented with a serious of words, and that

their task was to name the colour of each word aloud, as quickly as they can. They were shown an example of each colour, and then completed two practice trials consisting of 10 neutral words each. They were then provided an opportunity to ask questions. Once they understood the task, the experimenter left the room and subjects completed the first trial of 24 words.

At the end of the first Stroop trial, the experimenter returned to the testing room and asked subjects to remain seated in front of the computer monitor. The cold pressor apparatus was then placed beside the subject. Subjects were instructed to place their non-dominant arm on the moveable arm rest, and wait for further instructions. The experimenter then left the room, and provided the instructions over the intercom system from the observation room. The experimenter instructed subjects to immerse their arm in the ice water, and to initiate the Stroop task by pressing the space bar on the keypad. During the time that subjects' arm was immersed in the ice water, they completed the second trial of 24 stimuli words. In every case the stimulus words were completed prior to the end of the one minute period. Subjects were therefore instructed to keep their arm in the ice water until the experimenter told them to remove their arm. After the one minute period, they were instructed to remove their arm from the ice water. The experimenter then returned to the room, and asked subjects to rate their level of pain during the procedure, and to estimate the percentage of immersion time that they thought about their pain. At this time, they were also asked to rate their mood during the time that their arm was immersed in the ice water.

Subjects were then asked to complete a third trial of the Stroop task. Subjects were told that they may initiate the trial anytime after the experimenter left the room. At the end of the trial, the experimenter returned, and asked subjects to complete the PCS.

Results[6]

Ratings of Pain and Mood

Immediately prior to the cold pressor procedure, subjects immersed their arm in room temperature water for five minutes, and indicated their current level of pain and rated their current mood. This was followed by the cold pressor procedure in which subjects immersed their arm in ice water for one minute. Subjects' level of pain and moods during the cold pressor procedure were assessed immediately following removal of their arm from the ice water. Table 9 presents the mean ratings for pain and mood during the room temperature water immersion, and during the cold pressor procedure. In order to present the data in table format, subjects scoring within the bottom, middle and top third of the distribution of PCS scores were classified as low, medium and high catastrophizers, respectively.

[6]Descriptive statistics summarizing the raw data for the variables in this study are provided in Appendix K.

Table 9: Means and Standard Deviations for Pain and Mood Ratings During the Room Temperature Water Immersion and Cold Pressor Procedure in Study 2

	Room Temperature			Cold Pressor		
	Low	Medium	High	Low	Medium	High
Pain	1.83 (0.98)	2.25 (1.33)	2.30 (1.33)	6.83 (1.17)	7.25 (1.37)	8.05 (1.27)
Anxiety	3.17 (2.14)	4.90 (4.33)	6.32 (6.02)	4.33 (2.88)	9.50 (7.46)	11.86 (6.47)
Anger	0.17 (0.41)	1.35 (1.81)	1.95 (2.74)	2.00 (3.95)	5.90 (6.55)	10.76 (7.73)
Sadness	0.33 (0.52)	0.50 (0.83)	1.57 (2.51)	0.33 (0.82)	1.90 (2.86)	5.92 (6.33)
Happiness	7.17 (5.38)	9.20 (5.16)	6.97 (5.98)	1.67 (3.20)	3.50 (4.30)	1.57 (3.17)

Note: **Low:** Subjects scoring within the bottom third of the distribution of scores on the PCS; **Medium:** Subjects scoring within the middle third of the distribution of scores on the PCS; **High:** Subjects scoring within the top third of the distribution of scores on the PCS. **Pain:** Pain intensity ratings during the room temperature water immersion and cold pressor procedure (with endpoints '0' and '10'); **Anxiety:** Ratings of anxiety during the room temperature water immersion and cold pressor procedure (with endpoints '0' and '30'); **Anger:** Ratings of anger during the room temperature water immersion and cold pressor procedure (with endpoints '0' and '30'); **Sadness:** Ratings of sadness during the room temperature water immersion and cold pressor procedure (with endpoints '0' and '30'); **Happiness:** Ratings of happiness during the room temperature water immersion and cold pressor procedure (with endpoints '0' and '30').

Pearson correlation coefficients were computed to examine the relation between catastrophizing, pain and mood during limb immersion in room temperature water. Analyses revealed that PCS scores were unrelated to pain intensity ratings during limb immersion in room temperature water, $r = .07$; ns. Also, PCS scores were unrelated to level of anxiety, $r = 12$; ns, anger, $r = .19$; ns, and happiness, $r = -.09$; ns, during the limb immersion to room temperature water. However, PCS scores were significantly correlated with level of sadness during this period, $r = .26$; $p < .001$. The results are presented in Table 10.

Table 10: Correlation Matrix for Pain and Mood During Room Temperature Water Immersion in Study 2

	Pain	Anxiety	Sadness	Anger	Happiness
PCS	.07ns	.12ns	.26*	.19ns	-.09ns
Pain	–	.16ns	.26*	.52**	-.06ns
Anxiety	–	–	.35**	.30**	.29*
Sadness	–	–	–	.64**	.17ns
Anger	–	–	–	–	-.02ns

Note: **PCS:** Pain Catastrophizing Scale composite score. **Pain:** Pain intensity ratings during the room temperature water immersion; **Anxiety:** Ratings of anxiety during the room temperature water immersion; **Sadness:** Ratings of sadness during the room temperature water immersion; **Anger:** Ratings of anger during the room temperature water immersion; **Happiness:** Ratings of happiness during the room temperature water immersion.

* $p < .05$

** $p < .001$

ns=nonsignificant

Pearson correlation coefficients were computed to examine the relation between catastrophizing, pain and mood during the time that subjects' arms were immersed in the ice water. Analyses revealed that PCS scores were significantly correlated with pain intensity ratings during the cold pressor procedure, $r = .48$; $p < .001$. PCS scores were also significantly correlated with subjects' ratings of anxiety, $r = .43$; $p < .001$, anger, $r = .50$; $p < .001$ and sadness, $r = .52$; $p < .001$, during the cold pressor procedure. The results are presented in Table 11.

Table 11: Correlation Matrix for Pain and Mood During the Cold Pressor Procedure in Study 2

	Pain	Anxiety	Sadness	Anger	Happiness
PCS	.48**	.43**	.52**	.50**	-.24ns
Pain	–	.46**	.35**	.48**	-.21ns
Anxiety	–	–	.37**	.44**	-.16ns
Sadness	–	–	–	.56**	-.14ns
Anger	–	–	–	–	-.22ns

Note: **PCS:** Pain Catastrophizing Scale composite score. **Pain:** Pain intensity ratings during the cold pressor procedure; **Anxiety:** Ratings of anxiety during the cold pressor procedure; **Sadness:** Ratings of sadness during the cold pressor procedure; **Anger:** Ratings of anger during the cold pressor procedure; **Happiness:** Ratings of happiness during the cold pressor procedure.
* $p < .05$
** $p < .001$
ns=nonsignificant

Expectancies for Pain and Mood

Prior to the cold pressor procedure, subjects provided an estimate of the level of pain and intensity of different moods that they expected to experience during the time that their arm was to be immersed in the ice water. Pearson correlation coefficients were computed to examine the relation between PCS scores and these measures. Analyses revealed that catastrophizing was significantly and positively correlated with expectancies for pain, $r = .31$, $p < .05$, indicating that subjects scoring high on level of catastrophizing expected to experience more pain. Catastrophizing was also significantly correlated with expectancies for anxiety, $r = .32$, $p < .05$, sadness, $r = .37$, $p < .05$, and anger, $r = .57$, $p < .05$. These results are shown in Table 12.

Table 12: Correlation Matrix for Pain and Mood Expected During the Cold Pressor Procedure in Study 2

	Pain	Anxiety	Sadness	Anger	Happiness
PCS	.31*	.32*	.37*	.57**	-.07ns
Pain	–	.47**	.32*	.36*	-.04ns
Anxiety	–	–	.55**	.55**	-.01ns
Sadness	–	–	–	.66**	.09ns
Anger	–	–	–	–	-.19ns

Note: **PCS:** Pain Catastrophizing Scale composite score. **Pain:** Pain intensity expected during the cold pressor procedure; **Anxiety:** Ratings of anxiety expected during the cold pressor procedure; **Sadness:** Ratings of sadness expected during the cold pressor procedure; **Anger:** Ratings of anger expected during the cold pressor procedure; **Happiness:** Ratings of happiness expected during the cold pressor procedure.
* $p < .05$
** $p < .001$
ns=nonsignificant

Previous studies have shown that pain-related expectancies and appraisals play an important role in pain perception (Jensen et al., 1991; Turk & Rudy, 1992). It is therefore possible that pain-related expectancies may play a role in mediating the relation between catastrophizing and pain intensity. A regression analysis was performed in order to examine the relation between catastrophizing, expectancies for pain, and reported pain intensity. Pain intensity served as the dependent variable. Subjects' expectancies for pain were entered on the first step, followed by subjects' PCS scores on the second step. Subjects' expectancies for pain accounted for approximately 15% of the variance in predicting pain intensity. The addition of

PCS scores contributed an additional 15% of unique variance to the prediction of pain intensity. The results of the analysis are shown in Table 13.

Table 13: Results of Regression Analysis Predicting Pain Intensity Based on Expectancies for Pain

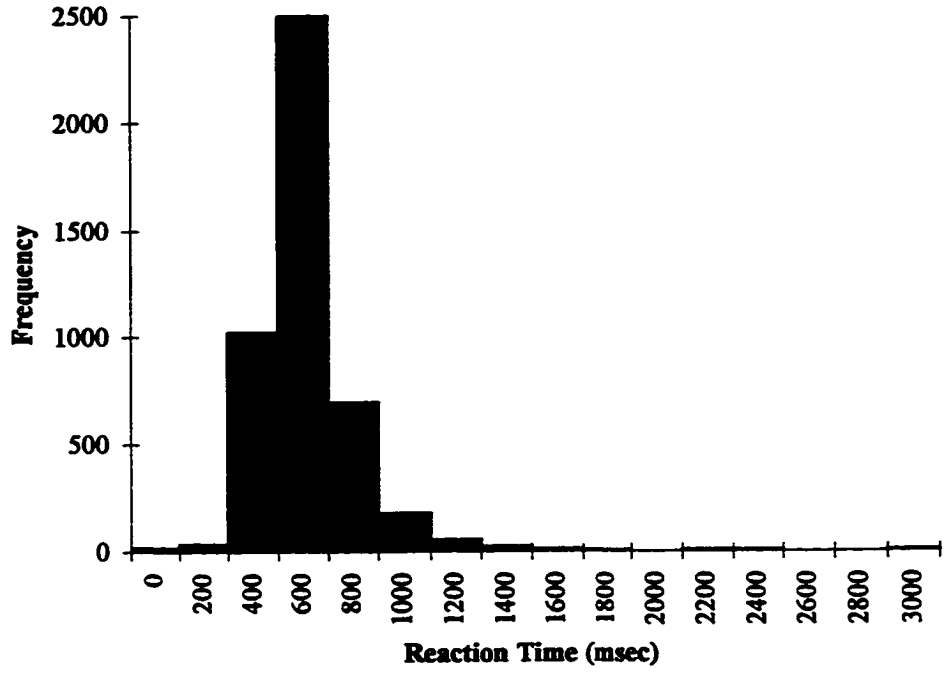
	Mutli R	R^2 change	F change	Signif.
Step 1: Expect Pain	.39	.15	11.11	.0015
Step 2: PCS.	.55	.15	13.33	.0005

Note: **Expect Pain:** Subjects' self-report estimates of intensity of pain that they expected to experience during the cold pressor procedure. **PCS:** Pain Catastrophizing Scale total score.

Analyses of the Stroop Data

A frequency distribution of reaction times during the Stroop colour interference task pooled across subjects and experimental trials was computed. The frequency distribution is shown in Figure 2. Mean reaction times on the task across subjects was 611.40msec with a standard deviation of 198.61msec.

Figure 2: Frequency distribution of reaction times during the Stroop colour interference task pooled across subjects and experimental trials in Study 2 before exclusion of extreme reaction times.



As in Study 1, reaction times below 300msec were thought to reflect response errors so these reaction times were designated as missing values and therefore not included in the analyses of the data. On average, subjects made less than one response below 300msec over the three trials (M = .76; Sd = 2.07; range = 0-10). Reaction times that were more than 3 standard

deviations above the mean, or 1200msec, were also designated as missing values and were therefore not included in the analyses of the data. On average, subjects made one response above 1200msec (M = 1.14; Sd = 2.79; range = 0-18).[7]

Subjects completed three experimental trials on the Stroop colour interference task: (a) prior to the cold pressor procedure; (b) concurrent with the cold pressor procedure; and (c) following the cold pressor procedure. During each experimental trial, subjects were asked to name the colour of words that were either pain-related, social-threat related, or neutral. For each trial, mean response latencies for each of the word-types were calculated. Table 14 shows the mean reaction times for pain-related, social-threat related and neutral words on the Stroop colour interference task for each of these three trials. In order to present the data in table format, subjects scoring within the bottom, middle and top third of the distribution of PCS scores were classified as low, medium and high catastrophizers, respectively. The error rates were approximately 2 - 4% for each of the three word-types in each trial.

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[7] Catastrophizing was unrelated to the number of responses below 300msec, r = -.20, ns, and number of responses above 1200msec, r = .21, ns. Catastrophizing was also unrelated to the total number of response errors (the number of responses below 300msec plus the number of responses above 1200msec), r = .05; ns.

Table 14: Means and Standard Deviations for Colour-Naming Latencies (msec) for Experimental Trials in Study 2

	Level of Catastrophizing		
	Low	Medium	High
Trial 1			
Pain Words	561.80 (81.85)	565.65 (84.06)	588.25 (115.64)
Social Words	554.30 (63.65)	554.69 (89.67)	538.37 (105.72)
Neutral Words	585.60 (75.32)	573.70 (80.27)	580.13 (114.58)
Trial 2			
Pain Words	582.40 (65.01)	647.57 (91.00)	658.06 (94.07)
Social Words	598.67 (83.00)	633.96 (93.59)	667.33 (124.42)
Neutral Words	616.70 (87.51)	651.70 (90.70)	646.75 (78.87)
Trial 3			
Pain Words	579.80 (35.46)	584.76 (97.15)	598.75 (104.33)
Social Words	588.07 (73.04)	597.90 (95.32)	603.91 (112.00)
Neutral Words	596.80 (52.58)	620.14 (97.10)	616.63 (91.79)

Note: **Low:** Subjects scoring within the bottom third of the distribution of scores on the Pain Catastrophizing Scale; **Medium:** Subjects scoring within the middle third of the distribution of scores on the Pain Catastrophizing Scale; **High:** Subjects scoring within the top third of the distribution of scores on the Pain Catastrophizing Scale. **Pain Words:** Mean reaction times for pain-related words; **Social Words:** Mean reaction times for social-threat related words; **Neutral Words:** Mean reaction times for neutral words.

An examination of the means in Table 14 indicates that reactions times generally increased from the Stroop trial preceding the cold pressor procedure to the trial concurrent with the cold pressor procedure. During both trials, low and medium catastrophizers were slightly faster in colour naming pain-relevant and social-threat related words than neutral words. However, high catastrophizers were slower in colour-naming pain-relevant and social-threat related words during these trials. During the trial concurrent with the cold pressor procedure, response latencies for neutral words generally remained constant as a function of catastrophizing. However, response latencies for pain-relevant and social-threat related words increased as a function of catastrophizing.

The amount of attentional bias for pain-related words for each trial was calculated by subtracting the mean colour naming latencies observed for neutral words from the mean latencies observed for the pain-related words for each subject. Similarly, the amount of attentional bias for social-threat related words for each trial were calculated by subtracting the mean colour naming latencies observed for neutral words from the mean latencies observed for the social threat words for each subject. Only correct responses to colour-naming were considered for analyses.

Stroop Trial Prior to the Cold Pressor Procedure. The results of the Stroop performance for this trial are shown in Table 15. Consistent with the results from Study 1, PCS scores were unrelated to the amount of attentional bias for pain-related words during the trial prior to the cold pressor procedure, $r = .16$; ns.

Table 15: Correlational Matrix for Stroop Performance Prior to the Cold Pressor Procedure in Study 2

	Pain	Pain Bias	Social Bias	Total Words	Estimated Attention	Gender
PCS	.50**	.16ns	-.14ns	.01ns	.58**	.04ns
Pain	--	.40**	.04ns	.04ns	.67**	.12ns
Pain Bias	--	--	.50**+	.05ns	.17ns	-.18ns
Social Bias	--	--	--	.03ns	-.05ns	-.04ns
Total Words	--	--	--	--	-.06ns	-.02ns
Estimate Attention	--	--	--	--	--	.27*

Note: **PCS:** Pain Catastrophizing Scale composite score; **Pain:** Mean pain intensity during the cold pressor procedure; **Pain Bias:** The degree of attentional bias for pain-related words (i.e., the difference in reaction times calculated by subtracting the response latencies for neutral words from pain-related words); **Social Bias:** The degree of attentional bias for social-threat related words (i.e., the difference in reaction times calculated by subtracting the response latencies for neutral words from social-threat related words); **Total Words:** Mean reaction times for all words on the Stroop task; **Estimated Attention:** Subjects' estimate of percentage of time attending to their pain during the cold pressor procedure (from 0% to 100%); **Gender:** Males were coded as '1' and females were coded as '2.'

* $p < .05$

** $p < .001$

+ This correlation is not meaningful as the two bias scores have a common component hence a significant correlation is expected for mathmatical reasons.

ns=nonsignificant

Stroop Trial During the Cold Pressor Procedure. The results of the Stroop performance for this trial are shown in Table 16. Consistent with the predictions of the attentional model, PCS scores were significantly correlated with the degree of attentional bias

for pain-related words, $r = .29$; $p < .05$, during the cold pressor procedure. The direction of the correlation indicates that high levels of catastrophizing were associated with slower response latencies to pain-related words relative to neural words. Gender was unrelated to the degree of attentional bias for pain-related words, $r = -.02$, ns.

Table 16: Correlational Matrix for Stroop Performance During the Cold Pressor Procedure in Study 2

	Pain	Pain Bias	Social Bias	Total Words	Estimated Attention	Gender
PCS	.50**	.29*	.22*	.24*	.58**	.04ns
Pain	--	.23*	.08ns	.17ns	.67**	.12ns
Pain Bias	--	--	.61**+	.11ns	.18ns	-.02ns
Social Bias	--	--	--	.25*	.09ns	-.10ns
Total Words	--	--	--	--	.22*	.17ns
Estimate Attention	--	--	--	--	--	.27**

Note: **PCS:** Pain Catastrophizing Scale composite score; **Pain:** Mean pain intensity during the cold pressor procedure; **Pain Bias:** The degree of attentional bias for pain-related words (i.e., the difference in reaction times calculated by subtracting the response latencies for neutral words from pain-related words); **Social Bias:** The degree of attentional bias for social-threat related words (i.e., the difference in reaction times calculated by subtracting the response latencies for neutral words from social-threat related words); **Total Words:** Mean reaction times for all words on the Stroop task; **Estimated Attention:** Subjects' estimate of percentage of time attending to their pain during the cold pressor procedure (from 0% to 100%); **Gender:** Males were coded as '1' and females were coded as '2.'

* $p < .05$

** $p < .001$

+ This correlation is not meaningful as the two bias scores have a common component hence a significant correlation is expected for mathmatical reasons.

ns=nonsignificant

Catastrophizers are thought to differ from non-catastrophizers primarily in the content of their pain schemata. Therefore, it was predicted that catastrophizing would be associated with an attentional bias for pain-related stimuli, but not pain-irrelevant threat stimuli. However, PCS scores were significantly correlated with the degree of attentional bias for social-threat stimuli during the cold pressor procedure, $r = .22$; $p < .05$.

Stroop Trial Following the Cold Pressor Procedure. Following the cold pressor procedure, subjects participated in a third trial of the Stroop colour interference task. The results for this trial are shown in Table 17. Correlational analysis revealed that PCS scores were unrelated to the degree of attentional bias for pain-related words, $r = .01$; ns. However, gender was significantly correlated with the degree of attentional bias for pain-related words, $r = -.22$; $p < .05$. Males showed a mean difference in colour naming pain-related words relative to neutral words of -12.50msec with a standard deviation of 41.23msec. Females showed a mean difference in colour naming pain-related words relative to neutral words of -35.26msec with a standard deviation of 56.02msec. Pearson correlation coefficients were performed in order to examine the relation between catastrophizing and the degree of attentional bias for pain-related words separately for males and females. Analyses revealed that for PCS scores were unrelated to the degree of attentional bias for pain-related words for both males, $r = .17$; ns and females, $r = .02$, ns.

Table 17: Correlational Matrix for Stroop Performance Following the Cold Pressor Procedure in Study 2

	Pain Total	Pain Bias	Social Bias	Total Words	Estimated Attention	Gender
PCS	.50**	.01ns	-.06ns	.09ns	.58**	.04ns
Pain	–	.07ns	.04ns	.13ns	.67**	.12ns
Pain Bias	–	–	.49**+	.03ns	-.04ns	-.22*
Social Bias	–	–	–	.14ns	-.20ns	-.41**
Total Words	–	–	–	–	.04ns	-.02ns
Estimate Attention	–	–	–	–	–	.27**

Note: **PCS:** Pain Catastrophizing Scale composite score; **Pain:** Mean pain intensity during the cold pressor procedure; **Pain Bias:** The degree of attentional bias for pain-related words (i.e., the difference in reaction times calculated by subtracting the response latencies for neutral words from pain-related words); **Social Bias:** The degree of attentional bias for social-threat related words (i.e., the difference in reaction times calculated by subtracting the response latencies for neutral words from social-threat related words); **Total Words:** Mean reaction times for all words on the Stroop task; **Estimated Attention:** Subjects' estimate of percentage of time attending to their pain during the cold pressor procedure (from 0% to 100%); **Gender:** Males were coded as '1' and females were coded as '2.'

* $p < .05$

** $p < .001$

+ This correlation is not meaningful as the two bias scores have a common component hence a significant correlation is expected for mathmatical reasons.

ns=nonsignificant

Gender was also significantly correlated with the degree of attentional bias for social-threat related words during the trial following the cold pressor procedure. Males showed a mean difference in colour naming social-threat related words relative to neutral words of 16.13msec with a standard deviation of 51.47msec. Females showed a mean difference in

colour naming social-threat related words relative to neutral words of -31.79msec with a standard deviation of 49.92msec. Pearson correlation coefficients were performed in order to examine the relation between catastrophizing and the degree of attentional bias for pain-related words separately for males and females. Analyses revealed that for PCS scores were unrelated to the degree of attentional bias for pain-related words for both males, $r = .13$; ns and females, $r = -.03$, ns.

Overall Stroop Performance. Pearson correlation coefficients were computed in order to examine the relation between catastrophizing and overall performance (i.e., regardless of word type) on the Stroop colour interference task for each of the three trials. During the trial preceding the cold pressor procedure, PCS scores were unrelated to overall colour naming latencies on the Stroop task, $r = .08$; ns.[8] However, during the cold pressor procedure, PCS scores were significantly correlated with overall colour naming latencies, $r = .22$; $p < .05$, indicating that high levels of catastrophizing were associated with longer response latencies in colour naming. During the trial following the cold pressor procedure, PCS scores were unrelated to overall colour naming latencies, $r = .15$, ns. For each of the three trials, overall colour naming latencies were unrelated to pain intensity ratings during the cold pressor procedure, all p's > .05. These results are shown in Table 18.

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[8]In Study 1, catastrophizing was associated with overall Stroop performance prior to the cold pressor procedure, although the correlation only approached significance. The failure to replicate this finding in the current study can likely be attributed to a lack of statistical power for the analysis. The stimulus set for each trial in current study consists of one-third the number of words as those used during the single Stroop trial in Study 1. When the Stroop stimulus set from Study 1 was re-examined using only the words included within Trial 1 of the current study, the magnitiude of the correlation between catastrophizing and overall Stroop performance was much smaller, and clearly not significant, $r = .14$, $p = .19$.

Table 18: Overall Stroop Performance as a Function of PCS Scores in Study 2

	Pain	Trial 1	Trial 2	Trial 3
PCS	.50**	.08ns	.22**	.15ns
Pain	–	.04ns	.08ns	.12ns
Trial 1	–	–	.59**	.78**
Trial 2	–	–	–	.74**

Note: **PCS:** Pain Catastrophizing Scale composite score: **Pain:** Pain intensity during the cold pressor procedure; **Trial 1:**. Colour naming latencies for total words during Trial 1; **Trial 2:**. Colour naming latencies for total words during Trial 2; **Trial 3:** Colour naming latencies for total words during Trial 3.
* $p < .05$
** $p < .001$
ns=nonsignificant

Stroop Performance and Reported Pain Intensity

A positive correlation between the degree of attentional bias for pain-related stimuli during the cold pressor procedure and pain intensity was expected. Analyses revealed that the degree of attentional bias for pain-related words during the trial prior to the cold pressor procedure was significantly correlated with reported pain intensity during the subsequent cold pressor procedure, $r = .40$; $p < .001$. Similarly, the degree of attentional bias for pain-related words during the cold pressor procedure was significantly correlated with reported pain intensity, $r = .23$; $p < .05$. The results indicate that a high degree of attentional bias for pain-related words prior to and during the cold pressor procedure was associated with greater levels of pain. During the trial following the cold pressor procedure, the degree of attentional bias for

pain-related words was unrelated to reported pain intensity during the cold pressor procedure, $r = .07$; ns.

According to the attentional model, schematic processes associated with catastrophizing are thought to be the mechanism by which the attentional bias for pain-related stimuli occurs during pain. However, heightened levels of pain intensity have been found to result in an increase in attention to pain-related stimuli (Eccleston, 1994). It is therefore possible that the attentional bias for pain-related stimuli may have been the direct result of heightened levels of pain intensity, not schematic processes associated with catastrophizing. If this is the case, then the relation between pain intensity and the attentional bias should be independent of level of catastrophizing. In order to address this hypothesis, a partial correlation between pain intensity and the degree of attentional bias for pain-related words on the Stroop colour-interference task was performed, while holding level of catastrophizing constant. Analysis indicated that level of pain intensity was unrelated to the degree of attentional bias for pain-related words, $r = .10$; ns, when the effect of catastrophizing was removed. The results suggest that the relation between catastrophizing and the attentional bias is not due to the independent influence of pain intensity.

According to the attentional model, the relation between catastrophizing and pain is mediated, at least in part, by the degree of attentional focus to pain-related stimuli. In order to examine this hypothesis, a regression analysis was performed with reported pain intensity during the cold pressor procedure as the dependent variable. The degree of attentional bias for pain-related words during the Stroop trial concurrent with the cold pressor procedure was

entered first, followed by PCS scores on a separate step. The degree of attentional bias for pain-related words during the Stroop trial concurrent to the cold pressor procedure accounted for approximately 5% of the variance in predicting pain intensity ratings. The addition of PCS scores contributed an additional 20% of unique variance to the prediction of pain intensity. The results of this analysis are shown is Table 19.

Table 19: Results of Regression Analysis Predicting Pain Intensity Based on Stroop Performance in Study 2

	Mutli R	R^2 change	F change	Signif.
Step 1: Pain Bias	.23	.05	3.40	.07
Step 2: PCS Scores	.50	.20	16.13	.0002

Note: **Pain Bias:** Colour naming latencies for pain-related words minus neutral words; **PCS:** Pain Catastrophizing Scale total score.

Self-Report Estimates of Attention

Immediately following the cold pressor procedure, subjects estimated the percentage of time that they thought about their pain during the cold pressor procedure. Consistent with the results of Study 1 and with the predictions of the attentional model, PCS scores were positively correlated with subjects' estimates of attention to pain during the cold pressor procedure, $r = .58$; $p < .001$. Subjects' estimates of attention to pain were positively correlated with subjects' ratings of pain intensity during the cold pressor procedure, $r = .67$; $p < .001$. A regression analysis was performed in order to examine the relation between catastrophizing, self-report

attention to pain, and reported pain intensity during the cold pressor procedure. Pain intensity served as the dependent variable. Subjects' self-report estimates of the amount of time that they thought about their pain during the cold pressor procedure was entered on the first step, followed by subjects' PCS scores on the second step. Subjects' estimates of the amount of time that they thought about their pain accounted for approximately 45% of the variance in predicting pain intensity ratings. The addition of PCS scores did not contribute any unique variance to the prediction of pain intensity. The results of the analysis are shown in Table 20.

Table 20: Results of Regression Analysis Predicting Pain Intensity Based on Self-Report Estimates of Attention

	Mutli R	R^2 change	F change	Signif.
Step 1: Est of Atten	.67	.45	49.27	.00001
Step 2: PCS.	.68	.02	1.88	.18

Note: **Est of Atten:** Subjects' self-report estimates of the percentage of time that they paid attention to their pain during the cold pressor procedure; **PCS:** Pain Catastrophizing Scale total score.

Analysis of PCS Components

In order to examine the relative contribution of the PCS components to pain intensity ratings during the cold pressor procedure, a multiple regression analysis was performed, with the three factors entered together in a single step. The pattern of findings was similar to those reported in Study 1. An examination of the beta weights indicates that the helplessness factor

contributed the greatest proportion of variance to pain intensity ratings during the cold pressor procedure, followed by the rumination factor and magnification factor. None of these factors independently contributed unique variance to the prediction of pain intensity ratings. The results of this analysis are shown in Table 21.

Table 21: Results of the Direct Regression Analysis of PCS Components Predicting Reported Pain Intensity in Study 2

Factor	b	Beta	Correl	Part Cor.	Partial Cor.	Signif.
Rumination	.10	.27	.48	.17	.19	.13
Magnification	-.06	-.10	.13	-.09	-.11	.40
Helplessness	.10	.33	.50	.21	.24	.06

Note: **Correl:** correlation coefficient; **Part Corr:** part correlation coefficient; **Partial Corr:** partial correlation coefficient; **Signif:** significance level.

There may be gender differences in the relative contribution of PCS to pain intensity. Separate regression analyses for men and women were therefore performed. The results of the separate analyses for men and women are shown in Table 22 and Table 23, respectively. An examination of the beta weights indicates that the helplessness factor contributed the greatest proportion of variance to pain intensity for men. In contrast, the rumination factor contributed the greatest proportion of variance to pain intensity for women.

Table 22: Results of the Direct Regression Analysis of PCS Components Predicting Reported Pain Intensity for Males in Study 2

Factor	b	Beta	Correl	Part Cor.	Partial Cor.	Signif.
Rumination	.03	.07	.47	.04	.04	.86
Magnification	.09	.13	.36	.11	.13	.58
Helplessness	.11	.46	.54	.19	.23	.36

Note: **Correl:** correlation coefficient; **Part Corr:** part correlation coefficient; **Partial Corr:** partial correlation coefficient; **Signif:** significance level.

Table 23: Results of the Direct Regression Analysis of PCS Components Predicting Reported Pain Intensity for Females in Study 2

Factor	b	Beta	Correl	Part Cor.	Partial Cor.	Signif.
Rumination	.13	.37	.48	.25	.27	.07
Magnification	.09	-.19	.05	.17	-.20	.21
Helplessness	.08	.26	.47	.18	.21	.19

Note: **Correl:** correlation coefficient; **Part Corr:** part correlation coefficient; **Partial Corr:** partial correlation coefficient; **Signif:** significance level.

Discussion

According to the attentional model, catastrophizers posses pain-related schemata that when activated direct attentional resources towards aspects of their pain. In the current study, the Stroop colour interference task was used to test this hypothesis. Although catastrophizers were expected to allocate attentional resources to aspects of their pain during

the cold pressor procedure, the demands of the Stroop task requires subjects to allocate some of their attentional resources to colour naming the stimulus words. Although the activation of the pain-related schemata associated with catastrophizing was expected to increase attention toward pain-related sensations, attention was also expected to be directed towards the pain-related words on the Stroop task.

As predicted, catastrophizing was significantly and positively correlated with the degree of attentional bias for pain-related words on the Stroop colour interference task during the cold pressor procedure.[9] An examination of the means reveals that response latencies for pain-related words increased as a function of catastrophizing while neutral words did not. In other words, high catastrophizers were slower in colour-naming pain-related words relative to neutral words during the time that their arm was immersed in the ice water. This indicates that they were attending more to the pain-related words than neutral words when naming the colours of the stimuli.

However, catastrophizing was also significantly and positively correlated with the degree of attentional bias for social threat-related words on the Stroop colour interference task during the cold pressor procedure. This was unexpected. According to the attentional model,

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[9]The three different sets of stimuli (presented prior to, during and following the cold pressor procedure) included in the Stroop colour interference task were matched for both word valence and frequency. However, because the stimuli sets were not counter-balanced, it was necessary to rule out the possibility that the observed attentional bias associated with catastrophizing during the cold pressor procedure was due to that particular stimuli set. In order to address this, the Stroop performance in Study 1 was re-examined including only the stimuli that were included during the Stroop trial concurrent to the cold pressor procedure in Study 2. Correlational analysis revealed that PCS scores were unrelated to the degree of attentional bias for pain-related words, r=.15; ns, and the degree of attentional bias for pain-related words was unrelated to reported pain intensity, r = .20; ns. The results suggest that the observed attentional bias for pain-related stimuli in this study was triggered by painful stimulation, and was not the result of the particular stimulus set.

catastrophizers are thought to possess pain-specific schemata that direct attentional resources toward pain-relevant stimuli. Therefore, it was predicted that catastrophizing would be associated with an attentional bias for pain-related stimuli, but not for pain-irrelevant threat stimuli. The results of this study do not support the notion that catastrophizers possess pain-specific schemata or that catastrophizing is associated with a selective attentional focus for pain-related stimuli during pain. Instead, the results suggest that catastrophizing is associated with an attentional bias for threat-related stimuli generally during pain. In other words, it appears that catastrophizers allocate attentional resources to any threat-related stimuli (including pain-related stimuli) in their environment during noxious stimulation.

While the results of the current study do not support the notion that catastrophizers possess pain-specific schemata, the findings also do not rule out the possibility that a schematic organization mediates the relation between catastrophizing and the attentional bias for threat-related stimuli. It is possible that catastrophizers possess schemata which contains information about the high threat value of a wide range of stimuli or situations. When activated, the general threat schemata may direct catastrophizers' attentional focus towards threat-related stimuli.[10] Thus, the current findings may still be interpreted within a modified schemata activation model. Within this conceptualization, the cold pressor procedure may have activated general threat schemata associated with catastrophizing, and resulted in the allocation of attentional

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[10]A series of regression analyses were performed to rule out the possibility that the relation between catastrophizing and the degree of attentional bias for pain-related and social-threat related words on the Stroop task was due to high levels of emotional distress. Analyses indicated that the relation between catastrophizing and the degree of attentional bias for both pain-related words and social-threat related words was independent of level of emotional distress. These results suggest that something about catastrophizing, in the presence of pain, results in an attentional bias for threat-related stimuli.

resources to threat-related stimuli on the Stroop colour interference task. Further examination of the role of schematic processes in mediating the relation between catastrophizing and attentional focus is needed, however.

The attentional bias for threat-related stimuli (i.e., pain-related and social-threat related words) associated with catastrophizing was only observed during the cold pressor procedure. Catastrophizing was unrelated to the degree of attentional bias for threat-related stimuli both prior to and following the cold pressor procedure. These findings suggest that painful stimulation is necessary to evoke and maintain the attentional bias associated with catastrophizing. The attentional bias appears to cease when painful stimulation is terminated.

If catastrophizers possess general threat related schemata which mediate the relation between catastrophizing and attentional focus, then painful stimulation may not be the only stimuli that elicits an attentional bias for threat-related stimuli among catastrophizers. It is possible that exposure to other threatening situations may also result in an attentional bias for threat-related stimuli among catastrophizers. It would be interesting to replicate this study using both painful stimulation as threat as well as a pain-irrelevant threat (e.g., a task that might produce a threat of evaluation by others) and assess the impact of the two situations on attentional focus..

Although catastrophizing was associated with an attentional bias for both types of threat related stimuli on the Stroop colour interference task during painful stimulation, only the degree of attentional bias for pain-related stimuli was significantly correlated with reported pain intensity. Indeed, the degree of attentional bias for pain-related words on the Stroop colour

interference task both prior to and during the cold pressor procedure was significantly and positively correlated with subjects' ratings of pain intensity. An examination of the Pearson coefficients revealed that catastrophizing, the degree of attentional bias for pain-related words during the cold pressor procedure, and pain intensity were all significantly inter-correlated. Similar findings emerged with a self-report measure of attention. Subjects' self-report estimates of the percentage of time that subjects thought about their pain during the cold pressor procedure was significantly and positively correlated with reported pain intensity. Catastrophizing, the estimates of attention to pain, and pain intensity were all significantly inter-correlated. These findings are consistent with the attentional model and suggests that increased attention to painful stimuli results in heightened pain intensity.

The results of a series of regression analyses further support the position that attentional processes play a role in mediating the relation between catastrophizing and pain. However, it is difficult to determine how much of a role attentional processes play in mediating the relation between catastrophizing and pain intensity based on the current study. An examination of the various regression models reveals a substantially different pattern of findings depending on which attentional measure was used in the analysis.

The degree of attentional bias for pain-related words on Stroop colour interference task during the cold pressor procedure accounted for only five percent of the variance in predicting pain intensity ratings. While the results support the notion that attentional processes play a mediating role in the relation between catastrophizing and pain intensity, the amount of variance accounted for by this measure is quite small and it only approached statistical

significance. Catastrophizing contributed unique variance to the prediction of pain intensity beyond that accounted for by the attentional bias. These findings do not support the attentional model of catastrophizing and pain. In contrast, the self-report measure of attention to pain accounted for 45% of the variance in pain intensity ratings. Catastrophizing did not contribute unique variance beyond the self-report measure. Based on this analysis, and consistent with the attentional model, the relation between catastrophizing and pain intensity was mediated primarily by the degree of attentional focus to pain-related stimuli.

The different pattern of findings is likely due to the differences and limitations of the attentional measures used in this study. The Stroop colour interference task was used primarily to provide a behavioral test of the hypothesis that catastrophizing is associated with an attentional bias for pain-related stimuli. The task does not specifically provide a measure of the degree in which subjects were attending to their pain. Instead, the task measures the relative response latencies to pain-related words. The task is likely a weak measure of the degree to which catastrophizing is associated with attention to painful sensations. This probably accounts for the low amount of variance in pain intensity ratings associated with the task.

In contrast, the self-report measure specifically asks subjects to estimate the percentage of time that they thought about their pain. While it may appear that the measure provides a more accurate estimate of attention to painful sensations, there is no validation data on the measure to address it's accuracy. Since the measure was completed following the cold pressor procedure, the measure is likely prone to some retroactive memory bias. More importantly, there is a high degree of redundancy between the self-report measure and items on the PCS

which likely resulted in an inflated correlation between the two measures. The high degree of redundancy has important implications for the interpretations of the regression analyses. Since there is a high degree of redundancy between the PCS and self-report measure of attention, it is not surprising that catastrophizing did not contribute unique variance beyond that accounted for by the attention measure. The Stroop colour interference task circumvents the problems associated with the self-report measure since it uses behavioral performance to estimate attentional focus to pain-related stimuli and is therefore not redundant with the measure of catastrophizing, but it is an inadequate measure of subjects' attention to pain.

There are also some inconsistencies in Stroop performance when comparing the results of the current study with the results of Study 1. In Study 1, catastrophizing was positively correlated with overall response latencies on the Stroop task (i.e., regardless of word-type) prior to the cold pressor procedure. Although the correlation only approached significance, this does suggest that catastrophizing was associated with general slowing in responses to the Stroop task prior to the cold pressor procedure. In the current study, catastrophizing was unrelated to overall response latencies on the Stroop task prior to the cold pressor procedure. The failure to replicate this finding may be due to the lack of power resulting from using a smaller stimulus set during the trial in the current study. The stimulus set for each trial in this study consists of one-third the number of words as those used during the single Stroop trial in Study 1. When the Stroop stimulus set from Study 1 was re-examined using only the words included within trial one of the current study, the magnitude of the correlation

between catastrophizing and overall Stroop performance was much smaller and not significant.

In addition, there were some inconsistencies in the pattern of responses to stimulus words across studies. In Study 1, subjects were consistently slower in colour naming pain-related and social-threat related words relative to neutral words prior to the cold pressor procedure. However, in the current study subjects were faster in colour naming pain-related and social-threat related words than neutral words prior to the cold pressor procedure. The only exception was among high catastrophizers who were slightly slower in colour-naming pain-related words prior to the cold pressor procedure, and significantly slower in colour naming both pain-related and social-threat related words during the cold pressor procedure. These discrepancies cannot be attributed to differences in catastrophizing scores across studies. An examination of the means, standard deviation and range of PCS scores indicates a consistency in subject selection across studies.

Similar inconsistencies have been observed within the anxiety literature. Some studies have reported that low anxious individuals show faster colour naming latencies for threat-related words relative to neutral words. This effect has been labelled "cognitive avoidance" and has generally been interpreted as attempts to avoid threat-related stimuli. Some studies have found cognitive avoidance among low anxious individuals (Foa & Kozak, 1986), but others have not (Mathews & McLeod, 1985; Watts et al., 1986) despite similar methodologies. In this study, low and medium catastrophizers showed evidence for cognitive avoidance of threat-related words (i.e., they were faster in colour naming pain-related and social-threat

related words relative to neutral words). However in Study 1, low and medium catastrophizers were slower in colour naming the pain-related and social-threat related words relative to neutral words. Since it is not clear under what conditions or situations cognitive avoidance effects are observed (MacLeod et al., 1986), it is difficult to interpret these findings.

An examination of the separate PCS factor components revealed that no single factor uniquely contributed to the prediction of pain intensity. However, it appears that there may be gender differences in the relative contribution of PCS components that contribute to pain intensity. For women, the rumination factor contributed the greatest proportion of variance to the prediction of pain intensity. For men, the helplessness factor contributed the greatest proportion of variance to the prediction of pain intensity. The pattern of results suggests that attentional processes may be a stronger mediator of the relation between catastrophizing and pain intensity for women than men. However, since none of the PCS factor components contributed unique variance to the prediction of pain intensity, it is possible that helplessness interacts with attentional processes for men. Perhaps helplessness increases pain to the extent that male catastrophizers focus their attention to their perceptions of lack of control, which would be expected to change the meaning of the sensory stimuli (Cioffi, 1991). Unfortunately, methodological limitations preclude an adequate examination of this hypothesis. Further investigations into gender differences in catastrophizing and pain are needed.

Taken together, the results of Study 2 provide only partial support for the attentional model of catastrophizing and pain. The results suggest that while catastrophizers have a tendency to allocate attention to pain-related stimuli during noxious stimulation, the focus of

attention is not limited to pain-related stimuli. Catastrophizers directed their attentional focus to both pain-related stimuli and social-threat related stimuli during the cold pressor procedure. This suggests that, during pain, catastrophizers direct their attention to anything in their environment that is threatening or negative. However, only the degree of attentional bias to pain-related stimuli was correlated with perceived pain intensity. This supports the position that the degree of attentional focus to pain-related stimuli plays a role in mediating the relation between catastrophizing and pain.

Unfortunately, it is difficult to make a determination of the degree to which attentional focus to pain-related stimuli mediates the relation between catastrophizing and perceived pain intensity based on the results of the current study. Both the behavioral measure and self-report measure of attention have a number of limitations which preclude strong statements regarding the importance of attention as a mediator variable in the relation between catastrophizing and pain. A study that allows for a manipulation of attentional focus is necessary to further clarify the role for attentional processes in mediating the relation between catastrophizing and pain.

STUDY 3

Study 3 was designed to assess the impact of two manipulations of attentional focus on pain intensity as a function of catastrophizing. During a cold pressor procedure, subjects were instructed to either focus their attention to their painful sensations or provided with a cognitive task that was designed to direct attention away from their pain. A third condition served as a control to allow for an assessment of the impact of the two manipulation conditions. According to the attentional model, catastrophizers experience greater pain intensity because they excessively focus on their painful sensations. It may be possible to decrease the perceived pain intensity of catastrophizers by giving them a task that reduces the amount of available attentional resources to allocate to painful sensations. Further, it may be possible to increase the perceived pain intensity of non-catastrophizers by giving them a task that fosters attentional focus to painful sensations.

The effect of attentional focus on perceived pain intensity may be dependent on the aspects of the stimuli to which the individual attends (Cioffi, 1991). It has been suggested that catastrophizers have a propensity to focus their attention to painful sensations, but in a way that includes the threatening and emotional value of the sensations. Thus, it is possible that both the *direction* and *content* of attention mediate the relation between catastrophizing and pain. Non-catastrophizers may focus their attention to their pain when instructed to do so, but they may be more likely to attend to the concrete sensory aspects of their sensations, rather than the threatening and emotional value. Therefore, it may not be possible to affect an increase in pain intensity for non-catastrophizers by asking them to focus their attention to their pain. In fact, if

non-catastrophizers are more likely to focus their attention to the concrete sensory aspects of pain, then the attentional focus condition may actually result in lower rather than higher levels of pain for these individuals.

In this study, subjects in the attentional focus condition were asked to describe their sensations of pain aloud. This allowed for a transcription of the content of subjects' focus of attention. It was predicted that individuals who scored high on a measure of catastrophizing would focus primarily on their cognitive elaborations of the sensory stimuli. Individuals who scored low on a measure of catastrophizing were expected to focus primarily on the concrete sensory aspects of the sensory stimuli. It was further predicted that perceived pain intensity would be positively correlated with the percentage of time focused on the cognitive elaborations of sensory stimuli, and negatively correlated with the percentage of time focused on the concrete sensory aspects of sensory stimuli.

If attentional processes mediate the relation between catastrophizing and perceived pain intensity, then it should be possible to effect a pain reduction in catastrophizers by providing them with a task that directs attention away from the painful stimuli. However, there is some evidence which suggests that catastrophizers may be unable to benefit from attention diversion strategies (Heyneman et al., 1991). This may be due to an inability to control the flow of pain-related ideation into consciousness (Sullivan et al., 1996). Thus, catastrophizers in the attention diversion condition may not differ in reported pain intensity from catastrophizers in the control condition because they are unable to divert attention away from their pain. An increase in attention to painful sensations would interfere with the attention diversion task and

would be reflected in a greater number of errors on the task. If catastrophizers in the attention diversion condition are attending excessively to their pain, there would be a positive correlation between level of catastrophizing and number of errors during the attention diversion task. Again, the procedure of asking subjects to perform an attentional diversion task aloud allowed for an examination of this hypothesis.

Method

Subjects

Potential subjects considered for this study included all students at Dalhousie University who were registered in an Introductory Psychology course. The methods of recruitment, selection of subjects, and inclusion/exclusion criteria were identical to Study 1 and Study 2. Seventy-two subjects were recruited for this study (23 males, 49 females). The mean age of the sample was 19.1 years, with a range of 17 and 32 years. Subjects participated individually, and received one bonus percentage added to their final grade in Introductory Psychology.

Subjects were randomly assigned to one of three conditions; distraction (n=24), attentional focus (n=24), and control (n=24). Subjects were classified as catastrophizers and non-catastrophizers based on a median split of their PCS scores. This yielded thirty-four catastrophizers with a mean PCS score of 26.88 (Sd = 6.27) and a range of 20 to 48, and thirty-eight non-catastrophizers with a mean PCS score of 9.81 (Sd = 5.05) and a range of 1 to 18.

Apparatus

A plastic cooler containing room temperature water and cold pressor apparatus, described in Study 1 and Study 2, were utilized. A video camera as described in Study 1 was also used.

Measures

Pain intensity and mood during the room temperature water immersion and cold pressor procedure were assessed using the measures described in Study 1 and Study 2. The PCS was used as a measure of level of catastrophizing.

Procedure

Subjects were familiarized with the cold-pressor apparatus, and told that they would be placing their arm in the ice water for a one-minute period. They were assured that the procedure would not cause any damage to their arm, but that the ice water would likely cause some physical discomfort. They were made aware that they could discontinue the immersion at any time, and that they would receive course credit even if they did not complete the study. Once consent for participation was provided, subjects were randomly assigned to one of three conditions.

Subjects were asked to place their arm in the container of room temperature water for five minutes and told that the purpose of the immersion was to regulate the temperature of their arm. During the immersion they were provided with the questionnaires that asked them to rate a) the intensity of pain that they were experiencing at that moment, with their arm in the

room temperature water, and b) the intensity of different moods that they were experiencing at that moment, with their arm in the room temperature water.

Subjects were then placed beside the cold pressor apparatus. Those subjects who were assigned to the attention manipulation conditions were then told that they were to perform a cognitive task during the entire time that their arm was immersed in the ice water. Subjects who were assigned to the attentional focus condition were instructed to pay attention to the physical sensations that they experienced during the cold pressor procedure, and to describe them aloud during the entire time that their arm was immersed in the ice water. Subjects in the attentional diversion condition were instructed to count backwards from 500 by 7's aloud during the entire time that their arm was immersed in the ice water. The instructions provided to the attentional focus and attention diversion conditions are shown in Appendices L and M, respectively. Subjects in the control condition were not provided with any specific instructions other than those relevant to the cold pressor task.

The experimenter then left the room, and provided the instructions over the intercom system from the observation room. The entire session was recorded using the video camera located behind a one-way mirror in the experimenter's room. The experimenter instructed subjects to immerse their arm in the ice water. For subjects in the two attention manipulation conditions, subjects were also instructed to begin the cognitive task (i.e., "Begin to describe your sensations aloud." and "Begin to count backwards from 500 by 7's aloud."). The experimenter prompted subjects to continue with the task if they stopped anytime during the cold pressor immersion. At the end of one minute, subjects were instructed to remove their

arm from the ice water (and for subjects in the attention manipulation conditions, they were instructed to stop describing their sensations or stop counting). The experimenter returned to the room, and asked subjects to provide ratings of the level of pain and mood experienced during the time that their arm was immersed in the ice water, and to complete the PCS. Subjects were then debriefed, and thanked for their participation.

Data Reduction

Two independent research assistants, blind to PCS scores, coded the video-taped sessions for the content of verbalizations during the cold pressor procedure. For subjects in the attentional focus condition, the research assistants coded subjects' descriptions of their sensations as containing either concrete sensory information or containing information relevant to the threatening or emotional value of the sensations (Leventhal & Evenhardt, 1979). Verbalizations were coded as containing concrete sensory information if they described only the sensory properties of their pain (e.g., "It's getting colder," "My skin is tingling," and "There is a cramping sensation in my wrist."). Verbalizations were coded as containing threatening or emotional value if subjects described their emotional reactions to their pain (e.g., "I'm really anxious now" and "Oh please, when is the minute up!"), or their elaboration of the sensations (e.g., "My arm is freezing off" and "This is terrible"). The research assistants timed each utterance to yield a total percentage of time that subjects described the concrete sensory and threatening and emotional value of their sensations. For subjects in the distraction condition, the research assistants reviewed the tapes, and recorded the total number of errors in subtraction during the cold pressor procedure. The total number of errors was divided by the

total numbers attempted to yield the percentage of errors during the task. Inter-rater reliability's were .89, and .96 for the content of the attentional focus and distraction conditions, respectively.

Results[11]

Ratings of Pain and Mood

Immediately prior to the cold pressor procedure, subjects immersed their arm in room temperature water for five minutes, and indicated their current level of pain and rated their current mood. This was followed by the cold pressor procedure in which subjects immersed their arm in ice water for one minute. During the time that subjects' arm was immersed in the ice water, they either participated in a distraction task or a task that fostered an increase in attentional focus to the painful sensations. A third group served as a comparison group. They were not provided with a specific task during the cold pressor procedure. Subjects' level of pain and moods during the cold pressor procedure were assessed immediately following removal of their arm from the ice water.

Pain and mood ratings during the room temperature water immersion. Table 24 shows mean ratings for pain and mood during the room temperature water immersion for catastrophizers and non-catastrophizers in the attentional focus, distraction, and control conditions.

[11]Descriptive statistics summarizing the raw data for this study are shown in Appendix N.

Table 24: Means and Standard Deviations for Pain and Mood Ratings for Catastrophizers and Non-catastrophizers During the Room Temperature Water Immersion in Study 3.

	Catastrophizers			Non-catastrophizers		
	Distraction (n=9)	Attentional Focus (n=10)	Control (n=15)	Distraction (n=15)	Attentional Focus (n=14)	Control (n=8)
Pain	1.89 (0.78)	1.90 (1.20)	1.80 (0.94)	1.73 (0.70)	1.57 (0.94)	1.75(1.04)
Anxiety	4.56 (3.81)	5.60 (5.25)	5.67 (3.81)	1.33 (1.63)	3.43 (5.98)	3.50 (4.38)
Sadness	0.56 (0.88)	4.90 (5.70)	3.13 (3.98)	0.27 (0.59)	1.50 (4.26)	1.38 (3.89)
Anger	0.78 (0.83)	4.70 (6.46)	2.73 (4.15)	0.73 (1.93)	0.93 (2.20)	0.50 (0.76)
Happiness	10.11 (7.57)	7.90 (5.82)	12.47 (5.90)	11.87 (6.02)	11.71 (6.51)	10.50 (5.86)

Note: **Pain:** Pain intensity ratings during the room temperature water immersion; **Anxiety:** Ratings of anxiety during the room temperature water immersion; **Sadness:** Ratings of sadness during the room temperature water immersion; **Anger:** Ratings of anger during the room temperature water immersion; **Happiness:** Ratings of during the room temperature water immersion.

A 2 (group: catastrophizers, non-catastrophizers) X 3 (condition: attentional focus, distraction, control) between groups analysis of variance was performed in order to examine subjects' ratings of pain during the room temperature water immersion. Catastrophizers and non-catastrophizers did not differ in reported pain intensity during the room temperature water immersion, F (1,67) = 1.12, ns. Further, subjects in the attentional focus, distraction and control conditions did not differ with respect to reported pain intensity during the room temperature water immersion, F (1,67) = .98, ns. A multivariate analysis of variance on subjects' ratings of anxiety, sadness, anger and happiness yielded a significant main effect for group, multi F (4, 68) = 2.26, $p < .05$. As shown in Table 24, catastrophizers felt more

anxious, $F(1, 67) = 5.70$, $p < .05$, sad, $F(1,67) = 4.11$, $p < .05$, and angry, $F(1,67) = 6.24$, $p < .05$, during the room temperature water immersion.

Pain ratings during the cold pressor procedure. Table 25 shows mean ratings for reported pain intensity during the cold pressor procedure for catastrophizers and non-catastrophizers in the attentional focus, distraction, and control conditions.

Table 25: Means and Standard Deviations for Pain and Mood for Catastrophizers and Non-catastrophizers During the Cold Pressor Procedure in Study 3.

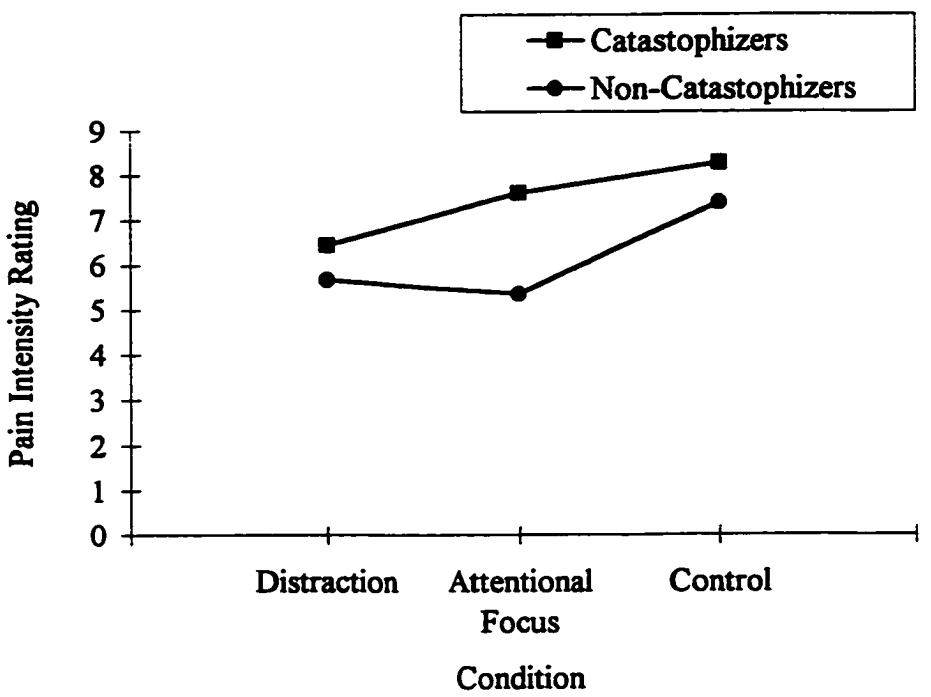
	Catastrophizers			Non-catastrophizers		
	Distraction (n=9)	Attentional Focus (n=10)	Control (n=15)	Distraction (n=15)	Attentional Focus (n=14)	Control (n=8)
Pain	6.44 (2.01)	7.60 (1.43)	8.27 (0.96)	5.67 (2.47)	5.36 (2.47)	7.38 (1.41)
Anxiety	7.76 (4.77)	11.30 (8.97)	12.40 (4.22)	3.13 (2.85)	3.57 (3.55)	6.38 (5.90)
Sadness	5.11 (6.81)	8.10 (8.28)	3.80 (4.66)	0.87 (1.88)	0.43 (1.60)	2.25 (4.10)
Anger	5.44 (6.21)	7.40 (7.28)	8.67 (5.83)	2.73 (4.35)	1.50 (2.68)	3.38 (3.62)
Happiness	3.78 (3.87)	3.30 (4.74)	2.07 (2.25)	5.53 (6.16)	6.86 (8.55)	3.00 (4.21)

Note: **Pain:** Pain intensity ratings during the cold pressor procedure; **Anxiety:** Ratings of anxiety during the cold pressor procedure; **Sadness:** Ratings of sadness during the cold pressor procedure; **Anger:** Ratings of anger during the cold pressor procedure; **Happiness:** Ratings of happiness during the cold pressor procedure.

The ratings of pain were analyzed with a 2 (group: catastrophizers, non-catastrophizers) X 3 (condition: attentional focus, distraction, control) between subjects analysis of variance. The analysis yielded a significant main effect for group where

catastrophizers reported more pain (M = 7.59) than non-catastrophizers (M = 5.92), F (1, 67) = 8.84, p < .01. The analysis of variance also yielded a significant main effect for condition, F (1,67) = 5.70, p < .01. There was no interaction, F (1,66) = 1.18; SE = .31. Pair-wise comparisons using Scheffe's test indicated that subjects in the attentional focus (M = 6.29) and distraction (M = 5.96) conditions reported less pain than subjects in the control condition (M = 7.96), t (23) = 7.06, p < .001. Subjects in the attentional focus condition did not differ in reported pain from subjects in the distraction condition, t (23) = .63, ns. These results are shown in Figure 3.

Figure 3: Mean Pain Intensity During the Cold Pressor Procedure as a Function of Catastrophizing and Condition in Study 3



Mood during the cold pressor procedure. A multivariate analysis of variance on subjects' ratings of anxiety, sadness, anger and happiness yielded a significant main effect for group, multi F (4,68) = 7.47, $p < .001$. As shown in Table 25, catastrophizers felt more anxious, F (1,67) = 23.97, $p < .05$, sad, F (1,67) = 14.60, $p < .001$, and angry, F = 13.58, $p <$ .001, than non-catastrophizers during the cold pressor procedure. There were no main effects for condition and no interactions.

Content Analysis of Attentional Manipulations

Subjects in the attention manipulation conditions were asked to perform their tasks aloud during the cold pressor procedure and were video-recorded during this period. Two independent research assistants coded these tapes for the content of subjects' verbalizations. The attentional focus and distraction conditions were analyzed separately. Pearson correlation coefficients were computed to examine the relation between catastrophizing, cognitive activity and pain intensity. Because of the small number of subjects in each condition (n=24), alpha was set at .10 to compensate for the lack of power in the analyses.

For the attentional focus group, catastrophizing was significantly and positively correlated with the percentage of time that subjects described the threatening and emotional value of their pain sensations, $r = .51$; $p < .05$. The percentage of time subjects described the threatening and emotional value of their pain was significantly and positively correlated with reported pain intensity, $r = .33$, $p < .10$. Further, catastrophizing was significantly and negatively correlated with the percentage of time subjects described the concrete sensory aspects of their pain, $r = -.36$, $p < .05$. The percentage of time subjects described the concrete

sensory aspects of their pain was significantly and negatively correlated with reported pain intensity, $r = .41$, $p < .05$. For the distraction group, catastrophizing was unrelated to the percentage of errors during the task, $r = .15$, ns, although the percentage of errors was significantly and positively correlated with reported pain intensity, $r = .42$, $p < .05$.

Analysis of PCS Components

In order to examine the relative contribution of the PCS components to the prediction of pain intensity ratings during the cold pressor procedure, a multiple regression analysis was performed, with the three factors entered together in a single step.[12] An examination of the beta weights indicates that the rumination factor contributed the greatest proportion of variance to pain intensity ratings during the cold pressor procedure. Further, only the rumination factor contributed unique variance to the prediction of pain intensity ratings. The rumination factor contributed approximately 31% of unique variance to the prediction of reported pain intensity during the cold pressor procedure. The results of this analysis are shown in Table 26.

Table 26: Results of the Direct Regression Analysis of PCS Components Predicting Reported Pain Intensity in Study 3

Factor	b	Beta	Correl	Part Cor.	Partial Cor.	Signif.
Rumination	.22	.40	.56	.22	.26	.03
Magnification	.18	.21	.46	.17	.21	.09
Helplessness	.02	.05	.52	.03	.03	.80

Note: **Correl:** correlation coefficient; **Part Corr:** part correlation coefficient; **Partial Cor:** partial correlation coefficient; **Signif:** significance level.

[12]Unfortunately, there were too few males in the sample to examine the relative contribution of the PCS components to the prediction of pain intensity ratings seperately for males and females in Study 3.

Discussion

Consistent with previous research (Spanos et al., 1983; Sullivan et al., 1995; Sullivan et al., 1996), catastrophizers reported more pain than non-catastrophizers during the cold pressor procedure in the absence of an attention manipulation. However, when provided with a task that directed attentional focus away from painful sensations, catastrophizers rated their pain as less intense than catastrophizers who were not provided with an attention manipulation. Similarly, non-catastrophizers who were provided with a task that directed attentional focus away from painful sensations reported less pain than non-catastrophizers who were not provided with an attention manipulation. The task utilized in this study appears to have been effective in directing attentional resources away from pain-related stimuli for both catastrophizers and non-catastrophizers. An examination of the error rates indicated that level of catastrophizing was unrelated to the percentage of errors on the task. This suggests that catastrophizers and non-catastrophizers were equally successful in sustaining their attention to the task. More importantly, catastrophizers who directed their attention away from their pain during the cold pressor procedure did not differ in reported pain intensity from non-catastrophizers who were not provided with an attention manipulation. In other words, the task that directed attentional focus away from subjects' painful sensations made catastrophizers look like non-catastrophizers with respect to perceived pain intensity.

The results of the current study are consistent with previous research that has shown that distraction strategies are effective in reducing perceived pain intensity during aversive stimulation (Cioffi, 1991; Fernandez & Turk, 1989). However, the finding that the distraction

task was effective in reducing catastrophizers' pain was not entirely expected. Heyneman et al. (1990) provided data suggesting that catastrophizers may not benefit from the use of distraction strategies during cold pressor pain. Their distraction task involved having subjects use visual imagery to generate a mental picture inconsistent with the cold pressor procedure (e.g., imagining warm water on their arm, laying in the sun, etc.). They reported that while the distraction task was effective in increasing non-catastrophizers' tolerance times and reducing reported pain intensity from a baseline to post-intervention immersion, catastrophizers did not increase their tolerance times or report a pain reduction. Since distraction strategies are generally effective to the extent that they impose demands on attentional resources (Fernandez & Turk, 1989), it is possible that their distraction task did not have a heavy enough "cognitive load" to direct catastrophizers' attentional resources away from pain-related stimuli. It could be argued that counting backwards by 7's from 500 requires a greater attentional focus than generating a visual image.

The results also indicated that both catastrophizers and non-catastrophizers who were provided with a task that increases attention to painful sensations reported less pain than catastrophizers and non-catastrophizers who were not provided with an attention manipulation. This was not entirely expected. It was suggested that non-catastrophizers could be made to look like catastrophizers with respect to pain intensity by providing them with a task that increases attentional focus to their pain.

An examination of the content of subjects' descriptions of their painful sensations indicated that non-catastrophizers focused their attention to the concrete sensory aspects of the

nociceptive stimuli, while catastrophizers focused on the threatening and emotional value of the nociceptive stimuli. Further, the results suggested that the content of subjects' attentional focus was an important determinant of perceived pain intensity. The percentage of time that subjects attended to the concrete sensory aspects of their pain was negatively correlated with perceived pain intensity. Conversely, the percentage of time that subjects' attended to the threatening and emotional value of their sensations was positively correlated with perceived pain intensity. These results are consistent with previous research showing that pain is perceived as less intense when attention is focused on the concrete sensory aspects, than when focused on their threatening and emotional value (Cioffi, 1991; Leventhal, 1993). It appears that non-catastrophizers benefited from the attentional focus manipulation because they increased their attention to the concrete sensory aspects of their pain.

The manipulation that fostered attentional focus to painful sensations was not expected to result in lower pain intensity for catastrophizers. One possibility is that the attentional focus task increased catastrophizers' attentional focus to the concrete sensory aspects of their pain relative to catastrophizers in the control condition. Catastrophizers in the attentional focus condition may have continued to focus on the emotional and threatening value of their pain sensations, but to less of an extent than catastrophizers in the control condition. This could explain why catastrophizers in the attentional focus condition reported more pain than non-catastrophizers in this condition, but less pain than catastrophizers in the control condition. A second possibility is that the process of finding words to describe pain sensations distracted catastrophizers attention away from their sensations. Since catastrophizers appear to typically

focus on the emotional and threatening value of their pain sensations, they may have less language to describe the concrete sensory properties of their pain. A task that requires subjects to describe their pain sensations may require more effort and therefore more attentional resources for catastrophizers.

An examination of the separate factor components of the PCS indicated that the rumination factor contributed the greatest proportion of variance to pain intensity ratings during the cold pressor procedure. Further, only the rumination factor contributed unique variance (31%) to the prediction of pain intensity ratings. In Study 1 and Study 2, none of the separate factor components uniquely predicted pain, although the rumination and helpless factors together accounted for almost all of the variance in the relation between PCS scores and reported pain. It is difficult to account for the discrepancy. However, the results of the three studies are consistent in suggesting that there is an attentional component that mediates the relation between catastrophizing and perceived pain intensity.

The results of the current study also indicated that catastrophizers experienced more anxiety, sadness and anger both prior to and during the cold pressor procedure. This replicates the findings of Study 1 and Study 2, as well as previous research (Sullivan et al., 1995, Sullivan et al., 1996). The attention manipulation tasks did not have an effect on subjects' mood during the cold pressor procedure. Interestingly, even though catastrophizers in the distraction condition reported relatively lower levels of pain than catastrophizers in the other conditions, they reported similar levels of emotional distress during the cold pressor procedure. This suggests that catastrophizers' distress reactions may be independent of pain intensity.

GENERAL DISCUSSION

Recent research has identified catastrophizing as a pervasive and enduring individual difference in the experience of pain (Sullivan et al., 1995). A review of the literature indicates that catastrophizing is typically associated with heightened levels of pain during aversive stimulation. While the relation between catastrophizing and pain has been well documented, there have been no well developed theoretical positions presented in the literature and empirical investigations addressing the tenability of hypothesized mechanisms have been virtually non-existent. This work represents the first empirical test of a theoretical model of catastrophizing and pain perception.

An Attentional Model of Catastrophizing and Pain

The primary purpose of this research was to investigate the tenability of an attentional model of catastrophizing and perceived pain intensity. According to the model developed in this paper, catastrophizers are thought to posses pain-related schemata that, when active, result in the allocation of attentional resources to pain-related stimuli. The increase in attention to aspects of pain-related stimuli, specifically painful sensations, is thought to result in a perception of increased pain intensity. According to the attentional model, the relation between catastrophizing and pain intensity is mediated primarily by an attentional process.

The results of this research provided evidence that catastrophizers have a propensity to allocate attentional resources toward pain-related stimuli. In both Study 1 and Study 2, catastrophizing was significantly and positively correlated with self-report estimates of time

attending to painful sensations during the cold pressor procedure. Consistent with this finding, catastrophizing was significantly and positively correlated with the degree of attentional bias for pain-related words on the Stroop colour interference task during the cold pressor procedure in Study 2. This indicates that individuals who scored high on a measure of catastrophizing were slower in colour-naming pain-related words relative to neutral words during the cold pressor procedure.

However, the results of this research did not support the notion that catastrophizers selectively attend to pain-related stimuli during pain. In Study 2, catastrophizing was significantly and positively correlated with an attentional bias for both pain-related and social-threat related words on the Stroop colour interference task during the cold pressor procedure. This suggests that individuals who score high on a measure of catastrophizing direct their attentional focus to anything in their environment that is threatening. Further, this finding is not consistent with the position that pain-related schematic activation during pain mediates the relation between catastrophizing and increased attention to pain-related stimuli. Since catastrophizers respond to painful stimulation with an increase in attention to threat-related stimuli generally, a more likely explanation is that catastrophizers possess more general threat-related schemata.

Colour-naming words on a Stroop task is a controlled attentional process that requires the inhibition of competing stimuli (Cohen, Dunbar, & McClelland, 1990; Neill, 1977; Tipper, 1985; Yee & Hunt, 1991). Subjects must allocate attentional resources to the colour of the words, while inhibiting attentional focus to the word itself. The results of Study 2 suggest that

catastrophizers were unable to inhibit or ignore the threat-related words on Stroop task during the cold pressor procedure. This interfered with colour-naming resulting in slower response latencies for threat-related words relative to neutral words. The results of Study 2 suggest that threat-related stimuli have a high degree of saliency for catastrophizers, and have an ability to capture their attentional focus.

The attentional model therefore needs to be modified so that catastrophizers are described as having a propensity to direct attentional focus to threat-related stimuli during pain. This includes, but is not limited to, directing attentional focus towards painful sensations during noxious stimulation. Catastrophizers also likely focus their attention on other threatening aspects of painful stimulation as well (e.g., being judged for their reactions to a painful procedure).

The finding that catastrophizing is associated with an increase in attention to pain-related stimuli is consistent with several reports that catastrophizing is associated with increased attentional focus to pain during aversive stimulation (Keefe et al., 1989; Rosensteil & Keefe, 1983; Spanos et al., 1979; 1981; Sullivan et al., 1995). However, to date these observations have been based primarily on subjects' responses to self-report questionnaires or testimony during interviews following pain-induction procedures. The results of Study 2 provide the first *behavioral* evidence for an increase in attention to pain-related stimuli associated with catastrophizing during painful stimulation. Although the Stroop colour-interference task does not provide a direct measure of subjects' attention to painful sensations, it does provide an estimate of the degree to which subjects allocate attentional resources to

pain-relevant stimuli. Given the saliency of painful stimulation, it is reasonable to assert that catastrophizers would also have a propensity to direct their attention to their painful sensations. Indeed, catastrophizers in these studies reported that they were paying attention to their pain during the cold pressor procedure.

It appears that the attentional bias for threat-related stimuli associated with catastrophizing is only present during painful stimulation. In both Study 1 and Study 2, catastrophizing was unrelated to the degree of attentional bias for threat-related words on the Stroop colour interference task prior to the cold pressor procedure. Further, catastrophizing was unrelated to the degree of attentional bias for threat-related words following cessation of painful stimulation in Study 2. It therefore appears that painful stimulation is necessary to elicit and maintain the attentional bias associated with catastrophizing.

However, there was some evidence to suggest that catastrophizers may also direct attentional focus to threat-related stimuli before the onset of pain. In Study 1, catastrophizing was correlated with overall colour naming latencies on the Stroop colour interference task prior to the cold pressor procedure. It is possible that catastrophizers were not attending to the words on the Stroop task because they were thinking about the upcoming pain induction procedure (i.e., ruminating about the impending pain) or possibly concerned about their performance on the Stroop task (i.e., ruminating about the experimenters perception of them). Waiting for pain may therefore be sufficiently salient to cause catastrophizers to direct their attentional focus to threat-related stimuli (e.g., appraisals, emotional distress).

There were several convergent findings which support the notion that attentional processes mediate the relation between catastrophizing and perceived pain intensity. First, subjects' self-report estimates of attention to pain were significantly and positively correlated with reported pain intensity during the cold pressor procedure in both Study 1 and Study 2. Similarly, the degree of attentional bias for pain-related words on the Stroop colour interference task both prior to and during the cold pressor procedure in Study 2 were significantly and positively correlated with reported pain intensity.

Secondly, a series of regression analyses, using both the self-report measure of attention to pain and subjects' Stroop performance as a behavioral measures of attention to pain-related stimuli, yielded findings which support the role of attention in mediating the relation between catastrophizing and pain intensity. However, an examination of the various regression models reveals a substantially different pattern of findings depending on which attentional measure was used in the regression analysis.

In Study 2, the degree of attentional bias for pain-related words on Stroop colour interference task during the cold pressor procedure accounted for only five per cent of the variance in predicting pain intensity ratings. Catastrophizing contributed unique variance to the prediction of pain intensity beyond that accounted for by the degree of attentional bias. The low amount of variance is not surprising given that the Stroop colour interference task measures the degree of attentional bias to pain-words, not pain sensations. In contrast, the self-report measure of attention specifically asked subjects to estimate the percentage of time that they attended to their pain during the cold pressor procedure. In Study 1 and Study 2,

subjects' estimates of attention to pain accounted for 43% and 45% of the variance in pain intensity ratings, respectively. In both studies, catastrophizing did not contribute unique variance beyond the self-report measure. Based on these analyses, the relation between catastrophizing and pain intensity was mediated primarily by the degree of attentional focus to pain-related stimuli. However, the self-report measure lacks validation as an index of attention to pain and it may overlap with many of the items on the catastrophizing measure. Therefore, strong statements regarding the role of attention in mediating the relation between catastrophizing and pain intensity cannot be made based on the self-report measure alone.

Study 3 provided stronger evidence that attention mediates the relation between catastrophizing and pain intensity. The results of this study indicated that catastrophizers who were provided with a task that directed attentional focus away from their painful sensations during the cold pressor procedure experienced less pain than catastrophizers who were not provided with an attention manipulation. More importantly, catastrophizers who were provided with a task that directed attentional focus away from their painful sensations during the cold pressor procedure *did not differ from non-catastrophizers who were not provided with an attention manipulation.* In other words, it was possible to make catastrophizers look like non-catastrophizers with respect to perceived pain by manipulating their attentional focus away from their pain. In the absence of a manipulation of attentional focus, catastrophizers reported more pain than non-catastrophizers during the cold pressor procedure. Following the results of Study 1 and Study 2, it is reasonable to make an inference that catastrophizers who did not

receive an attention manipulation were likely focusing on their pain during the cold pressor procedure.

Finally, an examination of the PCS factor components provided data consistent with the notion that attentional processes mediate the relation between catastrophizing and pain. In Study 3, only the rumination component (which includes items that measure the degree to which subjects report thinking about various aspects of their pain) contributed unique variance (31%) to the prediction of pain intensity. The results indicated that the relation between catastrophizing and pain was no longer significant when level of rumination was removed from the equation. This is consistent with the results in Study 3 showing that catastrophizing was not associated with increased pain when attention was focused away from painful sensations. However, in Study 2, while the rumination component contributed the greatest proportion of variance to the prediction of pain intensity for women, the helplessness component contributed the greatest proportion of variance for men. This suggests that attentional processes may be a more important mediating variable in the relation between catastrophizing and pain for women than men.[13]

It was reasoned that if catastrophizers experience greater pain because they have a propensity to focus their attention to their painful sensations, then it may be possible to increase the perceived pain intensity of non-catastrophizers by giving them a task that fosters attentional focus to their pain. However, the results of Study 3 indicated that non-catastrophizers who

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[13]The results of Study 3 suggest that the PCS rumination component contributed the greatest proportion of variance to the prediction of pain. However, the sample in that study consisted of significantly more women than men (2:1 ratio), which may account for this finding. If there were a sufficient number of men in the sample, it is possible that an examination of the PCS components by gender would have yielded similar results as those obtained in Study 2.

focused their attention to their painful sensations reported less pain than both catastrophizers and non-catastrophizers who were not provided with an attention manipulation. In other words, the increase in attentional focus decreased, rather than increased, the perceived pain intensity for non-catastrophizers.

There was evidence that catastrophizers and non-catastrophizers focused on different aspects of their pain. When non-catastrophizers were provided with a task that directed their attention to their painful sensations during the cold pressor procedure, they primarily focused on the concrete sensory aspects of their pain. In contrast, catastrophizers who were provided with a task that directed their attention to their painful sensations during the cold pressor procedure primarily focused on the threatening and emotional value of their pain Taken together with the results of Study 1 and Study 2, this suggests that catastrophizers have a propensity to direct attentional focus to their pain in a way that favours their threatening and emotional value over the concrete sensory aspects of the sensations.

The percentage of time that subjects focused their attention to the concrete sensory aspects of their pain was negatively correlated with pain intensity. In contrast, the percentage of time that subjects focused their attention to the threatening and emotional value of their pain was positively correlated with pain intensity. These findings are consistent with reports that pain is more intense when attention is focused on the threatening and emotional value of noxious sensations than when focused on their concrete sensory aspects (Cioffi, 1991; Leventhal et al, 1983; Leventhal, 1993; Melzack, 1982). It has been suggested that attention to the concrete sensory aspects of pain produces a relatively neutral perception of the

sensations (Ahles et al, 1983; Cioffi, 1991), while attention to the threatening and emotional value of painful sensations adds information that yields a perception of increased pain intensity (Cioffi, 1991). It therefore appears that catastrophizers experience heightened levels of pain intensity because they have a propensity to focus their attention to the threatening and emotional aspects of their pain.

The results of the current findings are consistent with a substantive body of research showing that distraction strategies are effective in reducing perceived pain intensity (for a review, see Fernandez & Turk, 1989). Catastrophizers and non-catastrophizers who were provided with a task that directed attentional focus away from their painful sensations reported less pain than catastrophizers and non-catastrophizers who were not provided with an attention manipulation. According to Fernandez & Turk (1989), distraction strategies are effective because they place demands on attentional capacity. Distraction strategies are hypothesized to reduce the amount of attentional resources available for the processing of nociceptive activity, thereby attenuating perceived pain. There is evidence that distraction strategies that reduce attentional focus to either the noxious sensations or their threatening and emotional value are effective in reducing perceived pain intensity (Cioffi, 1991). Since non-catastrophizers appear to attend to the concrete sensory aspects of their pain, it is possible that the distraction task was effective because it primarily reduced the amount of attentional resources available to process the sensory information. Conversely, providing catastrophizers with a distraction task may have been effective because it primarily reduced the availability of attentional resources to allocate to the threatening and emotional value of the sensations.

In summary, the results of the current research only partially support the attentional model of catastrophizing and pain. While catastrophizers appear to have a propensity to direct their attentional focus to their pain during noxious stimulation, they also have a tendency to direct attentional focus to other threat-related stimuli. Thus, the attentional bias associated with catastrophizing is not pain-specific, as predicted. Instead, it appears that during painful stimulation, catastrophizers have a tendency to direct attentional focus to both physical and social threat-related stimuli. Despite this however, the results of this research support a model that posits the role of attentional processes in mediating the relation between catastrophizing and perceived pain intensity.

Alternate Interpretations of Findings

Although the results of the current research provide data that are consistent with an attentional model of catastrophizing and pain, there are a number of possible alternate interpretations of the findings which need to be addressed. Further, there are a number of potential mechanisms that were not directly investigated in the research, but which may play a role in the relation between catastrophizing and perceived pain intensity.

One possibility is that catastrophiziers experience more pain than non-catastrophizers because they are physiologically at risk for increased pain. For example, catastrophizers may have developed a pain system which is characterized by nociceptive fibers which have a lower threshold for firing or they may have a greater density of fibers throughout their periphery. Catastrophizers generally have a lower threshold for pain and

report a quicker rate of increase in pain than non-catastrophizers (Heyneman et al., 1990; Spanos et al., 1983) which may be interpreted as evidence for this hypothesis. Within this conceptualization, catastrophizing may be a response style which has developed out of having a sensitive pain system.

Although the current research does not provide a direct test of this hypothesis, a physiological model of catastrophizing and pain appears untenable. The level of pain intensity associated with catastrophizing appears to be very responsive to manipulations of cognitive processes as demonstrated in this study and others (e.g., Turner and Clancy, 1986). In fact, it appears that the effects of catastrophizing can be entirely eliminated by manipulations which direct attentional focus away from pain sensations. One would not expect cognitive manipulations to eliminate the effects of catastrophizing if the relation between catastrophizing and pain intensity is mediated by primarily physiological variables.

It is also possible that while catastrophizing may be associated with an attentional bias for threat-related stimuli, the increase in attention to threat is the result of catastrophizers experiencing greater levels of pain or emotional distress. For example, heightened levels of pain intensity have been found to result in an increase in attention to pain-related stimuli (Eccleston, 1994). Similarly, heightened levels of anxiety have been associated with increased attention to both physical and social threat-related stimuli (Dalgleish & Watts, 1990; MacLeod et al., 1986; MacLeod & Mathews, 1989). These also appear untenable, however. In Study 2, pain intensity was unrelated to the degree of attentional bias for pain-related stimuli when level of catastrophizing was statistically

controlled. Similarly, the relation between catastrophizing and the attentional bias for both pain-related stimuli and social-threat related stimuli remained significant even when controlling for level of anxiety. This suggests that something about catastrophizing, in the presence of painful stimulation, results in an increase in attentional focus to threat-related stimuli.

According the attentional model, the relation between catastrophizing and increased pain intensity is mediated primarily by an attentional process. The strongest evidence for this notion was provided by the results of Study 3 which demonstrated that the effects of catastrophizing can be eliminated when catastrophizers are provided with a task that directs attention away from pain. However, the attention manipulation used in this study may have affected other variables which could account for the reduction in pain intensity associated with catastrophizing. For example, providing subjects with a distraction task may have suggested to subjects that the manipulation would help them to decrease their pain during the cold pressor procedure. This may have changed their expectations of the cold pressor procedure, decreased their helplessness or increase their self-efficacy, variables which have been shown to be important determinants of perceived pain intensity (Jensen et al., 1991; Turk & Rudy, 1992). Unfortunately, it is difficult to rule out this possibility since measures of expectancies for pain, helplessness and self-efficacy were not included in this study. A replication of this study which includes these measures is warranted. However, when interpreted within the context of the findings of

Study 1 and Study 2, the results of Study 3 provide strong evidence that attention plays a significant role in mediating the relation between catastrophizing and pain intensity.

Finally, while this research provides some strong evidence in support of the saliency of attentional processes as a mediating variable in the relation between catastrophizing and pain intensity, other findings suggest that variables unrelated to attention may play an important role. Perhaps most problematic for the attentional model is the finding that the PCS helplessness component of catastrophizing was a stronger predictor of pain than the rumination component in both Study 1 and Study 2. However, it is also important to note that in both studies, none of the PCS components contributed uniquely to pain intensity. This suggests that the various components tapped by the catastrophizing measure are highly inter-dependent. It is possible that helplessness (as well as magnification) contributes to pain intensity to the extent to which it becomes a focus of attention. This would be consistent with Cioffi (1991) who suggests that focusing on threatening aspects of pain sensations adds information that biases the perception of the sensations. This remains speculative, however.

There are a number of alternate interpretations of the current findings as well as other potential mechanisms of catastrophizing that need to be considered. Further research is needed in order to more fully explore these alternate hypotheses. Nonetheless, the current research supports the saliency of attentional processes as a mediating variable in the relation between catastrophizing and pain intensity.

Catastrophizing and Information Processing: Towards a Unified Theoretical Model

Schematic models of information processing are useful heuristics for interpreting the results of the current findings and may provide the foundations of a unified theoretical model of catastrophizing and distress reactions. Schematic processes are hypothesized to influence several areas of information processing and are thought to be the fundamental elements upon which all information processing depends (Bartlett, 1932; Hastie, 1980; Markus, 1977; Neisser, 1976; Rumelhart, 1980). Two of the major functions of schemata, which are most relevant to this discussion, are the role that they play in the construction of the interpretation of events and as an active process of stimulus selection.

Schemata are private theories about the nature of an event, object, or situation (Rumelhart, 1980). They are based on past experiences, and are thought to be the basis of recognition, comprehension, and interpretation or appraisal of similar future events, objects, or situations. Current theories of emotion emphasize the role of schematic processes in distress reactions (Beck, 1967; Clark & Teasdale, 1982; Derry & Kuiper, 1981; Ellis, 1962; Lazarus & Folkman, 1984). The appraisal of a current pain experience determines the emotional response to the situation, and depends on past pain experiences that are organized within pain-related schemata (Turk & Rudy, 1992). If an individual appraises the painful stimulation as a threat, they will likely experience emotional distress.

A second major function of schemata is the modulation of the constant stream of stimuli from the internal or external environment by filtering irrelevant information, so that only information that is relevant and useful is selected for processing by the cognitive system. The

selection and integration of information are the processes of attention (Schriffin & Schneider, 1977). The selection/filtering of information is thought to occur at an early stage of information processing. Schematic processes are thought to play a major role in determining what is relevant to the organism and therefore should be a focus of attention (Rumelhart, 1980). Individuals typically allocate attentional resources to internal or external stimuli that, based on past experience, are important to their physical or psychological well-being. More attentional resources will likely be allocated to painful sensations if they are considered to be important to an individual's well-being.

In the catastrophizing literature, it has been suggested that catastrophizing ideation reflects negative beliefs, attitudes, and expectancies that are organized into pain-related schemata (Jensen et al., 1991; Turk & Rudy, 1992). Therefore, catastrophizers and non-catastrophizers are thought to differ primarily in the content of their pain schemata. Although the current research did not specifically test this hypothesis, the results do not support the notion that catastrophizers possess pain-specific schemata. Instead, the results suggest that if schematic processes play a role in catastrophizing, the schemata are not pain-specific. Rather, the schemata are more likely organized in such a way that they influences the processing of a range of threat-related stimuli. This would require that the schemata contain information about the high threat value of a range of stimuli or situations (Hastie, 1980; Neisser, 1976). Therefore, the results are more consistent with the notion that catastrophizers possess general threat-related schemata. Catastrophizers may have a learning history characterized by a range of negative experiences which have yielded beliefs about the high threat value of various

stressors (of which pain is one of many), and/or have developed a perception of themselves as unable to deal with threat. This suggests a possibility that catastrophizers may respond to other (i.e., pain-irrelevant) threat with an attentional bias for threat-related stimuli, and perhaps even experience distress reactions.

Although speculative, threat-related schemata acting at different levels of information processing within the cognitive system may account for both the observation that catastrophizers experience increased emotional distress during pain, and that they focus their attention to threat-related stimuli, including pain sensations. At the level of stimulus selection, the schemata may result in the allocation of attentional resources to threat-related stimuli, thus increasing attentional focus to pain-related sensations. At the level of stimulus interpretation/appraisal, the schemata may give rise to negative appraisals of the painful stimuli, increasing the threat value of the pain and resulting in heightened levels of emotional distress. Also, the schemata may give rise to negative appraisals of pain-irrelevant stimuli. For example, catastrophizers may be more likely to perceive the experimenter as threatening (i.e., critical, rejecting) which may further increase emotional distress. This position is consistent with a substantive body of mood research demonstrating the relation between negative appraisals and distress reactions (for a review, see Tararyn, Nadel, & Jacobs, 1989). Since individuals typically show vigilance for stimuli that is thought to be relevant to their well-being, catastrophizers would then be expected to increase their attentional focus to their pain experience, which now includes both sensory information (e.g., the intensity and quality of the noxious stimulation) and their perceptions of threat and high level of emotional distress. The

results of this research suggest that catastrophizers tend to focus on the threatening and emotional value of their pain experience. This would add information about the sensations that bias their perception toward increased pain intensity (Cioffi, 1991).

Schematic models of information processing provide tempting heuristics for interpreting attentional bias effects associated with catastrophizing. However, it is not possible at this time to make strong statements about the role of schematic processes in mediating the relation between catastrophizing and attentional focus. The current research cannot provide any direct evidence that supports the existence of threat-related schemata associated with catastrophizing, nor is there any data which can be cited in support of the role of schemata as a mediating variable in the relation between catastrophizing and attentional focus. In addition, the current research does not provide data that addresses alternate explanations for the attentional bias associated with catastrophizing. For example, catastrophizing may be associated with heightened levels of physiological arousal which may increase vigilance for threat-related stimuli. Alternate models would need to ruled out in order to espouse a schematic model of catastrophizing and attention. However, despite the lack of evidence, a schematic model of information processing is promising and may eventually yield a unified theoretical model of catastrophizing and pain. Further research is clearly warranted.

Gender Differences in Catastrophizing and Pain

There are important differences in the ways in which men and women are impacted by and cope with pain (for a thorough review, see Unruh, 1996). For example, women are more

likely to show distress reactions during pain than men (Crook, 1993; Fishbain, Goldberg, Meagher, Steele & Rosomoff, 1986; Keefe, Wilkins, Cook, Crisson & Muhlbaier, 1986; Magni, Caldieron, Rigatti-Luchini & Merskey, 1990; Von Knorring, Perris, Eisemann, Eriksson & Perris, 1983) and are more likely to engage in catastrophizing ideation (Sullivan et al., 1995). Further, women appear to cope with pain differently than men. Women are more likely to use emotion-focused strategies, social support, relaxation, and distraction during pain, while men tend to engage in problem-focused coping, minimization, denial, and tension reducing activities (Unruh, 1996).

The results of the current research are consistent with the general pain literature in indicating that there may be important gender variations associated with catastrophizing. Specifically, there is some data to suggest that attentional processes may play a more important role in the relation between catastrophizing and pain for women than men. Based on an examination of the PCS components in Study 2, pain-related ruminations were a stronger predictor of pain intensity for women, while helplessness was a stronger predictor of pain intensity for men. These findings are consistent with reported gender differences in pain within the general pain literature.

These observed gender differences may reflect differences in preferred methods of coping with pain for men and women. Men are generally more likely to rely on direct action and problem-focused coping, while women are more likely to use distraction strategies to cope with pain (Unruh, 1996). For women, catastrophizing may increase attentional focus to painful sensations making it difficult for them to effectively use distraction strategies. For men,

catastrophizing may yield perceptions of inability to manage or cope with painful sensations, which may bias their perception of the intensity of pain (Cioffi, 1991).

An alternate interpretation of the observed gender differences is that male and female catastrophizers focus on different aspects of their pain. An examination of the item content of the PCS suggests that the three factor components assess a tendency to focus on different aspects of pain-related cognitions during aversive stimulation. For example, the rumination component primarily contains items relevant to emotionally relevant cognitions (e.g., "I anxiously want the pain to go away" and "I keep thinking about how badly I want the pain to go away."), while the helplessness component contains items that reflect a tendency to focus on a perceived lack of control (e.g., "I worry all the time about whether the pain will end" and "It's terrible and I think it's never going to end."). Male catastrophizers may have a greater propensity to focus their attention to perceptions of helplessness and lack of control, while female catastrophizers may focus on their emotional distress. This interpretation would be consistent with research suggesting that men are generally more concerned with increasing their sense of control over pain while women are more concerned with the emotional impact of pain (Unruh, 1996).

Although unexpected, the results of the current research indicate that there may be significant gender variations in catastrophizing. While these results are consistent with findings within the general pain literature, it is yet unclear how these gender differences influence the relation between catastrophizing and perceived pain intensity. Further research is needed in order to examine the extent to which gender variations influence the relation between

catastrophizing and pain, as well as associated processes. The results of this research also highlight the need to examine the effects of gender within experimental pain research.

Generalizability to Clinical Pain

While the results of the current findings suggest a possible mechanism by which catastrophizing impacts on pain within experimental pain induction procedures, there are a number of contextual and situational cues that distinguish pain induced in the laboratory and pain in a clinical setting. It is generally accepted that perceptions of pain are closely affiliated with the situation in which it occurs; people use situational cues to construct a representation and lend meaning to their pain (Cioffi, 1991; Pennebaker, 1982). The context in which pain occurs is therefore an important variable in the overall experience of pain (Melzack, 1986; McCaul & Mallott, 1984). There are a number of differences between pain induced in the laboratory and clinical pain that raise questions concerning the generalizability of the findings of this research.

Clinical pain patients probably perceive less control over their pain than participants in a laboratory (McCaul & Mallott, 1984). In this research, participants were free to remove their arm from the ice water and cease painful stimulation at any time during the procedure. This would likely give them a sense of control and predictability that is frequently not available in clinical pain settings and with many clinical pain conditions. Most clinical procedures that would induce painful stimulation are under the control of a physician or other health professional (e.g., spinal tap, gynaecological examination, dental surgery). There are also many

clinical pain conditions where pain control is difficult (e.g., cancer pain, fibermyalgia). There is some evidence that perceived control is an important determinant of pain intensity (Jensen et al., 1991).

Further, most clinical settings are strongly associated with illness (Cioffi, 1991) and clinical pain by definition is typically the result of physical damage or pathology. In contrast, an experimental setting would not typically be associated with illness, and pain produced in the laboratory would be less likely to be associated with physical damage. For example, in this research subjects were assured that the cold pressor procedure would not result in any tissue damage. Participants in a laboratory setting would likely have different expectations for the procedure (e.g., they would not expect to see blood or tissue), and the meaning of the situation is very different from pain that would result from clinical procedures or pathology. Again, these have been shown to be important determinants of pain intensity (Cioffi, 1991; Melzack & Wall, 1982; Leventhal, 1993).

Similarly, there are a number of clinical procedures and pain conditions where the pain is too severe or chronic to ignore. For example, most individuals, regardless of level of catastrophizing, would direct attentional focus toward painful sensations produced by kidney stones or a sudden rupturing of a disk. Further, there are a number of chronic pain conditions, such as low back pain and carpal tunnel syndrome that because of their unremitting quality are difficult to ignore (Cioffi, 1991; McCaul & Mallott, 1984). Pain produced in the laboratory is considerably less severe than many types of clinical pain, and it is time limited (typically, pain produced in the laboratory does not exceed three minutes).

Thus, clinical pain is frequently more intense, more difficult to control and usually occurs within an illness/pathology context. These are important variables that need to be considered in process research (Cioffi, 1991). While it is possible that attentional processes mediate the relation between catastrophizing and pain intensity in clinical pain, it would be necessary to examine the impact of contextual variables as well. For example, catastrophizers frequently report that they have less control over their pain and are more likely to exaggerate the seriousness of their painful sensations. These may be even more important as mediator variables within the context of clinical pain. It is also possible that contextual variables interact with attentional processes. For example, catastrophizers may experience increased pain to the extent that they focus their attention to their perceived lack of control and exaggerations, and use them in their perception of pain intensity.

It is also important to note that there are several clinical pain conditions where catastrophizers and non-catastrophizers would likely have similar perceptions of pain intensity. Many types of clinical pain have a very high threat value and produce physically intense sensations. Both of these factors would be expected to capture attentional focus, but attention likely does not influence perceived pain intensity for many types of clinical pain. There are simply many kinds of pain that are too serious or intense to ignore (e.g., cancer pain).

Despite important phenomenological and contextual differences between clinical pain and pain induced in the laboratory, the observed relations between catastrophizing and clinical pain reported within the literature has paralleled the observations within experimental pain induction studies. Consistent with experimental pain research, catastrophizing within the

context of clinical acute and chronic pain has been shown to be quite reliably associated with increased pain intensity. In both literatures, there has been evidence that catastrophizing is associated with an increase in attention to pain. The results of this research confirm these observations within the context of experimentally induced pain. Further research is necessary to examine the tenability of an attentional model of catastrophizing within the context of clinical pain.

Potential Clinical Implications

Research has been fairly consistent in showing that catastrophizing is a fairly stable individual difference variable that contributes to increased pain during aversive stimulation (Jensen et al., 1991; Keefe et al., 1989; Spanos et al., 1979; Sullivan et al., 1995). The results of the current research suggest that the relation between catastrophizing and pain is mediated, at least in part, by an increase in attentional focus to pain. In particular, this research suggests that catastrophizers have a propensity to direct their attention to their painful sensations in a way that includes their threatening and emotional value. According to Cioffi (1991), this would add information about the sensory stimuli towards a perception of increased pain intensity. There is some speculation that a stable pain-related schematic organization underlies the relation between catastrophizing and distress reactions. Although the generalizability of these findings to clinical pain is not addressed in the current research, the findings may have important implications for clinical intervention.

The results of this research suggest that catastrophizers may be able to effectively reduce the intensity of their pain when they are provided with a task that directs their attentional focus away from their painful sensations. There are a number of clinical procedures were this may be effective. For example, catastrophizers may benefit from a distraction task during blood tests, minor elective surgery or dental procedure. However, the efficacy of distraction tasks likely depends on the duration and intensity of the pain (McCaul & Mallott, 1984). Distraction strategies are typically most effective for pain that is short in duration. Clinical pain conditions that are longer in duration (e.g., chronic low back pain) may not be as effective since patients may tire of their use. Further, some clinical procedures and pathology produce pain that is too intense to ignore (e.g., spinal tap, kidney stones).

Catastrophizers may also benefit from strategies that fosters a concrete sensory focus of attention to their pain sensations. For example, Leventhal and his colleagues have reported that instruction to attend to the sensory aspects of pain produces a decrease in perceived pain intensity (Ahles et al., 1983; Leventhal et al., 1979; Leventhal & Mosbach, 1983). However, the results of the current research suggest that catastrophizers are less able to attend to the concrete sensory aspects of pain, even when instructed to do so. It may therefore be necessary to teach catastrophizers to attend to the concrete sensory aspects of their pain. Kabat-Zinn (1982; 1984) has shown that chronic pain patients can be taught to focus on the concrete sensory aspects of their pain using mindfulness meditation - a wilful, directed focus of attention to the sensory aspects of the bodily sensations. These patients experienced a dramatic reduction in perceived pain intensity that generalized beyond the meditation sessions. It may be possible

to use similar strategies to teach catastrophizers to attend to the concrete sensory aspects of their pain.

Finally, catastrophizers may benefit from interventions that impact at a schematic level. It has been suggested that pain-related schemata associated with catastrophizing contains beliefs, attitudes and expectancies that gives rise to the interpretation or appraisal of pain-related sensations as a threat to the individual's well-being. It was also suggested that individuals show vigilance for stimuli that are relevant to their well-being. Psychological interventions, such as cognitive-behavioral therapy (CBT; Beck, 1976; Ellis, 1962), which has been used to target pain-related beliefs, attitudes and expectancies (Sullivan et al., 1991) may be effective in reducing pain intensity. Interestingly, Turner & Clancy (1986) reported that CBT was effective in reducing the frequency of catastrophizing ideation among chronic pain patients, and reduction in catastrophizing was associated with decreases in pain intensity. Although the mechanism of change was not investigated, it is possible that CBT affected a re-organization of the pain-schemata. No longer considered a threat, attention may have been less focused on the painful sensations.

CBT is also effective is reducing emotional distress associated with pain (Sullivan et al., 1991). A re-organization of the pain-related schemata associated with catastrophizing to reflect more adaptive beliefs, attitudes and expectancies would be expected to result in a different appraisal of painful situations. If painful stimulation is no longer considered a threat, then the individual will be less likely to show a distress reaction (Beck, 1976; Lazarus & Folkman, 1984).

CONCLUSIONS

The primary purpose of this research was to investigate the tenability of an attentional model of catastrophizing and perceived pain intensity. According to the model developed in this paper, catastrophizers are thought have a propensity to direct their attentional focus toward their pain during aversive stimulation. The increase in attention to pain was hypothesized to result in a perception of increased pain intensity. A central assertion of this model is that the relation between catastrophizing and pain intensity is mediated primarily by this increase in attentional focus to pain.

The results presented in this paper provided behavioral evidence supporting the position that that catastrophizers have a propensity to direct their attentional focus to their pain. In addition, the results suggest that catastrophizers pay more attention to the threatening and emotional value of their pain than the concrete sensory aspects of their pain. It was argued that an increase in attention to the threatening and emotional value of pain adds information about the sensations that biases their perception toward increased pain intensity. This research yielded convergent evidence suggesting that a high degree of attentional focus to aspects of painful sensations mediates the relation between catastrophizing and pain. The findings were discussed within the context of research and theory in the general pain literature.

APPENDIX

Appendix A

Pain-Related Words	Social-Threat Words	Neutral Words
Disease	Lonely	Triangle
Agony	Criticism	Permit
Harm	Silly	Jacket
Stabbing	Intimidated	Clipboard
Wound	Mistake	Nights
Lancing	Scorn	Hibernation
Sore	Hostile	Foam
Gash	Foolish	Frogs
Pain	Enemies	Beans
Fatal	Regret	Tidal
Scalpel	Insecure	Salon
Gore	Submission	Navigate
Suffer	Stupid	Text
Freezing	Hated	Latter
Numb	Inferior	Circus
Sting	Neglected	Caribou
Burn	Failed	Collect
Mutilated	Coerce	Showplace
Injury	Deserted	Curtains
Scorching	Ridicule	Steed
Moan	Worthless	Haul
Torture	Inadequate	Glacial
Tormented	Pathetic	Unpack
Scalding	Humiliated	Enlist

Appendix B

Rate how much physical discomfort you are experiencing at this moment:

1	2	3	4	5	6	7	8	9	10
Not at all									Extreme pain

Appendix C

Self-Report Questionnaires

I. Please read each question, and choose the item that best describes how you currently feel.

AT THIS MOMENT, I FEEL...

1. SAD
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

2. ANGRY
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

3. HAPPY
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

4. ANXIOUS
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

5. DISCOURAGED
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

6. HOSTILE
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

7. DELIGHTED
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

8. AFRAID
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

9. HOPELESS
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

10. IRRITABLE
    0 1 2 3 4 5 6 7 8 9 10
    not at all extremely

11. JOYFUL
    0 1 2 3 4 5 6 7 8 9 10
    not at all extremely

12. WORRIED
    0 1 2 3 4 5 6 7 8 9 10
    not at all extremely

Appendix D

Rate how much physical discomfort you **experienced** when your arm was in the ice water:

1	2	3	4	5	6	7	8	9	10

Not at all Extreme pain

Appendix E

III. Please read each question, and choose the item that best describes how you felt when your arm was in the ice water.

WHEN MY ARM WAS IN THE ICE WATER, I FELT...

1. SAD
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

2. ANGRY
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

3. HAPPY
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

4. ANXIOUS
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

5. DISCOURAGED
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

6. HOSTILE
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

7. DELIGHTED
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

8. AFRAID
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

9. HOPELESS
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

10. IRRITABLE
    0 1 2 3 4 5 6 7 8 9 10
    not at all extremely

11. JOYFUL
    0 1 2 3 4 5 6 7 8 9 10
    not at all extremely

12. WORRIED
    0 1 2 3 4 5 6 7 8 9 10
    not at all extremely

Appendix F

Rate how much physical discomfort you **expect** to experience when your arm is in the ice water:

1	2	3	4	5	6	7	8	9	10

Not at all Extreme pain

Appendix G

II. Please read each question, and choose the item that best describes how you will feel when your arm is in the ice water.

WHEN MY ARM WAS IN THE ICE WATER, I FELT...

1. SAD
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

2. ANGRY
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

3. HAPPY
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

4. ANXIOUS
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

5. DISCOURAGED
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

6. HOSTILE
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

7. DELIGHTED
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

8. AFRAID
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

9. HOPELESS
   0 1 2 3 4 5 6 7 8 9 10
   not at all extremely

10. IRRITABLE
    0 1 2 3 4 5 6 7 8 9 10
    not at all extremely

11. JOYFUL
    0 1 2 3 4 5 6 7 8 9 10
    not at all extremely

12. WORRIED
    0 1 2 3 4 5 6 7 8 9 10
    not at all extremely

Appendix H

PCS

Name:_____ Age:_____ Gender:_____ Date:_____

Everyone experiences painful situations at some point in their lives. Such experiences may include headaches, tooth pain, joint or muscle pain. People are often exposed to situations that may cause pain such as illness, injury, dental procedures or surgery.

We are interested in the types of thoughts and feelings that you have when you are in pain. Listed below are thirteen statements describing different thoughts and feelings that may be associated with pain. Using the following scale, please indicate the degree to which you have these thoughts and feelings when you are experiencing pain.

0 - not at all **1** - to a slight degree **2** - to a moderate degree **3** - to a great degree **4** - all the time

When I'm in pain...

1. ☐ I worry all the time about whether the pain will end.
2. ☐ I feel I can't go on.
3. ☐ It's terrible and I think it's never going to get any better.
4. ☐ It's awful and I feel that it overwhelms me.
5. ☐ I feel I can't stand it anymore.
6. ☐ I become afraid that the pain will get worse.
7. ☐ I keep thinking of other painful events.
8. ☐ I anxiously want the pain to go away.
9. ☐ I can't seem to keep it out of my mind.
10. ☐ I keep thinking about how much it hurts.
11. ☐ I keep thinking about how badly I want the pain to stop.
12. ☐ There's nothing I can do to reduce the intensity of the pain.
13. ☐ I wonder whether something serious may happen.

...Total

Appendix I

Summary of Raw Data for Variables in Study 1

Variable Name	Mean	SD	Range
Pain Catastrophizing Scale Score	21.34	7.98	3 - 38
Rating of pain during room temperature water immersion	4.52	1.47	1 - 6
Rating of anxiety during room temperature water immersion	7.58	5.05	0 - 22
Rating of anger during room temperature water immersion	2.25	3.29	0 - 14
Rating of sadness during room temperature water immersion	2.07	3.44	0 - 16
Rating of happiness during room temperature water immersion	11.90	6.67	0 - 23
Rating of pain expected during the cold pressor procedure	8.60	2.49	3 - 9
Rating of anxiety expected during the cold pressor procedure	9.63	5.97	0 - 25
Rating of anger expected during the cold pressor procedure	8.11	6.88	0 - 27
Rating of sadness expected during the cold pressor procedure	3.96	4.95	0 - 25
Rating of happiness expected during the cold pressor procedure	6.16	6.03	0 - 21
Rating of pain at 20 seconds during cold pressor procedure	6.50	2.00	2 - 10
Rating of pain at 40 seconds during cold pressor procedure	7.73	1.91	2 - 10

Summary of Raw Data for Variables in Study 1 (continued)

Variable Name	Mean	SD	Range
Rating of pain at 60 seconds during cold pressor procedure	7.80	1.94	2 - 10
Rating of anxiety experienced during the cold pressor procedure	10.45	6.91	0 - 24
Rating of anger experienced during the cold pressor procedure	7.46	6.74	0 - 26
Rating of sadness experienced during the cold pressor procedure	4.15	5.73	0 - 23
Rating of happiness experienced during the cold pressor procedure	4.28	5.21	0 -19
Reaction times for Stroop pain words (in msec)	635.47	76.74	513 - 900
Reaction times for Stroop social words (in msec)	624.35	79.70	508 - 839
Reaction times for Stroop neutral words (in msec)	621.42	70.99	497 - 846
Overall reaction times for Stroop words (in msec)	627.15	72.28	520 - 837
Self-report estimates of attention to pain during the cold pressor procedure	76.50	22.36	5 - 100

Appendix J

Stimuli presented during the trial preceding the cold pressor procedure:

Pain-Related Words	Social-Threat Words	Neutral Words
Disease	Lonely	Triangle
Agony	Criticism	Permit
Harm	Silly	Jacket
Stabbing	Intimidated	Clipboard
Wound	Mistake	Nights
Lancing	Scorn	Hibernation
Sore	Hostile	Foam
Gash	Foolish	Frogs

Stimuli presented during the trial preceding the cold pressor procedure:

Pain-Related Words	Social-Threat Words	Neutral Words
Pain	Enemies	Beans
Fatal	Regret	Tidal
Scalpel	Insecure	Salon
Gore	Submission	Navigate
Suffer	Stupid	Text
Freezing	Hated	Latter
Numb	Inferior	Circus
Sting	Neglected	Caribou

Stimuli presented during the trial preceding the cold pressor procedure:

Pain-Related Words	Social-Threat Words	Neutral Words
Burn	Failed	Collect
Mutilated	Coerce	Showplace
Injury	Deserted	Curtains
Scorching	Ridicule	Steed
Moan	Worthless	Haul
Torture	Inadequate	Glacial
Tormented	Pathetic	Unpack
Scalding	Humiliated	Enlist

Appendix K

Summary of Raw Data for Variables in Study 2

Variable Name	Mean	SD	Range
Pain Catastrophizing Scale Score	23.81	8.78	4 - 10
Rating of pain during room temperature water immersion	2.23	1.29	0 - 7
Rating of anxiety during room temperature water immersion	5.57	5.31	0 - 22
Rating of anger during room temperature water immersion	1.58	2.30	0 - 11
Rating of sadness during room temperature water immersion	1.11	2.05	0 - 9
Rating of happiness during room temperature water immersion	7.70	5.69	0 - 23
Rating of pain expected during the cold pressor procedure	6.47	1.96	1 - 9
Rating of anxiety expected during the cold pressor procedure	9.27	5.88	0 - 26
Rating of anger expected during the cold pressor procedure	8.30	6.74	0 - 24
Rating of sadness expected during the cold pressor procedure	3.69	4.71	0 - 17
Rating of happiness expected during the cold pressor procedure	3.79	3.95	0 - 16
Rating of pain experienced during the cold pressor procedure	7.76	1.35	4 - 10

Summary of Raw Data for Variables in Study 2 (continued)

Variable Name	Mean	SD	Range
Rating of anxiety experienced during the cold pressor procedure	10.39	6.86	0 - 30
Rating of anger experienced during the cold pressor procedure	8.38	7.64	0 - 28
Rating of sadness experienced during the cold pressor procedure	4.11	5.55	0 - 20
Rating of happiness experienced during the cold pressor procedure	2.19	3.62	0 - 13
Overall reaction times for Stroop words (in msec) prior to the cold pressor procedure	565.60	82.50	396 - 894
Reaction times for Stroop pain words (in msec) prior to the cold pressor procedure	570.78	91.75	395 - 868
Reaction times for Stroop social words (in msec) prior to the cold pressor procedure	550.49	89.51	366 - 848
Reaction times for Stroop neutral words (in msec) prior to the cold pressor procedure	577.22	87.86	388 - 800
Overall reaction times for Stroop words (in msec) during the cold pressor procedure	640.11	86.44	463 - 833
Reaction times for Stroop pain words (in msec) during the cold pressor procedure	639.89	90.65	451 - 916
Reaction times for Stroop social words (in msec) during the cold pressor procedure	636.83	101.14	453 - 863
Reaction times for Stroop neutral words (in msec) during the cold pressor procedure	644.89	86.94	472 - 852

Summary of Raw Data for Variables in Study 2 (continued)

Variable Name	Mean	SD	Range
Overall reaction times for Stroop words (in msec) after the cold pressor procedure	600.33	86.81	406 - 875
Reaction times for Stroop pain words (in msec) after the cold pressor procedure	587.52	91.34	418 - 793
Reaction times for Stroop social words (in msec) after the cold pressor procedure	597.86	95.45	378 - 931
Reaction times for Stroop neutral words (in msec) after the cold pressor procedure	615.54	89.36	420 - 895
Percentage of time attending to pain during the cold pressor procedure	64.76	25.63	15 -100

Appendix L

Instructions provided to the attentional focus group in Study 3:

"During the time that your arm is in the ice water, I would like you to describe your experiences aloud. In order to describe your experiences accurately, you will need to pay particularly close attention to what you are feeling during the entire time that your arm is immersed in the ice water. Try to pay close attention to the sensations in your arm, and describe these sensations aloud as your arm sits in the ice water. Try not to get distracted during the immersion: instead stay focused on the sensations that you experience for the entire time that your arm is in the ice water. It is also important for you to talk aloud during the entire time that your arm is in the ice water. This microphone is connected to a tape recorder, so I will be taping you as you describe your experiences...".

Appendix M

Instructions provided to the distraction group in Study 3:

"During the time that your arm is in the ice water, I would like you to do a task that involves counting backwards by 7's aloud. For example, if you started at 500, and counted backwards by 7's, you would count like this; 500, 493, 486, 479...Do you understand? You will start at 500, and count backwards by 7's just like I did. In order to count backwards accurately, you will need to pay close attention to the task during the entire time that your arm is immersed in the ice water. Try not to get distracted during the immersion: instead stay focused on counting backwards by seven. If you make a mistake, just keep going. You should be counting aloud during the entire time that your arm is in the ice water. This microphone is connected to a tape recorder, so I will be taping you as you count backwards..."

Appendix N

Summary of Raw Data for Variables in Study 3

Variable Name	Mean	SD	Range
Pain Catastrophizing Scale Score	17.99	10.27	1 - 48
Rating of pain during room temperature water immersion	1.76	.90	0 - 5
Rating of anxiety during room temperature water immersion	3.92	4.45	0 - 22
Rating of anger during room temperature water immersion	1.73	3.49	0 - 18
Rating of sadness during room temperature water immersion	1.94	3.36	0 - 16
Rating of happiness during room temperature water immersion	11.03	6.22	0 - 29
Rating of pain expected during the cold pressor procedure	5.80	2.04	2 - 10
Rating of anxiety expected during the cold pressor procedure	5.04	4.49	0 - 21
Rating of anger expected during the cold pressor procedure	3.18	4.38	0 - 19
Rating of sadness expected during the cold pressor procedure	2.01	3.57	0 - 14
Rating of happiness expected during the cold pressor procedure	7.24	6.24	0 - 30
Rating of pain experienced during the cold pressor procedure	6.72	2.07	1 - 10

Summary of Raw Data for Variables in Study 3 (continued)

Variable Name	Mean	SD	Range
Rating of anxiety experienced during the cold pressor procedure	7.27	6.20	0 - 30
Rating of anger experienced during the cold pressor procedure	4.82	5.66	0 - 20
Rating of sadness experienced during the cold pressor procedure	3.11	5.30	0 -23
Rating of happiness experienced during the cold pressor procedure	4.23	5.62	0 - 30

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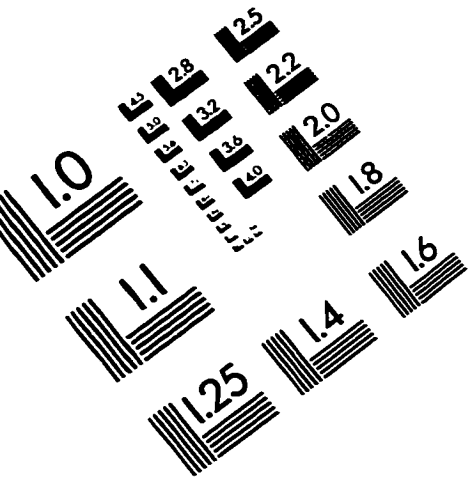
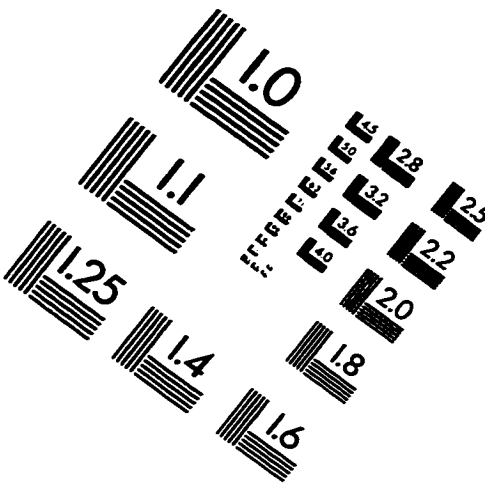
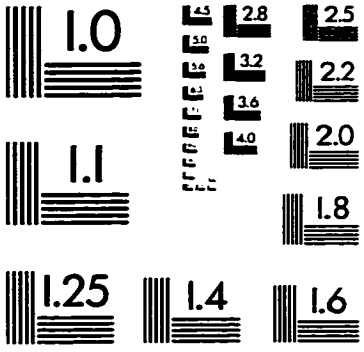
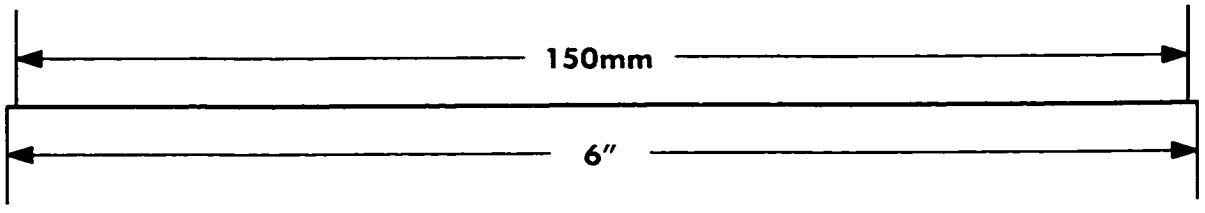
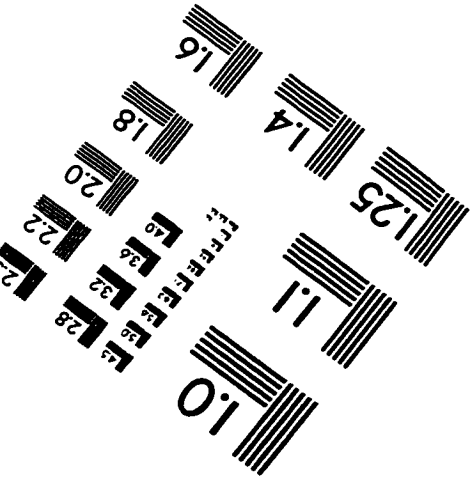
IMAGE EVALUATION
TEST TARGET (QA-3)

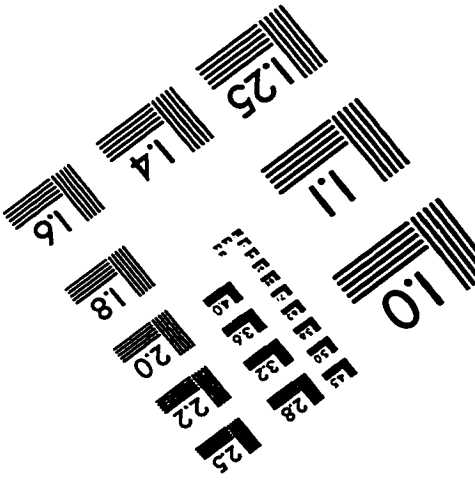












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