Pain Catastrophizing in Athletic Individuals: Scale Validation and Clinical Application.

by

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Abstract

This research examined the scale validation and clinical application of the Pain Catastrophizing Scale (PCS) in athletes. The aim of Study 1 was to test for factorial invariance between an athletic and non-athletic population for the PCS (i.e., Helplessness, Rumination, & Magnification). Participants completed the PCS and a sport/activity questionnaire. The PCS was shown to be statistically invariant across athletic and non-athletic samples. The purpose of Study 2 was to examine the PCS in predicting athletes' pain responses with experimental pain. Participants completed the PCS and a cold-water immersion task (2-4°C) for one minute, providing verbal pain ratings. Athletes reported less pain than non-athletes, men reported less pain than women, and catastrophizing significantly predicted pain for athletes. These findings suggest that athletes who catastrophize about pain will experience greater pain. Study 3 examined the relation between pain, pain catastrophizing, and functional disability in a sample of athletes following knee surgery in a prospective design. Catastrophizing was associated with greater post-op pain, Rumination was the lone significant psychological predictor of pain at 24 and 48-hours post-op, and Helplessness was the lone predictor of pain while resting at the 8-weeks post-op. Catastrophizing was not a predictor of disability but at 24-hours post-op predicted pain at 48-hours, and 48-hour catastrophizing predicted disability at 8-weeks post-op. These findings suggest that catastrophizing is a significant factor in pain for athletes following ACL surgery. Studies 1,2,3 show that catastrophizing is a significant factor in pain for athletes in experimental and clinical situations.

Abbreviations and Symbols

<u>Measures</u>

FDI	Functional Disability Inventory
PCS	Pain Catastrophizing Scale
STAI	State-Trait Anxiety Inventory
BDI	Beck Depression Inventory
VAS	Visual Analogue Scale

<u>Medical and Health Terms</u>

ACL	Anterior Cruciate Ligament

<u>Statistical and Scientific Notation</u>

α	coefficient alpha, or probability level
ANOVA	Analysis of Variance
ANCOVA	Analysis of Covariance
°C	Degrees Celsius
df	Degrees of Freedom
F	F-test Statistic
χ^2	Chi Square statistic
<u>M</u>	Mean
<u>n</u>	Number of subjects/respondents
ns	not statistically significant
p	probability level
r	Correlation Coefficient
<u>SD</u>	Standard Deviation
t	T-test statistic
^{M}	Marginally Significant

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General Introduction.

Pain has been described by prominent sport psychology writers as the most pervasive and debilitating obstacle to effective rehabilitation experienced by injured athletes, with significant physical and psychological effects across many aspects of recovery (Heil, 1993). However, despite its importance for recovery and return to sport, empirical investigations of the psychological and physical determinants of pain and recovery in athletes are few. Further, it appears that little attention has been directed toward educating injured athletes on the effects of pain and better pain management strategies (Taylor & Taylor, 1998).

There are several important reasons why research should be focused on the psychological predictors of pain experience in athletic individuals. It has been suggested that pain intensity is the most powerful predictor of pain tolerance, particularly within the context of rehabilitation from injuries (Taylor & Taylor, 1998; Waddell & Turk, 1992). However, no research within the sport literature has examined the variables related to the prediction of pain intensity. There has also been increasing concern that the laboratory paradigms used to study pain tolerance among athletes may fail to adequately mimic the conditions under which athletes must endure pain in sporting activity or rehabilitation (e.g., Pen & Fisher, 1994). Therefore, research examining issues related to pain tolerance or pain intensity in sports participants must strive for greater ecological validity. Finally, it has been suggested that effective pain management following sport-injury must proceed from a clearer understanding of athletes' subjective experience of pain and how negative aspects of coping responses may interfere with rehabilitation (Bartholomew, et al., 1998; Taylor & Taylor, 1998).

Both clinical and experimental literature have suggested that the tendency to engage in negative, pain-related cognitive appraisals, generally defined as "pain catastrophizing" (e.g., Jensen, Turner, Romano, & Karoly, 1991; Turk & Rudy, 1992), has resulted in greater pain intensity, lower pain tolerance, and increased emotional distress such as anxiety and depression (e.g., Chaves & Brown, 1987; Spanos, Radtke-Bodorik, Ferguson & Jones, 1979; Sullivan et al., 1995). Other research examining postoperative pain has also shown that pain catastrophizing is significantly associated with many factors related to negative outcomes following surgery. For example, several different studies examining postoperative outcomes have shown that individuals high in pain catastrophizing reported significantly greater postoperative pain, postoperative disability, and greater postoperative analgesic consumption than non-catastrophizers (e.g., Bennett-Branson & Craig, 1993; Butler, Damarin, Beaulieu, Schwebel, & Thorn, 1989; Jacobsen & Butler, 1996).

A precise uniform definition of pain catastrophizing has not been endorsed in the literature but it is generally agreed that it is a process that involves a predominantly negative cognitive appraisal of pain stimuli (e.g., Jensen et al., 1991; Sullivan et al., 1995). The catastrophizing literature has described several primary characteristics of pain catastrophizing including: 1) negative thoughts that are ruminatory, with excessive focus on the negative aspects of the pain situation (e.g., Spanos et al., 1979); 2) thoughts that magnify pain sensations, such as increased accessibility to previous memories of painful episodes (e.g., Chaves & Brown, 1978, 1987); and 3) thoughts that evoke feelings of helplessness and an inability to cope effectively with pain (Rosenstiel & Keefe, 1983). These three sorts of thoughts are purported to occur simultaneously but are also believed to have distinctive effects.

Pain catastrophizing is an important cognitive factor in better understanding individual differences in perception of pain intensity and rehabilitation from surgery. However, there have been few attempts to empirically investigate its effects among athletes. Several factors may account for this apparent gap in the literature. Of primary concern, the theoretical and conceptual models of sport-injury and injury recovery have fundamentally focused on emotional reactions of the athletes to their injuries (e.g., Wiese-Bjornstal, Smith & LaMott, 1995), while comparatively little empirical effort has focused on pain, its prediction, and its management. As well, pain catastrophizing and individual differences in pain have only recently been proposed as a significant factor in the sport injury and recovery literature (e.g., Bartholomew et al., 1998).

Sullivan et al. (1995) developed the Pain Catastrophizing Scale (PCS), a 13-item self-report measure, and have successfully employed it with clinical and non-clinical populations to assess the contribution of catastrophizing to a variety of pain situations (e.g., Sullivan et al., 1995; Sullivan & Neish, 1998; Sullivan, Stanish, Waite, Sullivan & Tripp, 1998). On the basis of a validating factor analytic study, Sullivan et al. (1995) suggested that pain catastrophizing should be viewed as a conceptually integrated concept that comprises three related components. Firstly, *Rumination,* "I can't stop thinking about how much it hurts". Secondly, *Magnification,* "I worry that something serious may happen". Finally, *Helplessness,* "There is nothing I can do to reduce the intensity of the pain" (Sullivan et al., 1995; Study 1; Osman et al., 1997).

Catastrophizing has been shown to be associated with greater pain intensity, lower pain tolerance, and increased emotional distress (e.g., Chaves & Brown, 1987; Spanos et al., 1979; Sullivan et al., 1995), as well as with increased postoperative pain, greater postoperative disability, and more postoperative analgesic consumption (e.g., Bennett-Branson & Craig, 1993; Butler et al., 1989; Jacobsen & Butler, 1996; Keefe et al., 1991). These broad and consistent findings lend support to the theoretical and clinical importance of pain catastrophizing as a significant and potentially rich source of information about the factors related to athlete's pain and recovery following injury.

The present research was designed to examine the relations among pain catastrophizing, pain, emotional distress, and functional disability in athletes. Study 1 was designed to test the factorial stability of the PCS among individuals who are actively involved with sporting activities. The aim of Study 1 was to illustrate concordance between an athletic and non-athletic population for the principal factors of the PCS (i.e., Helplessness, Rumination, & Magnification). This study is essential to show stability of the factor structure of the PCS across populations, providing an initial degree of psychometric assurance that the PCS may be used in pain research with athletes. Study 2 was designed to assess the utility of the PCS in predicting ratings of pain intensity in athletes and non-athletes in response to an experimental, pain induction paradigm, the cold pressor task. This study also examined the construct validity of the PCS as it has been used in previous laboratory-based pain research. Study 3 was designed to examine the relation between pain catastrophizing, pain, and functional disability in a sample of sports participants that have undergone Anterior Cruciate Ligament (ACL) reconstructive surgery of the knee. This study allowed for examination of the relationships between catastrophizing and indices of recovery following a serious knee injury and its required surgery.

Literature Review.

Converging evidence from several different areas of research has provided the impetus for the present research. An understanding of the key factors related to: 1) individual differences in pain perception and the historical and cultural forces which have shaped our understanding of these variables; 2) pain in athletes; 3) sport-related post-injury response models; 4) stress, pain, and pain catastrophizing will provide a comprehensive rationale for the three studies proposed.

A Brief History of Individual Differences in Pain Perception.

Our current conceptualizations about pain and the nature of individual differences in pain perception have been shaped by centuries of theoretical writings and major shifts in culture and science (Rey, 1993). To gain a greater appreciation for this history and how it relates to our current understanding of pain, a brief overview is provided.

As outlined by Gatchel (1999), the association between the mind and body has been debated for centuries by philosophers, physiologists, and psychologists. The ancient Greeks were the first to debate a mind-body holistic tradition suggesting that psychological factors were significantly associated with bodily disease processes. For example, Galen's (AD 130-200) elaboration of Hippocrates' four-humor theory suggested that several aspects of personality were influential in personal dispositions as well as disease generation.

During the Renaissance period, Rene Descartes (1596-1650) espoused theories of mind-body dualism wherein the body was best explained by its own mechanisms and suggestions that the mind (or soul) influenced the body were argued to be unscientific (Gatchel, 1999). Indeed, Descartes positioned the mind as a separate entity, almost parallel to the body, which was incapable of affecting physical matter in any significant manner. Descartes conceptualized pain in a mechanical manner, stating that it had a specific type of activity in the nervous system, separate from the influence of an individual's mind. Descartes suggested that pain experience was produced by a "straight-through" system where channels from the skin sent warning signals directly to the brain, allowing peripheral parts of the body to remove themselves from possible damage. Further, these responses were suggested to directly reflect the amount of damage being inflicted onto the site of injury and pain (Sullivan, 1998).

Descartes' dualistic approach was common in medicine and science well into the 19th century, bolstered by research discovering that microorganisms caused certain diseases. However, pain research in the 1950's provided impetus to a growing movement of dissatisfaction with a strictly sensory model of pain (e.g., that of Descartes). For example, studies showing that individuals high in anxiety reported significantly greater levels of pain (Hill, Kornestky, Flanary, & Wilder, 1952), were significant in demonstrating the importance of psychological status in determining pain experience. Other pain research made this point very dramatically. In particular, Beecher (1956) assessed requests for pain medications from soldiers taken to hospital following war wounds at the Battle of Anzio. He compared their requests with those of civilians who had to undergo similar surgeries. Beecher found that only one quarter of the wounded soldiers requested pain medications. Many others denied their pain, or many reported having little pain without the need for pain medication. His findings about pain following similar surgeries with civilians were quite different, with eight out of ten patients requesting pain medication following surgery. Beecher interpreted these findings in light of individual differences between the two groups. He suggested that psychological factors, such as a person's emotional state and state of secondary gain, could significantly affect his/her pain experience and expression. Further, Beecher suggested that the secondary gain of the wounded soldier was evident in his emotional relief from not having to go back to war because of his injuries and the likelihood of discharge from active service.

Beecher's research strongly suggested that Cartesian-like pain models may be critically limited in both clinical and laboratory utility. The psychology of pain became a central focus in providing a more accurate understanding the determinants of the pain experience. With the seminal works of Melzack and colleagues (e.g., Melzack & Casey, 1968; Melzack & Dennis, 1978; Melzack & Wall, 1965), pain was touted as a perceptual and individualistic experience. Melzack's and Wall's primary theory of pain regulation, the "Gate Control Model of Pain", was designed to encompass both the clinical experience of pain and to address the shortcomings of previous pain models regarding cognitive influences (e.g., Beecher, 1956). According to the Gate Control Model, there are important physiological pathways in which activity can either augment or reduce the subjective experience of pain. In particular, there are afferent pathways in the nervous system, where pain signals travel to the brain from the extremities, and there are efferent pathways, where the neurophysiological influence of emotions and cognitive activity travel down the spinal cord and modulate incoming afferent signals. For example, the model proposed that strong negative emotional states might increase subjective reports of pain by facilitating sensory processing, while positive emotional states may act to decrease subjective reports of pain by decreasing afferent processing (Melzack & Wall, 1982). This basic action of gating pain signals was not described as "all-or-nothing", but was suggested to be associated with the amount of distress experienced by the individual. Therefore, a person who is quite anxious about undergoing an aversive procedure is more likely to experience and report greater pain than those who are less anxious.

The Gate Control Model stipulates that pain is not entirely a sensory experience but rather a variable experience influenced by the subjective meaning of the situation, attention, and other cognitive activities of the individual (Melzack & Dennis, 1978). This model has been a significant contribution in understanding pain and fostering additional research because of its robustness in accounting for the psychological factors in pain. The diversity of description of pain experiences has opened the door for a multitude of pain treatments. For example, some advances in the treatment of pain that are theoretically rooted in the Gate Control Theory include nerve stimulation through transcutaneous devices (e.g., Long & Hagfors, 1975), heat, ice, and acupuncture (e.g., Gaupp, Flinn, & Weddige, 1989), as well as various psychological therapies such as progressive muscle relaxation (e.g., Melzack & Wall, 1982).

Although the Gate Control Model is seen as an advance over a purely physiological or sensory-based approach to pain, others have argued that more attention should be given to the effects that cognitive appraisals of pain, environmental influences, physical factors, or pain perceptions may have over time (e.g., Turk, Meichenbaum, & Genest, 1983). In particular, Turk and colleagues had described a "cognitive-biobehavioural perspective" of pain in hopes of addressing the importance of environmental factors as well as the individual cognitive factors on pain perception (Turk & Meichenbaum, 1984; Turk, Meichenbaum, & Genest, 1983). From this model, how one interprets or appraises pain, what coping resources an individual believes they have use of, and variables inherent in the current situation (e.g., the hospital milieu), may all combine in one way or another to create different degrees of anxiety or fear in individuals experiencing pain. In turn, these factors may exacerbate the experience of pain as suggested by the Gate Control Model.

More recent discussions of pain have provided a broader perspective, focusing on the role of psychological factors in pain as well as the pertinent physiological factors (see Philips & Rachman, 1996). Such an emphasis on the psychological factors would suggest that catastrophizing thoughts about pain play a significant role in the pain experience. As suggested by sources in the pain literature to date (e.g., Sullivan et al., 1995), an individual's cognitive appraisal of his/her pain may be central to how his/her pain is both experienced and reported. To this point, Philips and Rachman (1996) suggested that the interpretation and reaction to pain might have a direct influence on the amount of distress that follows.

Pain in Athletes.

> *"I was going backwards defending the ball when I stopped and shot forward to reach for the ball on the transfer... my left leg went forward as I lunged and stopped. That's when I heard that crack and felt that pain... I fell to the court and knew right away something was wrong."* (Personal communication from ACL-injured recreational basketball player, October 19, 1997)

Injuries to athletes are common (Kraus & Conroy, 1984). Although pain is a phenomenon familiar to all, participation in athletics often involves greater risk of exposure to a variety of pains (Ryan & Kovacic, 1966). Pain is an integral part of many North American sports (e.g., rugby, hockey, boxing, and marathon running), with the ability to tolerate pain often anecdotally associated with increased performance in athletes. Indeed, many endurance athletes (e.g., long distance runners) attribute much of their competition successes to higher levels of pain tolerance (Egan, 1987).

Despite technological advances in sports equipment, improved coaching techniques, and sport-specific physical conditioning, athletic injuries and their associated pain have been increasing in prevalence (Bergandi, 1985; Yaffe, 1983). Severity of sports injuries can range from bruises and minor cuts requiring stitches, to more devastating injuries like that of spinal cord damage and paralyses (Smith, Scott, & Wiese, 1990). Conservative estimates place the number of sports and recreation injuries as high as 5 million per year in the US alone (Kraus & Conroy, 1984). Such injuries may result in the restriction of life activity and the experience of significant pain for nearly half of all injured amateur athletes (Garrick & Requa, 1978; Hardy & Crace, 1990). Surveys of varsity sports suggest that as many as 35% of athletes may sustain injuries of sufficient severity to interfere with continued involvement in sports competition (Meeuswisse & Fowler, 1988). The costs associated with sport-related injuries are significant whether assessed in terms of medical or financial implications (i.e., diagnostic tests, surgery), or in terms of impairment in sport performance or daily functioning.

Pain is a normal and expected part of participation in sport, and athletes have been shown to have greater pain tolerance than non-athletes (e.g., Walker, 1971). However, just as the types of injury suffered by athletes are diverse, so too are their psychological and physical responses to injury, with more serious injuries usually provoking a greater amount of distress (LaMott & Petlichkoff, 1990; Smith, Scott, & Wiese, 1990).

There is little doubt that experience and expression of pain varies widely from one individual to the next. As Melzack (1973) suggested more than 20 years ago, pain intensity thresholds and tolerances may differ significantly across individuals in relation to a variety of psychological and physical factors (e.g., Melzack, 1973). There is evidence from the sport literature supporting this general position. For example, it has been shown that pain tolerance is higher in athletes of collision-sport than those in non-collision-sport (Ryan & Foster, 1967).

Both coaches and physicians currently acknowledge that athletes differ in their capacity to "handle" pain following an injury (e.g., Heil, 1993; Taylor & Taylor, 1998). There is also a growing awareness among sports medicine providers of the need to consider psychological factors as significant not only in sports performance, but in sports injuries, postoperative rehabilitation, and pain management as well (Flint, 1998; Weiss & Troxel, 1986; Wiese & Weiss, 1987; Wiese-Bjornstal, Smith, Shaffer, & Morrey, 1998). It is also acknowledged that athletes do experience a wide range of emotions in response to pain and injury, such as anger, anxiety, or depressed moods (e.g., Rotella, 1982; Wiese & Weiss, 1987).

Athletes who have experienced a painful injury are often faced with a variety of other stressors. As Coakley (1983) has suggested, athletes may suffer widespread distress when injured, with interpersonal and intrapersonal adjustments that can be stressful to manage. Extending Coakley's position, Danish (1986) noted that injuries are particularly stressful for athletes because they negatively affect their physical well-being, self-concept, belief systems, and emotional equilibrium.

In summary, the literature on pain in athletes has suggested that athletes are at increased risk for injury and have greater opportunity to experience pain because of the inherent risks involved with sporting activities. It has also suggested that athletes may differ greatly in their experience of pain and in the emotional turmoil they may manifest following injury. Observations of varied psychological responses to injury have researchers examining a variety of emotional responses to injury in athletic populations.

Sports-Related Post-Injury Response Models.

There is little doubt that athletes experience significant negative mood states following sports injuries. For example, Pearson and Jones (1992) found significant differences between injured and non-injured athletes in a variety of negative emotions, with depression, tension, confusion, hostility, and fatigue being the most common. As well, examining 916 injured and non-injured varsity football players, Brewer and Petrie (1995) found that significantly greater levels of depression and life-stress were present in the injured group of athletes. Research using the Profile of Mood States (POMS) across many studies has shown that depression, high tension, and low vigor are associated with athletic injuries (e.g., Meyers et al., 1992; Smith, Scott, O'Fallon, & Young, 1990). Further, among the psychological responses of athletes to injury, the expression of powerlessness (Thomas & Rintella, 1989), loss (Astle, 1986), lowered self-esteem (Smith, Scott, Wiese, 1990), increased fear and depression (Smith et al., 1990), and increased anxiety (McClay & Livitt, 1991) have all been documented.

Probably the most prominent model of post-injury psychological adjustment in the sport-injury literature is that of Wiese-Bjornstal, Smith, and LaMott (1995). Their model extended the sport-injury precursor model of Anderson and Williams (1988), who suggested that an athlete's personality, coping resources, history of stressors, and the availability of social support may affect an athlete's risk for injury. The Wiese-Bjornstal et al. (1995) model, also considers the severity of injury, any sport-specific situational factors, coping resources, and the emotional, cognitive, and behavioral responses of the athlete after the injury, to provide a theoretical framework from which researchers could examine a variety of post-injury psychological effects. The Wiese-Bjornstal et al. (1995) model is comprised of three interact ional factors: the athletes' cognitive appraisals, emotional responses, and behavioral responses. This model suggests that personal and situational factors form an athletes' cognitive appraisal of his/her injury. If the athlete presents with a negative cognitive appraisal of their injury (e.g., my season is ruined; I'll never play again), this may negatively affect either his/her cognitive coping style, the rate of perceived recovery, goal adjustments, sense of loss or relief, and beliefs about his/her injury, and may result in poor emotional adjustment (e.g., increased anxiety, depression). Poor emotional adjustment may then lead to poor adherence to rehabilitation, poor use of physiotherapy strategies, poor use of social support, risk taking behaviors, poor effort and intensity, or malingering.

In a recent review, Wiese-Bjornstal et al. (1998) concluded that the findings of several recent reports are consistent with and supportive of the model. In particular, in his unpublished Doctoral thesis, Lamott (1994) examined athletes' emotional responses to ACL injury and surgical recovery. For this study, 40 athletes were followed pre-surgery or immediately post-surgery for approximately 12 weeks. The major finding was that total mood disturbance scores (assessed by subtracting total positive mood score from negative mood scores on the Emotional Response of Athletes to Injury Questionnaire; ERAIQ; Morrey et al., 1999) was high after surgery but then decreased sharply. As time passed negative emotion increased, following a "U" shaped or curvilinear pattern. The emotional responses of anger and frustration were found to be related to a physical index of recovery (i.e., range of motion when foot is forced toward buttocks) obtained during physiotherapy sessions.

Morrey (1997) reported similar findings. Assessing ACL injured athletes over a six-month post-surgical period, he found that the calculated total mood disturbance in the post-surgery period followed the curvilinear "U" shaped pattern noted by LaMott (1994). Morrey also suggested that certain negative mood states predominated at different points during the post-surgical assessment period. For example, "boredom" exhibited a linear decline over time, while "frustration" showed the "U" shaped pattern. For positive mood states like "optimism", an inverse "U" pattern was shown across the assessment period. Additionally, as noted by LaMott (1994), negative mood states or greater emotional disturbance were significantly and negatively related to a measure of functional recovery (i.e., range of motion).

Other research has shown that negative cognitive appraisals following sport injury and surgery may act to hinder progress in rehabilitation programs (Daly et al., 1995). Suggesting that cognitive appraisal models (e.g., Lazarus & Folkman, 1984) may be quite useful in understanding how athletes psychologically respond to their injuries, Daly et al., (1995), examined 31 injured athletes who had undergone ACL reconstructive surgery. Their findings showed that negative cognitive appraisals of the athletes' ability to manage their injury were significantly associated with emotional disturbance and that emotional disturbance was significantly and inversely related to a measure of adherence to rehabilitation (i.e., attendance at treatment sessions).

The research of LaMott (1994), Morrey (1997), and Daly et al. (1995), has indicated that emotional responses of the athlete during ACL rehabilitation are significantly related to measures of physical recovery and rehabilitation adherence. As well, several studies examining the emotional responses to sport-injury have suggested that negative mood states are common features of ACL recovery and thus should be important components of a conceptual or organizational model of recovery from sport injury (e.g., McClay & Livitt, 1991; Smith et al., 1990; Wiese-Bjornstal et al., 1998).

There is little doubt that anxiety and pain are positively associated (Weisenberg, 1977; Sternbach, 1986), with some research suggesting that fear of pain may be a particularly salient feature of reports of pain (e.g., among dental patients; Gross, 1992). The relation between pain and anxiety has also been documented among individuals with anxiety disorders, who often report increased somatic complaints including pain (Beidel, Christ, & Long, 1991). Research on anxiety, pain, and surgery has suggested that anxiety is positively associated with both higher pain and the greater use of postoperative medications (e.g., Taenzer, 1983). Other research has shown that anxiety in the postoperative period is a significant factor in pain. For example, Nelson et al. (1998), investigating postoperative anxiety and pain after coronary artery bypass, found a positive relationship between anxiety and pain over the recovery period most strongly related to anxiety with pain on the second postoperative day. This relation remained even after controlling age, gender, marital status, number of previous surgeries, and operation time.

Depressive symptoms have also been demonstrated to have a positive association with pain. Blumer and Heilborn (1982) initially suggested that there was a close association between pain and depression. They argued that pain could emerge as a variant of a depressive disorder, suggesting that chronic pain could be manifested as the somatic expression of "psychic pain". Despite the theoretical mechanisms by which depression may contribute to the experience of pain or vice versa, clinical research has repeatedly demonstrated a positive association between pain and depression. Research has shown that the prevalence of depressive disorders is unusually high among individuals suffering from pain disorders (Sullivan & D'Eon, 1990). Further, in a substantive number of cases, depressive symptoms appeared prior to the development of chronic pain, suggesting that pain may be a risk factor for depression (cf. Romano & Turner, 1985). Significant positive correlations between pain intensity and ratings of depression have been reported in several clinical studies of chronic pain (e.g., Romano & Turner, 1985; Rosensteil & Keefe, 1983; Keefe et al., 1989; Sullivan & D'Eon, 1990), and recent research has shown that ischemic pain tolerance in individuals reporting minor depressive symptoms is clinically lower by 44% than in matched controls (Pinerua-Shuhaibar et al., 1999). Although no mechanism for this relation has been universally accepted in the literature, a number of investigators have suggested that through similar neurotransmitter involvement, pain may heighten susceptibility to symptoms of depression and that depression may lead to sensitivity to pain (Gershon, 1986; Ward, 1986).

Given the extent to which athletes experience emotional distress following a significant injury or injury-related surgery (e.g., Morrey 1997), that pain is associated with both anxiety and depression, and that pain has been suggested to be a significant contributing factor in understanding sport-injury recovery within current sport-injury response models (Wiese-Bjornstal et al., 1998), the investigation is warranted. Examining these relations might help outline how the factors that affect the pain experience in athletes impact upon functional recovery following serious injury.

Stress, Coping with Pain, and Pain Catastrophizing.

The stress and coping literature illustrates the crucial role played by the situation-specific cognitive and behavioral processes in responses to stress (e.g., Lazarus & Folkman, 1984). There is little doubt that the experience of pain can be stressful (Stoudemire, 1995). Therefore, models of stress and adaptation may be useful in understanding individual differences in pain reactions and outcomes, as Lazarus and Folkman's framework conceptualizes appraisal and coping strategies as different factors.

Historically, stress has been conceptualized as an event requiring adaptation, such as a significant life change (Holmes & Rahe, 1967), or a response within the person, such as increased blood pressure (Selye, 1956). More recent positions have suggested that stress involves a transaction between environmental events and the individual's responses (Lazarus & Folkman, 1984). More specifically, psychological stress has been defined as the relation between the person and their environment that is appraised as taxing, exceeding their resources, and endangering their well-being (Lazarus & Folkman, 1984).

Following the conceptualization of Lazarus and Folkman (1984) and Jensen et al. (1991), "appraisals" can be defined as collections of cognitions (i.e., thoughts) that an individual may have regarding their pain, whereas coping can be defined as any purposeful effort to reduce, manage, or halt the negative impact of stress. Further, if a particular response to stress is automatic in nature, adaptive or non-adaptive, it is not considered to be a coping response (Lazarus & Folkman, 1984).

In light of this definition of cognitive pain appraisals, Jensen et al. (1991) stated that the catastrophizing subscale of the Coping Strategies Questionnaire (Rosenstiel & Keefe, 1983), a questionnaire designed to assess pain coping strategies in chronic pain, assesses patients' tendency to engage in negative thought or worry in response to pain. This process runs counter to the current definition of coping, which Lazarus & Folkman (1984) describe as a purposeful effort to manage or reduce stress. It appears then, that catastrophizing may be best conceptualized as an appraisal process because it is more of an automatic, irrational thought that likely worsens the pain experience. These appraisals may be more closely related to certain beliefs about pain than to efforts to manage pain (Jensen et al., 1991).

There are different ways in which negative appraisals may affect pain. First, negative appraisals that exaggerate or overemphasize the personal threat of a situation, or lead to a perception of inability to control the outcome of that situation, are thought to be positively associated with heightened levels of emotional distress (e.g., Jensen et al., 1991; Turk & Rudy, 1992). This position is consistent with several prominent cognitive theories of emotional regulation, in which negative appraisals of life events are thought to bring about distress reactions (e.g., Beck, 1967; Lazarus & Folkman, 1984). Secondly, negative appraisals that emphasize an inability to cope or manage pain have been associated with higher ratings of pain intensity (Jensen et al., 1991; Turk & Rudy, 1992). For example, Turk and Rudy (1992) suggested that negative appraisals such as catastrophizing tend to take precedence over other incoming sensory information, resulting in a higher vigilance or attention that may result in an increased perception of pain. Finally, negative appraisals of situations would likely reduce the effort that an individual directs toward reducing the stressor.

People are more likely to engage in coping attempts if they feel they may have some success in reducing their pain (Lazarus & Folkman, 1984).

Both the clinical and experimental pain literatures have shown that pain catastrophizing is associated with heightened pain and emotional distress in response to pain (e.g., Heyneman et al., 1990; Jensen et al., 1991; Rosenstiel & Keefe, 1983; Spanos et al., 1979; Spanos et al., 1981; Sullivan & D'Eon, 1990; Sullivan et al., 1995). For example, laboratory studies examining cognitive differences in pain have shown that individuals higher in pain catastrophizing rate their pain as more intense and tolerate it for shorter periods (Sullivan et al., 1995). Clinical research on chronic pain also has suggested that pain catastrophizing can have detrimental effects. For example, chronic pain patients higher in pain catastrophizing have been shown to report greater pain intensity, more affective distress, such as depression or anxiety, and greater pain-related disability (Estlander & Harkapaa, 1989; Flor and Turk, 1988; Flor, Behle, & Birbaumer, 1993; Keefe et al., 1989; Keefe et al., 1991). Further, examining the longitudinal relation between catastrophizing and pain in rheumatoid arthritis patients, Keefe, Brown, Wallston, and Caldwell (1989) found that initial pain-related catastrophizing scores of the Coping Strategies Questionnaire (Rosenstiel & Keefe, 1983) were positively associated with pain intensity, physical disability, and depression six months into the future, even after controlling for demographic variables, disability support status, duration of pain, and initial scores on measures of adjustment.

In summary, pain catastrophizing has been broadly defined as an "appraisal" process, wherein individuals exaggerate the threat value of a painful stimulus, and perceive themselves as unable to cope effectively with the pain situation (Jensen et al., 1991; Sullivan et al., 1995). The relation between pain catastrophizing and the experience of pain has been demonstrated consistently with different populations, including experimentally induced pain among healthy individuals, individuals experiencing acute pain, and among those with chronic pain. Catastrophizing has been shown to predict pain intensity in individuals undergoing stressful medical diagnostic procedures (Sullivan et al., 1995), dental procedures (Chaves & Brown, 1978/1987; Sullivan & Neish, 1998), and in individuals suffering from chronic headache (Bedard et al., 1998). Recently, catastrophizing has also been shown to be a significant predictor of pain-related disability following traumatic injury (Sullivan et al., 1998). As suggested by Jensen et al. (1991) the relation between catastrophizing and other internal beliefs with pain must be investigated outside of chronic pain, because pain patients should not be considered representative of the larger population of people experiencing acute or persistent pain problems, such as the pain found in athletic injury.

Research has suggested that pain is a central feature of sport-related injury and rehabilitation from these injuries (e.g., Heil, 1993). Further, empirical investigation of individual difference factors in pain perception of athletic individuals has been identified as an important subject matter (e.g., Taylor &

Taylor, 1998). In both clinical and experimental pain research; catastrophizing has been a consistent predictor of pain intensity and measures of disability (e.g., Sullivan et al., 1995; Sullivan et al., 1998). As emphasized in reviews of the sport-injury (Bartholemew et al., 1998) and pain literatures (Jensen et al., 1991), the need to investigate pain perception in athletic individuals is both warranted and timely. The three studies in the present research were designed to examine the psychometric and ecological validity of pain catastrophizing (as assessed by the Pain Catastrophizing Scale; Sullivan et al., 1995) in athletic individuals.

Study 1

Pain is a central feature of involvement in sport activity. In practice and competition, pain may result from exertion or contact, and pain may also result from injuries sustained during sporting activity (Bartholomew et al., 1998; Brewer, Van Raalte & Linder, 1990; Nixon, 1993; Pen & Fisher, 1994; Taylor & Taylor, 1998). In non-athletic populations, it has been repeatedly shown that individuals who catastrophize in response to painful stimulation experience higher levels of pain and disability than those who do not (e.g., Sullivan et al., 1995; Sullivan et al., 1998).

There has been increasing speculation that catastrophizing may be a significant predictor of pain perception in athletes, in part promoted by Udry, Gould, Bridges and Beck's (1997) qualitative examination of responses to injury among elite skiers. They suggested that negative or catastrophic thoughts were common reactions to injury and that a significant proportion of injured skiers experienced excessively negative injury-related thoughts such as "I will never ski again", and "my career is over". Meyers et al. (1992) also suggested that catastrophizing may play a role in athletes' responses to pain incurred through sporting activities, and that catastrophizing and avoidance may represent cognitive factors that should be the target of interventions by sport psychologists.

It is plausible that a reliable assessment tool of pain catastrophizing, such as the Pain Catastrophizing Scale (Sullivan et al., 1995), may have specific utility in helping researchers illustrate the role of catastrophizing in pain perception in athletic individuals. However, the use of the PCS must be preceded by an examination of the factorial stability and psychometric properties of the measure with this population. To date, the PCS has been shown to yield three separate, but positively correlated factors that appear to assess Rumination, Magnification, and Helplessness. Further, the PCS has been examined from exploratory factor analytic approaches based on principal components analyses (e.g., Sullivan et al., 1995; Osman et al., 1997), showing a reasonably similar factor structure in asymptomatic and clinical pain samples. However, there is no evidence that the PCS will assess catastrophizing in a similar fashion within an athletic population.

Clinical research depends on the use of valid and reliable measures to evaluate treatment effects. However, the areas of clinical assessment and research are rife with measures that have little or no construct validity or reliability (see Morris, Bergan, & Fulginiti, 1991). Issues of measurement validity are especially important when assessment tools are used with populations before population-specific psychometric properties have been established. In these cases, the factorial and scale measurement properties must remain stable across groups to aid in unconfounded interpretations of the meaning of the relations between variables of interest (Pentz & Chou, 1994).

It is important to examine the cross-population factor performance of the PCS in order to have confidence that the items are truly expressing the subscale structure and that the subscale structure is truly expressing the factorial structure established in prior pain research. If such equivalence or similarity can be shown for the PCS in athletic and a non-athletic asymptomatic pain samples, it would provide an important link that catastrophizing, as assessed by the PCS, has similar relations to pain as shown in previous research (e.g., Sullivan et al., 1995). The comparison of the PCS between a non-athletic and athletic sample is important for research hoping to use the PCS as a measure of pain catastrophizing, because tests for evidence of multigroup invariance allows researchers to determine whether the items comprising a particular measure operate equivalently across different populations (Byrne, 1993). The present study is particularly interested in examining whether or not the multidimensional facets of catastrophizing, as measured by the PCS, function in a similar manner across populations. It was hypothesized that the three-factor solution of the

PCS would be replicated when compared across non-athletic and athletic populations.

Method

Participants.

Introductory psychology students at Dalhousie University (n=237; 81 men) volunteered to complete the PCS and a sport and activity questionnaire at the end of classes. The mean age of the participants was 19.4 years (SD=3.6). Individuals who reported engaging in sport-related activities once or less per week comprised the "non-athletic" group (40 men; 100 women; M age = 19.9, SD = 4.2). Individuals who reported engaging in competitive sport-related activities (e.g., swimming, basketball, soccer, track & field, football, rugby, hockey, baseball, volleyball, tennis, cycling) 5 times or more per week comprised the "athletic" group (41 men, 56 women; M age = 18.7 years, SD = 2.19) (see Blair & Morrow, 1998). Respondents who reported engaging in physical activities such as aerobics, walking, or home exercise, which are typically not associated with competition, were not included in the athletic group.

Measures.

Pain Catastrophizing.

The Pain Catastrophizing Scale instructions ask the respondents to reflect upon past painful experiences and to rate the degree to which they experienced each of the thoughts or feelings, which comprise the item pool. Each item is rated in reference to being in pain on a 5-point scale from 0 (not at all) to 4 (all the time) (see Appendix A). An example of an item representing each of the subscales follows: Rumination - "I can't seem to keep it out of my mind", Magnification - "I think of other painful experiences", Helplessness - "I feel I can't go on". Examining the factor structure of the PCS in a sample of 438 university students, Rumination, Magnification, and Helplessness, respectively accounted for 41%, 10%, and 8% of the variance (Sullivan et al., 1995). There were moderate correlations between the subscales and internal consistencies were reported from .60 to .87, with an overall reliability of .87. Test-retest reliability across a 6-week period was high (r=.75).

In a series of studies using the PCS (Sullivan et al., 1995), its validity and predictive ability in reference to greater pain responses have been highlighted. For example, construct validity was examined by comparing participants' responses on the PCS to their responses during an interview that examined catastrophizing content based on the procedure used by Spanos et al. (1979). Results showed high scores on the PCS to be associated with greater catastrophic thinking during painful stimulation as collected by interview responses. Similar results have been reported in a clinical sample undergoing a painful electrodiagnostic procedure (Sullivan et al., 1995). The PCS takes approximately 5-10 minutes to complete.

Sport/Activity Questionnaire.

The sport/activity questionnaire was developed for this study. This survey asked participants to report the frequency with which they typically engage in sport-related activities (e.g., "on average, how many times a week do you engage in sport-related activity", see Appendix B). Participants responded by choosing one of the following options: "not at all", "once per week", "twice per week", "three times per week", "four times per week", "five or more times per week". Participants were then asked to list the different sport-related activities in which they participate.

Procedure.

Participants were asked to complete the PCS and a sports activity questionnaire at the end of class in exchange for a class credit point. The measures were fully explained to the class by the researcher and the risks and benefits of the research, rights of research participants, and issues of confidentiality were discussed. Following this consent process, those not interested in completing the measures were excused. The remaining survey respondents completed the measures in class as a group.

Data Analyses.

Prior to conducting the data analyses, measures were examined for missing values. Data were analyzed in two stages using the "EQS" program of structural model equations (Bentler, 1989). In the first stage, the three-factor structure for the PCS proposed by Sullivan, Bishop and Pivik (1995) was examined separately for goodness-of-fit in the athletic and non-athletic groups. Once the baseline models for each group were satisfactorily produced, measurement models and factorial stability were examined. In these analyses, equality constraints were imposed on only those parameters similarly specified for both groups as suggested by Byrne, Shavelson, & Muthen (1989).

The most important aspect of Confirmatory Factor Analysis (CFA) is how well the proposed model fits the observed data (Byrne, Baron, & Campbell, 1993). Although the standard χ^2 statistics are reported with each model, in order to control for non-normality, evaluation of model fit was based primarily on the Sattora-Bentler scaled Chi square statistic (S-Bχ^2; Sattorra & Bentler, 1988) using a maximum likelihood estimation method. The S-Bχ^2 more closely approximates χ^2 than the usual test statistic (Hu, Bentler, & Kano, 1992). Additionally, other fit indices are reported including the Normed Fit Index (NFI; Bentler & Bonnet, 1980), Comparative Fit Index (CFI; Bentler, 1990a), Robust Comparative Fit Index (RCFI; Byrne, 1994), and the Incremental Fit Index (IFI; Bollen, 1989). Values for these fit indices range from zero to 1.00 and are derived from comparison of the hypothesized model with a null model. Each fit index may be described as a measure of the covariation between the data and the hypothesized model, where values equal to or greater than .90 indicate an acceptable fit of the proposed model to the observed data (Bentler, 1992b). Finally, the Lagrange Multipler Test (LM test; Byrne, 1994) accomplished determination of misfit amongst the model parameters. The LM test assesses the specified parameters of the model both univariately and multivariately to identify parameters that would contribute to a significant drop in χ^2 if they were to be freely estimated within subsequent nested models.

Results

There have been several general criticisms on the use of exploratory factor analysis (e.g., Bollen, 1989) and the use of principal components analyses in particular (Gorsuch, 1990). Therefore the present research sought to use another method of validating the factor structure of an assessment instrument. Confirmatory factor analysis (CFA) procedures are widely accepted as providing a powerful statistical test of factorial validity and recent software has been developed that allows for the simultaneous test of factorial validity across groups (e.g., EQS; Bentler, 1989). All models and analyses in the present study were based on CFA procedures within the framework of covariance structure modeling.

Baseline Models.

As shown in Table 1-1, for the athletic sample, the Sullivan et al. (1995) three-factor model (see Figure 1-1) represented a significant improvement compared to the null model and according to most fit indices, a reasonable fit to the data (i.e., indices $\geq$.90). However, examination of the fit indices (i.e., Normed Fit Index) and Lagrange Multipler test indicated that model fit could be significantly improved by allowing the error terms for items 2 (E2) and 3 (E3) to correlate. Model 2, which was a significantly improved model compared to Model 1, could be further improved according to the NFI index and the LM test statistics by allowing the error terms for items 11 (E11) and 10 (E10) to correlate. The resulting Model 3 was a significant improvement compared to Model 2.

With fit indices approaching .90 or greater and the LM test statistics indicating no clear model respecifications, Model 3 was considered optimal in representing the PCS for the athletic sample.

Insert Figure 1-1 about here

For the non-athletic group, the Sullivan, Bishop and Pivik (1995) three factor model was a significant improvement over the null model but fit indices (i.e., NFI; CFI) and the LM test indicated that the model could be substantially improved by allowing various error terms to correlate. Model 2 was specified with error terms (E1,E3)(E2,E3) and (E9,E10) allowed to correlate. Model 2 was a significant improvement over Model 1 and produced a satisfactory value on the CFI index. As indicated by the NFI and the LM test statistics, correlating error terms (E1, E2) would advance an improved model. Model 3 improved upon the NFI index and was a significant model compared to Model 2 but the LM test and NFI index approaching .90 indicated room for improvement. Therefore, Model 4, which correlated error terms (E8, E10) and was a significantly improved model with excellent fit indices, represented the best fitting model to the data and was considered optimal for the non-athletic group.

Insert Table 1-1 about here

The standardized parameters for the optimized models for the athletic and non-athletic samples are shown in Figure 2-1. These standardized models are scaled to have a variance of 1.00 and a mean of 0. All the specified relations among the variables, including the correlated error terms, were significant. It is important to note that the correlated error terms do not undermine the factorial validity of these models. Indeed, they are considered to provide a more realistic factorial representation of the observed data under such circumstances (Bentler & Chou, 1987).

Insert Figure 2-1 about here

Determination of Factorial Stability.

On the basis of the models shown in Figure 2-1, it is tempting to conclude that the PCS is factorially stable across the athletic and non-athletic groups. However, as Byrne, Baron and Campbell (1993) warned, this conclusion would be statistically unjustified because models that appear similar do not guarantee the equivalence of item measurement or theoretical factor structure. It has been argued that the factorial stability of a measure is best demonstrated using a statistical approach that considers simultaneous data from all groups considered (Bentler, 1989; Byrne, 1994). Such a method of model comparison involves specifying an analysis in which parameters are constrained to be equal in both groups, and then comparing the χ^2 values of these models to a less restrictive model (i.e., where the models are not constrained to be equal in each group).

Testing for instrument stability involved the testing of two increasingly restrictive models related to the cross group assessment of item measurement and factor structure of the PCS. As outlined in Byrne (1994), this method of model comparison involves specifying an analysis in which constraints of similar parameters are imposed across the groups, and then comparing the χ^2 values to a less restrictive model (i.e., one where the constrained parameters are free to be estimated). As with the baseline analyses, the change in χ^2 between the nested models provides the basis for justifying the equivalency of the constraints, where a significant change in χ^2 represents non-invariance or different models. In testing for invariance, EQS evaluates the goodness of model fit relative to the entire model, which may comprise the two baseline models with the equality constraints between them (i.e., NFI, CFI, IFI). The program also produces a LM test for each constraint to examine their validity; if the probability values are greater than .05 the hypothesized equality constraints are invariant.

As shown in Table 2-1, the baseline multi-group model (Model 1), tests for the adequacy of model fit in a simultaneous analysis of multi-group data and provides the criterion to which other models may be compared. Model 1 ($\chi^2_{(116)}$ = 139.99) produced satisfactory to excellent fit indices (NFI, CFI, IFI) and was considered appropriate. Two additional models were examined; in Model 2 ($\chi^2_{(125)}$ = 146.37) the PCS item loadings were constrained across groups, and in

Model 3 ($\chi^2_{(132)}$ = 152.90) the item variances and covariances were constrained across groups. Tests of both models yielded satisfactory to excellent fit indices.

Insert Table 2-1 about here

Reliability Indices.

Alpha coefficients (Cronbach, 1951) were computed for the different subscales of the Pain Catastrophizing Scale in both the athletic and non-athletic groups. For the non-athletic group, the alpha coefficients for the Rumination, Magnification and Helplessness subscales were .84, .54, and .79, respectively. For the athletic group, the alpha coefficients for the Rumination, Magnification and Helplessness subscales were, .89, .65, and .84, respectively. Alpha coefficients for the total PCS were .84 for the non-athletic group, and .87 for the athletic group. It is noted that the Magnification scale falls below what is commonly considered adequate internal consistency in both groups.

Discussion

The results showed that the factor structure of the Pain Catastrophizing Scale in an athletic sample is statistically comparable to the structure that has previously been reported in non-athletic and clinical pain samples (Osman et al., 1997; Sullivan et al., 1995). For both athletic and non-athletic individuals, pain catastrophizing appears to consist of three related dimensions. These dimensions reflect a tendency to focus excessively on pain sensations (i.e., Rumination), to magnify the threat value of the pain stimulus (i.e., Magnification), and to perceive one as unable to control the intensity of the pain (i.e., Helplessness). Reliability analyses showed that the different subscales of the PCS had adequate internal consistency for both athletic and non-athletic samples. These findings suggest that the PCS is a reliable measure of pain catastrophizing in athletic individuals and that athletic individuals respond to items in a manner similar to non-athletic and other samples.

Study 2

Although previous reports have pointed to the important role of catastrophizing in athletes' responses to pain (e.g., Meyers et al., 1992), the relation between catastrophizing and response to a painful stimulus has not yet been addressed empirically in an athletic sample. Examination of this relation was the primary focus of Study 2.

Anecdotal, empirical, and clinical reports have all suggested that athletes differ markedly in their responses to pain (Ryan & Kovacic, 1966) and their recovery from significant injury (Bartholomew et al., 1998). Further, a number of investigators have suggested that the manner in which athletes appraise situations associated with pain and injury will affect their distress responses and their rate of recovery (Andersen & Williams, 1993; Brewer, 1994). Brewer (1994) has indicated that theoretical approaches that maximize attention to individual differences in coping with athletic injury are essential for the development of interventions that will facilitate return to sporting activity.

There is a substantive empirical literature showing that pain catastrophizing is associated with greater pain, disability, and emotional distress (i.e., anxiety and depression) in various populations. However, despite this compelling evidence, it is possible that pain catastrophizing may not be a significant factor in the pain experience of athletic individuals. For example, athletic participants tend to have higher pain thresholds than non-athletic persons (Ryan & Kovacic, 1966; Scott & Gijsbers, 1981). There are also indications that the culture of athletic involvement may contribute to a different psychology of pain perception. There are several accounts where high levels of pain threshold are viewed positively and even rewarded in athletic activity and expressions of pain and distress are viewed as undesirable (Pen & Fisher, 1994; Udry et al., 1997). Thus, athletes may not engage in pain catastrophizing to the same degree as non-athletic individuals.

Demonstrating a relation between catastrophizing and pain in athletes may have several important implications. For example, because it is suggested that catastrophizing is a stable individual differences variable (e.g., Sullivan et al., 1995), it may be possible to provide interventions targeting catastrophizing in an attempt to minimize its adverse impact on pain, even before injury occurs. From a sports performance perspective, athletic people who catastrophize may over-react to the pain and discomfort associated with strenuous activity, and consequently fail to adhere to training regimes. Finally, from a recovery perspective, athletes who report greater catastrophizing may be more likely to manifest slower recoveries or return to sport following injury.

The primary aim of Study 2 was to examine the utility of the PCS in predicting pain responses of athletes participating in an experimental pain procedure. The design of Study 2 allowed for replication of previous findings showing that athletes report less pain than non-athletes, and examined the value of the PCS in predicting the pain responses of athletes. Fifty-four varsity athletes and 54 non-athletic controls were recruited to participate in reward for course credit. All participants completed the PCS and then underwent a cold-water immersion task (i.e., the cold pressor task) for a period of one minute, providing verbal ratings.

The cold pressor task is a classical experimental paradigm of pain perception in which participants immerse the forearm, up to the elbow, into a bath of cold water (e.g., Hilgard et al., 1974; Wolf, 1994; Gracely, 1994; Harris & Rollman, 1983). Several subjective measures of the pain resulting from the cold pressor task are possible. Threshold is typically defined by the point at which pain sensations first become noticed by the participant and is usually assessed by determining the amount of time that elapses between immersion and the point at which the person first notices pain. Tolerance is another subjective reaction to pain usually defined as the point when the participant terminates the immersion because he or she can no longer tolerate the sensations from cold water (Wolf, 1994). It is usually measured by determining the amount of time between the point of immersion and the point of withdrawal from the water. Self-reported pain intensity can also be assessed using a variety of methods including a visual analogue or numerical rating scale. The cold pressor paradigm was initially developed for use with adults. Water temperature is usually maintained between 1°C and 4°C, but other temperature levels, such as 0°C, 5°C, and 10°C have also been used (e.g., Hilgard et al., 1974).

Consistent with previous research, athletes were expected to report less intense pain than non-athletes (Ryan & Kovacic, 1966; Scott & Gijsbers, 1981). For Study 2, the following predictions were made: 1) sports participants will report less pain than non-athletic individuals; 2) pain catastrophizing will be a significant determinant of pain in both the athletic and non-athletic samples; and 3) catastrophizing will mediate group (athletic & non-athletic) differences in pain perception (i.e., intensity).

Method

Participants.

Fifty-four varsity athletes (26 men) and 54 non-athletic (27 men) controls participated in the research. Varsity athletes were identified from a general screening session of all Introductory Psychology students during the first week of class. In order to maintain equal gender distribution, the athlete group consisted of individuals who played on university basketball or rugby teams. Participants in the non-athletic group consisted of individuals who were not members of any university sport team, and who did not participate in any regular sporting activities (< 1 time per week). Participants ranged in age from 19 to 24 years (M = 21.2; SD = 4.3). Course credit was awarded for participation. Individuals who were suffering from a medical condition associated with persistent pain such as migraine headache or back pain, or from other conditions that may be adversely affected by the pain procedure (e.g., cardiovascular problems, previous experience of frostbite) were not considered for participation.

Apparatus.

A cold pressor apparatus was used to induce pain. The apparatus consisted of an insulated container, measuring 30 cm X 40 cm X 30 cm, divided into two compartments, which were separated by a wire mesh. The entire container was filled with water, and one compartment was filled with ice. The other compartment was equipped with a moveable armrest used to immerse a participant's arm in the ice water. Water temperature was maintained at 2-4°C. The water was circulated within the container by a pump affixed to the outside wall of the tank.

Measures.

Pain Catastrophizing.

The Pain Catastrophizing Scale (PCS; Sullivan et al., 1995) was used as a self-report measure of catastrophic thinking associated with pain. Properties of the PCS are described in greater detail in Study 1.

Pain.

An 11-point likert-type rating scale was positioned on the wall directly in front of the participants. Participants gave verbal reports of their current pain by choosing numbers between 0 "No Pain" and 10 "Worst Pain Ever".

Procedure.

Participants were told that the study was concerned with the relation between thoughts and physical discomfort. Participants were not aware that they had been selected on the basis of their involvement in sporting activities. In collecting informed consent of participants (see Appendix C), they were assured that the procedure would not result in physical injury and that they could withdraw from the study at any time or remove their arm from the water at any time. There were no cases of participant withdrawal. All participants received course credit for participation.

Prior to the cold pressor task, participants completed the PCS and provided their age and gender. To regulate arm temperature, participants immersed their dominant arm in a container of room temperature water for 5 minutes. Pain experience during the arm regulation period was collected to examine pre-cold pressor water adaptation. Participants were then instructed to place their arm on the moveable armrest of the cold pressor apparatus, to lower their arm into the ice water, and to keep their arm immersed for a period of one minute. They were instructed, by a voice on a tape recording, to provide verbal ratings of their current level of pain at the 30-second and one-minute interval during the water immersion. Given the high correlation between the two pain reports (r = .86), the two scores were averaged to yield a single index of pain intensity. At the end of one minute, participants were signaled to remove their arm from the ice water. Following the ice water immersion participants were debriefed (see Appendix D).

Data Analyses.

Prior to conducting data analyses, all measures were examined for accuracy of data entry, missing values, and fit between their distributions and the assumptions of multivariate analysis. Assumptions of normality were examined across all continuous data by examining measures of skewness, kurtosis, and probability plots. Analyses revealed approximate normality values for all variables.

Data analyses were conducted in several steps designed to examine particular hypotheses. The first set of analyses was designed to examine differences in pain ratings across group membership. A two-way Analysis of Covariance (ANCOVA) with group (athletic, non-athletic) and gender (male, female) as between-groups factors was used to examine group differences and possible gender interactions for pain. Pain ratings provided during the room temperature water immersion were used as a covariate to control for pre-cold pressor immersion experience. In the second step of analyses, a two-way (group X gender) Analysis of Variance (ANOVA) was employed to examine differences in pain catastrophizing between groups. The third set of analyses used correlations to examine the relations among pain, pain catastrophizing, and group membership (athletic or non-athletic). The fourth set of analyses used multiple regressions to address issues of mediation between pain catastrophizing and pain for groups (athletic vs. non-athletic). Regression analyses were also computed to address the possible role of catastrophizing in mediating gender differences in pain.

Results

Pain Ratings.

Pain ratings were analyzed by a two-way Analysis of Covariance (ANCOVA) with group (athletic, non-athletic) and gender (male, female), with pain ratings provided during the room temperature water immersion used as a covariate. Analysis of covariance (ANCOVA) revealed significant main effects for group, F (1, 103) = 17.3, $p < .001$, and gender, F (1, 103) = 3.8, $p < .05$. Athletes reported significantly less pain (M = 5.7, SD = 1.6) than non-athletic individuals (M = 7.0, SD = 1.7). Men reported significantly less pain (M = 6.1, SD = 1.7) than women (M = 6.8, SD = 1.7). The group by gender interaction was not significant, F (1, 103) = .25, ns.

Pain Catastrophizing.

A two-way (group X gender) Analysis of Variance (ANOVA) was conducted on the total score for the PCS. Results revealed a marginally significant effect for group, F (1, 104) = 3.5, $p < .06$, and a significant main effect for gender, F (1, 104) = 5.9, $p < .01$. The group by gender interaction was not significant, F (1, 104) = .05, ns. Men (M = 16.6, SD = 7.7) obtained lower PCS scores than women (M = 20.5, SD = 8.9), and athletic persons (M = 17.1, SD = 7.3) obtained lower PCS scores than non-athletes (M = 21.7, SD = 8.5). Follow-up analyses revealed that athletes scored lower than non-athletes on the Rumination, t (106) = 1.9, $p < .05$, and Helplessness, t (106) = 2.1, $p < .05$, subscales of the PCS. Similarly, men scored lower than women on the Rumination, t (106) = 3.1, $p < .01$, and Helplessness, t (106) = 3.5, $p < .01$, subscales of the PCS. There were no significant group or gender effects for the Magnification subscale of the PCS.

Catastrophizing and Pain Perception.

Correlational analyses are presented in Table 1-2. Consistent with previous research (Sullivan et al., 1995), the total PCS score was significantly correlated with pain ratings in the non-athletic sample (r = .43, $p < .01$). The PCS total score also correlated significantly with pain ratings in the athletic sample (r = .30, $p < .05$). The difference between these two correlations was not significant (z = .76, ns). The pattern of inter-correlations among PCS subscales was similar for athletic and non-athletic samples. For both athletic and non-athletic samples, the Rumination and Helplessness subscales were highly correlated (r = .68 to .95), and were significantly correlated with pain (r = .27 to .39). The Magnification subscale showed a weaker relation to the other subscales (r = .27 to .54), and for the athletic sample, Magnification was not significantly correlated with pain.

Insert Table 1-2 about here

Mediational Analysis.

Baron and Kenny (1986) suggested using three regression equations to test mediational hypotheses. In the first regression equation, the objective is to regress the mediator (catastrophizing) on the independent variable (group). The second regression equation is designed to regress the dependent variable (pain) on the independent variable (group). The final regression equation is designed to regress the dependent variable (pain) on both the independent variable (group) and the mediator (catastrophizing). It is argued that if the contribution of the independent variable is significantly reduced when the mediator is controlled, a mediational hypothesis is supported. For all regressions, gender and room temperature pain ratings were used as control variables in the first step of the analyses to account for pre-cold pressor differences.

The results of the first regression revealed that group was a significant predictor of catastrophizing scores, over and above the variance accounted for by gender and room temperature water pain ratings (R^2 change = .03, F change = 3.63, $p < .05$). A second regression revealed that group (Beta = -.36, $p < .001$) was a significant predictor of pain intensity (R^2 change = .13, F change = 17.6, $p < .001$). When group and catastrophizing were entered simultaneously as independent variables, both catastrophizing (Beta = .33, $p < .001$) and group

(Beta = -.31, $p < .001$) contributed significantly to the prediction of pain.

Regression analyses were also computed to address the role of catastrophizing in mediating gender differences in pain. The results of the first regression revealed that gender was a significant predictor of level of catastrophizing, over and above the variance accounted for by group and room temperature water pain ratings (R^2 change = .05, F change = 5.8, $p < .01$). A second regression revealed that gender (Beta = .16, $p < .06$) was not a significant predictor of pain intensity (R^2 change = .03, F change = 3.6, $p < .06$). When gender and catastrophizing were entered simultaneously, catastrophizing remained a significant predictor of pain intensity (Beta = .33, $p < .001$), but the contribution of gender was reduced (Beta = .08, $p < .29$).

Discussion

The results of the present study are consistent with previous research showing that athletic individuals report less intense pain than non-athletic individuals in response to an experimental pain procedure (Ryan & Kovacic, 1966; Scott & Gijsbers, 1981). The results of the present study also replicate previous findings showing that men report less intense pain than women (Sullivan, Tripp & Santor, 2000; Sullivan, Stanish, Sullivan, & Tripp, in press; Unruh, 1996). The present findings extend previous research in showing that catastrophizing is a significant predictor of pain in a sample of athletic individuals. Catastrophizing, however, did not mediate the differences in pain ratings between athletic and non-athletic individuals or between genders. Thus, although the results of the present study indicate that in athletic individuals, catastrophizing is an important correlate of pain perception, this study does not detail the factors that contribute to differences in pain perception between athletic and non-athletic individuals.

In previous research, the three subscales of the PCS have contributed approximately equal variance to the prediction of pain intensity (Sullivan et al., 1998). In the athletic sample, Magnification was not significantly correlated with pain ratings. The absence of a significant correlation between Magnification and pain may be due to the nature of the pain stimulus. Although cold pressor pain procedures can give rise to the experience of intense acute pain for some, the procedure is essentially innocuous for many. Indeed, participants are aware (i.e., reassured) that no injury will result from the pain experience. For the athletic sample, the use of ice water may have been a particularly non-threatening stimulus because ice is frequently used to alleviate pain and inflammation following sport injury or competition. Indeed, Pen and Fisher (1994) have argued that cold pressor pain inductions may not yield appropriate ecological validity for athletic individuals. Therefore, it is speculated that a more threatening pain stimulus, and one which would not hold therapeutic associations for athletic individuals, would have produced a more robust relation between Magnification and pain.

The present research has proceeded from assumptions that the level of competitive involvement (recreational versus varsity) and that the type of sport involvement (basketball versus track and field) are not central distinctions concerning the psychology of pain perception. Although these assumptions cannot be tested in a compelling fashion with the present data set, the pattern of findings suggests that the differences in samples may not have a substantive impact on the interpretation of the results. First, Study 1 showed that the factor structure of the PCS did not differ between athletic and non-athletic samples, suggesting that the PCS behaved similarly across the different sport categories contained within the athletic sample. In addition, the pattern of inter-correlations among the PCS subscales in Study 2 was similar for the athletic and non-athletic samples. Thus, although there are many important sport-specific distinctions that need to be considered in understanding the psychology of sport, these distinctions may not be crucial to understanding the psychology of pain in sport as suggested by the current data. Confidence in such a perspective however, must await further empirical examination.

The data of Study 2 indicate that athletes who have a tendency to engage in catastrophic ideation about pain will experience more pain than will athletes who do not catastrophize. The Helplessness subscale of the PCS showed the strongest relation to cold pressor induced pain in athletes. In other words, athletes who endorsed statements such as "There is nothing I can do to reduce the intensity of the pain "and" It's awful and I feel that it overwhelms me, were particularly likely to report higher levels of pain from a cold pressor immersion. The relationship between Helplessness and pain in Study 2 may have implications for rehabilitation outcomes. For example, athletes who have thoughts about their inability to control pain, and their feelings of being overwhelmed by pain, may also be the athletes who experience difficulty tolerating the rigor or pain of rehabilitation. Thus, it would be of interest to examine more directly whether athletes' scores on the Helplessness subscale of the PCS predict their progress or rate of functional recovery following sport injury, recovery, and rehabilitation.

Study 3

Studies 1 and 2 join a growing body of literature demonstrating that catastrophizing contributes to heightened pain. Further, Study 2 has shown that for athletic individuals the Helplessness component of pain catastrophizing was significantly associated with pain experience in a cold pressor pain paradigm. Thus, among the athletic sample examined, certain persons were likely to perceive themselves as unable to control or decrease their degree of distress associated with pain. It is not unreasonable to suggest that such individuals may be likely to report greater pain intensity following significant sport injury or rehabilitation.

Pen and Fisher (1994) have argued that experimental pain paradigms (i.e., the cold pressor procedure) may not provide an adequate test of the relation between psychological factors and pain experience in athletic individuals. Experimental pain procedures allow for the standardization of a pain stimulus and cold pressor procedures have been advocated as the closest laboratory approximation to clinical pain (Turk & Meichenbaum, 1984). However, experimental control may be gained at the high price of ecological validity.

While athletes may typically experience painful stimulation less intensely than sedentary individuals (e.g., Study 2), the potential consequences of sport-related injury to the athletic individual would have greater negative impact. For the sedentary individual, the pain of a knee injury may have either psychological or functional impact, but for the athletic person it may also signal the termination of competitive activities. As suggested by Danish (1986), sport injuries are particularly stressful for athletes because not only is their physical well being threatened but also their self-concept, belief systems, social network, and overall emotional equilibrium.

Injuries occur with high frequency in sports. One of the more prevalent and debilitating injuries associated with sports participation is an acute tearing of the anterior cruciate ligament (ACL) of the knee (Daniel et al., 1994; Noyes et al., 1983; Roos et al., 1995). The ACL is a critical ligament in providing stability to the knee joint (see Muller, 1983) and for young or old athletes alike, wishing to remain active into the future, ACL reconstructive surgery and its arduous rehabilitation is considered the treatment of choice (Marzo & Warren, 1991). The ACL is the principal ligamentous restraint to the anterior tibiofemoral displacement in the knee (i.e., the shinbone moving forward in comparison to the thighbone)(Butler, Noyes, & Grood, 1980). ACL injuries are primarily associated with sports that require sudden and strenuous jumping, cutting, or pivoting movements such as football, hockey, soccer, and baseball (Humphrey, 1992). Injuries to the ACL may range from partial tears to complete ruptures, resulting in varying degrees of knee joint instability. A rupture of the ACL is universally recognized as severe and is referenced as a Grade III injury (Harter et al., 1988; Humphrey, 1992).

As reported by Wroble and Brand (1990), the frequency of the ACL injury in athletic persons has dramatically increased and the cardinal symptom of ACL pathology is knee joint instability. Knee joint instability is a significant concern because unrestricted bone movement in the knee joint can lead to collateral damage to structures of the knee like the menisci (i.e., knee cartilage), and may lead to the development of arthritis if left untreated (Humphrey, 1992). ACL-related knee instability may lead to significant disability in activities such as running, squatting down, or walking up stairs (Harter et al., 1988). An ACL injury in the athletic individual can have a devastating effect upon his or her ability to perform at either competitive sports or recreational activities. Anecdotally, ACL patients have succinctly described their knee function as follows, "... at times my knee feels like it is about to fall apart" (Personal communication, basketball player).

As shown in Figure 1-3, the ACL is a broad ligament joining the anterior tibial plateau to the posterior femoral intercondylar notch. The tibial attachment is in front of and to the side of the anterior tibial spine. The femoral attachment is high on the posterior aspect of the lateral wall of the intercondylar notch (Cross, 1998). The ACL is composed of multiple non-parallel bundles of fibers (i.e., anteromedial, posterolateral, intermediate). These bundles of fibers provide support throughout the range of knee motion (Cross, 1998). The biomechanical function of the ACL has been summarized in four main stabilizing functions. The first function is that the ACL restrains anterior motion of the tibia. Secondly, it prevents hyperextension of the knee. The ACL acts as a stabilizer that supports the medial collateral ligament of the knee. The ACL also controls rotation of the tibia on the femur in femoral extensions of 0-30 degrees (Cross, 1998).

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Insert Figure 1-3 about here

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For individuals wishing to return to an active sporting lifestyle, reconstruction of the ACL is required to regain knee stability. If a torn ACL is treated without surgery, using physical rehabilitation alone, research indicates there is a 60% chance that athletes who continue to play sports involving jumping or pivoting will eventually experience another episode of the knee giving out (Noyes et al., 1980). Further, multiple episodes of the knee giving out can lead to greater collateral damage of the menisci in the knee joint, the eventual development of arthritis, or pronounced long-term functional disability (Daniel et al., 1994; Fetto & Marshall, 1980). The "gold standard" among the ACL reconstructive surgery options involves harvesting a tissue and bone graft of the middle 1/3 of the patellar tendon (see Figure 2-3). This patella graft is then used to replace the ruptured ACL in a procedure referred to as a bone-patellar tendon-bone graft (Bessette & Hunter, 1990; DeMaio, Noyes, & Mangine, 1992) (see Figure 3-3). These grafts are commonly drawn from one's own body (i.e., autograft) but may be drawn from cadavers (i.e., allograft).

Insert Figure 2-3 & Figure 3-3 about here

Recovery from ACL reconstructive surgery requires abstinence from sport-related activity and requires extensive physiotherapy of approximately 6 months. The usual time of return to competitive sporting activity is reported to vary with estimates ranging from 5 to 12 months (Rees, 1994). As indicated by Rees (1994) there is considerable disagreement in the sports medicine literature as to when the typical individual with ACL reconstruction returns to sporting activity. Although the ACL-reconstructed individual can be restricted from competitive sporting activity for up to 12 months, others suggest a return to sport in 6-8 months (Blair & Willis, 1991). Further, others claim that individual difference factors may mean that a full rehabilitation and return to sporting activity levels may range from 6-18 months (Howe, Johnson, & Kaplan, 1991). Regardless of the source then, research shows that individuals who experience surgical reconstruction of their ACL can expect several months of challenging rehabilitation.

It is well documented that hospital patients admitted for surgery often find themselves in a personally threatening situation (Stoudemire, 1995). In particular, the anticipation of harm during surgery and the anticipation of pain and disability postoperatively may give rise to a variety of negative thoughts or feelings. Although hospital personnel may consider some surgeries minor procedures, surgery is almost always experienced as a major distressing experience for the patient (Long, Gowin & Bushlong, 1983). Patients admitted to hospital abruptly enter a highly regimented, technological system where they have little experience, and little control over their care. As suggested by Stoudemire (1995), when the average patient has such experiences, emotional responses of distress such as feelings of fear or helplessness often follow.

Medical workers note that the psychological stress of surgery may vary depending on factors such as preoperative psychological characteristics, type of surgical procedures involved, overall prognosis, and especially feelings that events are out of one's control (e.g., Cohen & Lazarus, 1973; Salmon, 1992). Despite the stressful milieu of surgery, many patients can be expected to do quite well with respect to overall recovery. However, not all patients can be expected to have uncomplicated recovery periods especially with respect to pain and disability during recovery (Stoudemire, 1995).

ACL reconstruction using a bone-patellar tendon-bone autograft leads to significant postoperative pain. Research indicates that pain intensity in the first two or three days after the operation is significant but that it gradually decreases over the following weeks (e.g., Hoher et al., 1997; Matheny, Hanks & Rung, 1993). Recent data has shown that 24-hour postoperative pain measures assessed while resting may reach an average score of 6/10, and pain while moving may reach an average score of 7/10. Pain while resting at 48-hours postoperative may reach an average score of 5/10 and pain while moving a score of 5.5/10 (Hoher et al., 1997). In considering these data, it is important to note that these patients were not restricted from post-operative pain medication usage.

In addition to the issues of pain and loss of control facing the athletic individual having ACL reconstruction, post-injury affective distress must be considered. Indeed, several researchers have suggested that from 5-13% of athletes report clinically significant levels of psychological distress, including feelings of separation and loneliness, following sport-related injury (e.g., Brewer, Linder, & Phelps, 1995; Smith et al., 1990). These data may have important implications for recovery from ACL reconstruction because post-injury disturbances in affect have been associated with poor adherence to physical rehabilitation protocols (Daly et al., 1995). Research examining individual differences in recovery rates from surgery shows that an individual's interpretation of his/her life-events and how he/she affectively responds to such evaluations (i.e., anxious or depressive mood states) are associated with variations in recovery indices (e.g., range of motion) from ACL reconstructive surgery (e.g., Morrey et al., 1999).

Of the affective variables associated with pain, research has shown that individuals experiencing high levels of depression are likely to experience more intense pain (e.g., Blumer & Heilbron, 1982; Sullivan & D'Eon, 1990). Indeed, depression is significantly associated with heightened pain intensity in clinical and experimental pain populations (e.g., Keefe et al., 1989; Romano & Turner, 1985; Sullivan et al., 1990). Research has also shown that individuals experiencing high levels of anxiety are likely to experience more intense pain (e.g., Gross, 1992; Weisenberg, 1977; Sternbach, 1986). Further, specific research examining anxiety and pain following surgery has shown that individuals experiencing higher anxiety are likely to experience both higher pain and use greater amounts of postoperative medications (Taenzer, 1983). Current surgical data shows that anxiety in the postoperative period is a significant factor in predicting pain during recovery (Nelson et al., 1998).

Pain, affective distress, and feelings of losing control are suggested to be important factors to examine in ACL surgery. There is also a growing body of research suggesting that catastrophizing may be of primary importance to recovery from surgery. Catastrophic thinking has been associated with slower and more complicated surgical recoveries (Cohen & Lazarus, 1973), and has been suggested by others to be the most significant single predictor of overall healing (George, Scott, Turner, & Gregg, 1980).

In a sample of general surgical patients, Butler et al. (1989) examined the relationship between catastrophizing and postoperative pain. They found that patients endorsing greater catastrophizing were significantly more likely to report greater postoperative pain. Confirming and extending the findings of Butler et al. (1989), Jacobsen and Butler (1996) examined female patients undergoing breast cancer surgeries for postoperative pain, postoperative analgesic consumption, and postoperative cognition. They found that patients reporting greater catastrophizing were more likely to report more intense postoperative pain and greater in-hospital analgesic use. Their data also showed that catastrophizing was associated with clinically and statistically significant differences on pain measures. In particular, pain intensity was 50% greater for catastrophizers than non-catastrophizers. Catastrophizers were described as patients scoring above the median on the catastrophizing score.

Keefe et al. (1991) examined pain in arthritis patients at one year following knee replacement surgery. They used the Coping Strategies Questionnaire (CSQ; Rosenstiel & Keefe, 1983) to assess pain coping strategies and catastrophizing. In particular, they reported that patients who scored low on pain control, rational thinking, and who showed greater pain catastrophizing reported higher levels of pain intensity and greater psychological disability. This relationship was found to exist even after controlling for demographic and medical variables.

Research examining the influence of catastrophizing on postoperative pain has also been conducted with children undergoing tonsillectomy and other day surgery procedures. Bennett-Branson and Craig (1993) found that children reporting a greater frequency of catastrophizing thoughts also reported higher levels of postoperative pain and perceived themselves as being less able to perform recovery-enhancing behaviors. After controlling for type of surgery, nurse's ratings of patient pain, and suffering following surgery, catastrophizing remained significantly associated with pain intensity in regression analysis. Further, they found that those higher in catastrophizing experienced increased difficulty in their ability to perform postoperative self-care behaviors.

In sum, the surgery and sport-injury literatures have identified catastrophizing, loss of control, and affective distress as significant individual difference variables associated with increased postoperative pain and acute postoperative disability. Several investigators have also shown that catastrophizing is associated with subjective and objective indices of disability outside of the acute postoperative period. These data may have important implications for the rehabilitation that follows the distressing acute in-hospital period of ACL surgery.

In samples of patients with various pain conditions, catastrophizing has been shown to correlate significantly with increased disability. Beckham, Keefe, Caldwell and Roodman. (1991) showed that a high score on the catastrophizing subscale of the Coping Strategies Questionnaire was associated with higher levels of self-reported disability in a sample of rheumatoid arthritis patients. As well, Gil et al. (1989) reported that a factor formed from various subscales of the CSQ (including the catastrophizing subscale) predicted significant reductions in activity and mobility for patients with Sickle Cell Disease. This CSQ factor that includes the catastrophizing subscale has also been shown to predict functional impairments in fibromyalgia and rheumatoid arthritis (Parker et al., 1989; Nicassio et al., 1995).

Recent clinical studies have examined the relation between specific measures of catastrophizing and indices of disability. Sullivan et al. (1998) examined catastrophizing, pain, and disability with patients who had sustained soft tissue injuries to the neck, shoulders, or back following work or motor vehicle accidents. They found that greater catastrophizing, as assessed by the PCS, was significantly correlated with patients' reported pain intensity, perceived disability, and employment status. Further, regression analyses showed that catastrophizing contributed to the prediction of disability over and above the variance accounted for by pain intensity.

Catastrophizing was also significantly associated with disability independent of levels of depression and anxiety.

Several investigators have raised questions concerning the conceptual distinctiveness of catastrophizing. In both experimental and clinical research, catastrophizing has been shown to have significant association with depression, anxiety, and other constructs like fear of pain (e.g., Rosenstiel & Keefe, 1983; Sullivan et al., 1995; Sullivan et al., 1998; Vlaeyen et al., 1995). Specific reports of these associations have been sufficiently high to question the distinctiveness of catastrophizing from depression or anxiety. In particular, Sullivan and D'Eon (1990), the first to address this issue of conceptual overlap, surveyed Clinical Psychologists to rate the degree to which items of the CSQ 'reflected' symptoms of depression. They found that all of the catastrophizing items of the CSQ were rated as reflective of depression. When they removed these items from the CSQ items in their sample, the remaining CSQ items were no longer associated with depression scores. Similarly, Afflect et al. (1992) reported that although their path analysis found that catastrophizing was associated with pain intensity ratings in rheumatoid arthritis patients, this path became non-significant when depression was controlled. These data supported the position that catastrophizing could not be conceptualized as an explanatory construct for high levels of depression in chronic pain patients if it was conceptually confounded with depression.

A body of research has been accumulating in rebuttal to the claims of conceptual overlap between catastrophizing and affective distress. Sullivan and D'Eon's (1990) position was criticized by Haaga (1992) who argued that an ambiguous instructional set was involved in the psychologist's ratings and therefore rendered the findings as uninterpretable. Haaga (1992) also noted that the correlations between catastrophizing and depression were in the moderate range, which is not typically considered supportive of conceptual redundancy. Also, Keefe et al. (1989) directly assessed the issue of conceptual overlap between catastrophizing and depression by having patients complete measures at two points with a six-month period in between. Controlling for depression at time 1, they showed that catastrophizing significantly predicted later depression score. Research has also shown that catastrophizing can predict pain over and above the effects of neuroticism (Affleck et al., 1992), fear of pain (Sullivan et al., 1995), and also can predict pain and disability over and above the effects of depression and anxiety (Sullivan et al., 1998). In review, claims of possible conceptual overlap between catastrophizing and affective distress have been shown to be of concern but research continues to show that catastrophizing contributes unique variance to the prediction of pain and disability over and above depression and anxiety.

There has also been disagreement concerning the degree to which catastrophizing represents a trait-like or situation specific orientation to dealing with painful situations. These data are reviewed because the recovery period following ACL surgery may provide a unique opportunity to address issues related to the temporal stability and the prospective predictive value of catastrophizing.

Sullivan et al. (1995, Studies 2 & 4) reported high correlation between catastrophizing assessments conducted over a 6 to 8 week period in undergraduate students (.75, .70 respectfully). They suggested that at least in the absence of intervention, catastrophizing appears to be stable over time. In contrast, earlier work by Spanos et al. (1981) showed that when undergraduate students who were identified as catastrophizers were asked to not engage in catastrophic thought, the majority was no longer classified as catastrophizers upon re-interviewing. Vallis (1984) showed that following stress inoculation training, the majority of participants previously identified as catastrophizers no longer reported catastrophic thoughts during a cold pressor procedure. There is also a body of data indicating that cognitive behavioral interventions can lead to reductions in catastrophizing and that reducing catastrophizing is associated with better adjustment in chronic pain (e.g., Turner and Clancy, 1986; Parker et al., 1989; Keefe et al., 1991).

Based on the available research, a "reactive" view of catastrophizing cannot be ruled out. Although Sullivan et al. (1995) and Keefe et al. (1991) have provided longitudinal data showing that catastrophizing exhibits a high level of stability over time, the context within which these investigations were carried out does not specifically address whether catastrophizing is reactive to changing pain experience. In the Sullivan et al. (1995) study, undergraduate subjects were pain-free during the study period allowing no conclusions to be drawn about catastrophizing and pain reactivity. In the Keefe et al. (1991) study, the sample consisted of individuals who had been suffering from rheumatoid arthritis for over several years. During the 6-month study period pain experience would not have been expected to change in any significant manner.

Recovery from ACL surgery provides a unique opportunity to address the reactivity of catastrophizing. Prior to ACL surgery most patients are experiencing minimal discomfort. The natural course of recovery from ACL surgery involves high levels of pain in the first few days postoperative with diminishing levels of pain over time. If catastrophizing were a trait-like construct it would be expected to remain stable even as pain levels decrease. Thus, findings of the present research may help clarify the nature of catastrophizing.

Conclusions and Study Hypotheses.

The survey data suggest that coaches and physicians alike are aware that individual differences in an athletes' capacity to function with pain and disability following an injury are significant. In particular, sports medicine providers consider psychological factors as significant not only in sports performance, but also in sports injuries, postoperative rehabilitation, and pain management (Weiss & Troxel, 1986; Wiese & Weiss, 1987). However, the role of catastrophizing in determining levels of pain and disability following ACL surgery has not been empirically addressed. Therefore, the primary focus of Study 3 is to examine the predictive relations of catastrophizing on postoperative pain and functional disability in sporting individuals who have had arthroscopically assisted ACL reconstructive surgery.

Previous research indicates that individual differences in pain and levels of pain relief are common in people following orthopedic injury (e.g., Borenstein, 1983) but much of this work has not examined the particular effects of catastrophizing. As well, research has highlighted strong relationships between level of pain and physical and psychological dysfunction (e.g., Kremer, & Atkinson, 1981; Sternbach, & Timmermans, 1975; Sternbach et al., 1973), but has only recently addressed the effect of catastrophizing on pain and physical dysfunction (e.g., Sullivan et al., 1998). Finally, Studies 1 and 2 have indicated that the PCS is a valid and reliable measure of catastrophizing in athletic individuals.

In Study 3, issues of conceptual and clinical relevance will be addressed in a more ecologically meaningful context than previous investigations have afforded. The specific hypotheses addressed in this study are presented below:

1) Catastrophizing (as assessed by the PCS) will correlate positively with pain following ACL surgery (e.g., Butler & Jacobsen, 1996).

2) Catastrophizing (i.e., PCS) will correlate positively with disability following ACL surgery (e.g., Sullivan et al., 1998).

3) Based on previous data and contrary to the findings of Study 2 (i.e., that Helplessness was the best predictor of experimental pain), the Rumination subscale of the PCS will be the strongest predictor of pain and disability following ACL surgery (e.g., Sullivan et al., 1995; Sullivan et al., 1998).

4) The relation between catastrophizing (i.e., PCS) and pain-related outcomes will be independent of affective distress (i.e., anxiety & depression)(e.g., Sullivan et al., in press).

5) Catastrophizing will predict pain and disability in cross-sectional and prospective analyses.

6) Catastrophizing will remain stable across the 8-weeks assessment period of this study (e.g., Sullivan et al., 1995).

Methods

Participants.

Sports participants in the present study are described as recreational athletes because all were playing competitive sports at the time of their injuries. All recreational athletes were scheduled for arthroscopic ACL reconstructive surgery using the patella-autograft procedure. All participants were recruited from the orthopedic surgery service of the Queen Elizabeth II Health Sciences Centre, a large teaching hospital in Halifax, Nova Scotia, Canada. Two orthopedic surgeons provided access to their patients. A total of 54 patients (29 males and 25 females) comprised the sample[1]. The mean age was 25.4 years (SD = 8.08). The mean education level was 14 years (SD = 2.08). In this sample, 32% (17) were married, 67% were single (36), and 1% (1) was divorced at initial assessment. In regard to ethnicity 94% (51) of the sample was Caucasian, 3% (2) Black, and 1% (1) Asian. Nearly 24% of the sample reported that their ACL injury was due to sport-based contact (i.e., being struck in the knee), with the large percentage of the patients reporting that their ACL injury was due to non-contact sporting activity (e.g., running, jumping, pivoting)(76%; 41). Most patients injured their left knee (69%; 37). Table 1-3, shows the distribution of sport involvement for the study sample.

Insert Table 1-3 about here

Procedure.

[1] According to Cohen (1992) and Cohen and Cohen (1983) a power analysis for R^2 using an alpha = .05, setting power at .80, using seven predictor variables, with expected medium effect size (.30-.40), requires a sample size of 50.

As illustrated in Figure 4-3, the sampling procedure involved the monitoring of orthopedic admissions for ACL surgery. Initial contact with patients was made over the phone. During the initial contact, potential participants were provided with general information about the nature of the study. Interested participants were then screened according to the study eligibility requirements. Specifically, eligible patients had to be scheduled for the arthroscopically assisted ACL patella-tendon autograft procedure and must have incurred their injury through sporting participation. Potential participants were excluded if they reported a history of chronic pain (i.e., pain syndrome > 6 months in duration), reported a current dementia or acute psychopathology, or reported a history of neurological disease. Additionally, participants were told that if they developed significant postoperative complications, like deep wound infection, or required additional corrective surgery to their ACL, their data might be excluded from data analyses. Fifty-nine ACL patients were contacted by phone and four indicated they were not interested in participating.

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Insert Figure 4-3 about here

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All interested participants had a preoperative meeting arranged. The purpose of the preoperative meeting was to reiterate and expand upon the nature of the study, describe exactly what participation would entail, address all questions or concerns the potential participants might have, and have participants review and sign informed consent material (see Appendix E).

There were three distinct data collection phases in this study. In the first phase, the pre-operative assessment, the assessment package contained the Patient Demographics Form (PDF)(see Appendix F), Pain Catastrophizing Scale (PCS), the Patient Pain Form (PPF)(i.e., VAS pain intensity scales for moving and resting)(see Appendix G), the Beck Depression Inventory (BDI)(see Appendix H), the State Anxiety Inventory (STAI-S)(see Appendix I), a subjectively rated knee performance rating scale (Lysholm Knee Rating Scale; LYS; see Appendix J), and a measure of functional disability (FDI)(see Appendix K). The entire assessment was estimated as requiring approximately 40 minutes to complete. Preoperative information was collected the day before surgery.

The second phase of assessment was conducted during the two consecutive days of the postoperative period at 10 a.m. each morning. This assessment included measures of pain (PPF), anxiety (STAI), depression (BDI), and pain catastrophizing (PCS). Completion time for these measures was approximately 20 minutes. Upon hospital discharge, in-hospital consumption of pain medication was drawn from the medical charts and equated on a standard opioid equivalency table as used in previous surgical research (Jacobsen & Butler, 1996)(see Appendix L).

The final phase of assessment was conducted at 8-weeks postoperative. The decision to assess patients at 8-weeks postoperative coincided with the physician schedule (see Appendix M) and the fact that all patients are expected to be ambulating without the use of crutches or canes. At 8-weeks postoperative, all the assessment forms of the pre-operative period were again administered (i.e., PCS, BDI, STAI, PPF, FDI, and LYS). After collecting the final data, all participants were debriefed by the researcher (see Appendix N).

Measures.

Intra-operative Medical Status Variable.

Although all patients in this study were scheduled for the same type of surgery (i.e., ACL reconstructive surgery using patella autograft), it is difficult to ignore that there may be varying degrees of surgical intervention necessary to correct the knee pathology. For example, some patients may expect a fairly uncomplicated ACL procedure with minimal or no repair needed to other structures within the knee. However, from forces of the original trauma might result in collateral damage within the knee, especially to the meniscus, which may be repaired during the ACL procedure. As a measure of this medical variance between patients, and as suggested by the collaborating surgeons, the time that each patient spent on the operating table during their procedure (i.e., in minutes) was recorded and used as an index of extent of surgical involvement.

In-Hospital Analgesic Consumption.

It is common clinical practice to administer one or more intravenous (iv) or intramuscular (im) doses of morphine or other analgesic in the surgical recovery room. In addition, patients may be prescribed morphine (e.g., oral, iv, im, on a p.r.n. basis) and one or more of a variety of oral opioid analgesics (e.g., p.r.n. basis) including codeine or meperidine during the duration of their hospital stay. Using standard conversion tables (e.g., Patt, Szalados, & Wu, 1993), overall postoperative analgesic consumption was measured by converting the doses of analgesics administered into morphine equivalent units as practiced in previous catastrophizing and postoperative pain research (e.g., Jacobsen and Butler, 1996). For each postoperative day (i.e., 24 and 48-hours) spent in hospital the medications consumed were calculated from midnight to midnight providing a 24-hour time frame.

Beck Depression Inventory.

The Beck Depression Inventory (BDI; Beck et al., 1961) consists of 21 groups of statements presented in a multiple-choice format designed to measure depressive symptomatology in both adolescents and adults. The 21 item groupings of the BDI assess a specific symptom or attitude that is related to a state of depression. Examples of these groups include sadness, pessimism, feelings of guilt, crying, loss of interest, and irritability.

Internal consistency for the BDI has been reported at .86 while the Spearman-Brown correlation for the BDI was .93 (Beck et al., 1961). Test-retest reliability has been studied using psychiatric patients who were administered the BDI on two separate occasions (r=.70)(Beck, 1970). It has also been shown that scores on the BDI changed according to the observed clinical rating of depression, indicating a consistent relationship between BDI scores and patient state, with reliability figures above .90 (Beck, 1970).

The BDI has been examined for its concurrent validity in several studies. One study showed a correlation of .77 between the BDI and psychiatric rating using university students as subjects (Bumberry, Oliver, & McClure, 1978). Beck (1970) reported similar studies in which coefficients of .65 and .67 were obtained with psychiatric patients. Scores on the BDI range from 0 to 63. The BDI takes approximately 10 minutes to complete.

The BDI has also been used as a measure of depressive symptomotology in several medical populations including chronic pain patients and surgical patients (e.g., Croog, Baume, & Nalbandian, 1995). BDI scale reliability, averaged over the assessment periods in the present study was .81.

State Anxiety Inventory.

The State form of the State-Trait Anxiety Inventory (STAI-S) was used to assess situation-specific anxiety. The State-Trait Anxiety Inventory is a 40-item self-report questionnaire that measures state and trait anxiety among adults (Spielberger et al., 1983). The items of this questionnaire have been divided into two 20 item blocks addressing either state or trait levels of anxiety. The first 20 items of the STAI measure state anxiety. The items each begin with the phrase "I feel..." and include 10 statements that describe emotions that reflect absence of anxiety (e.g., "comfortable", "at ease", "secure", etc.) and 10 that reflect presence of anxiety (e.g., "upset", "nervous", "worried", etc.). Total scores are obtained by summing the values assigned to each response and range from a minimum of 20 to a maximum of 80. The state from of the STAI takes approximately five minutes to complete.

The STAI has high internal consistency, with alpha coefficients of .93 for the State scale reported for both men and women (Spielberger et al., 1983). The STAI has also been commonly used as a measure of anxiousness in surgical patients (e.g., Nelson et al., 1998). STAI-S scale reliability, averaged over the assessment periods in the present study was .94.

Lysholm Knee Performance Rating Scale (LYS).

The LYS consists of 8 questions that ask patients to respond to areas related to gait disturbances, use of supports for ambulating, clinical features of knee locking or catching, activity tolerance before pain, activity tolerance before swelling, ability to climb stairs, and ability to squat down. These questions have graded responses that total to a possible score of 100 (which would indicate no difficulties in the areas mentioned above). Lower scores indicate that the patient is experiencing significant disability in the domains assessed by the scale. LYS internal scale reliability, averaged over the assessment periods in the present study was .75.

A standard measure of knee ratings for ACL injuries, the Lysholm scale (Tegner & Lysholm, 1984) has been shown to have good reliability and is easily understood and responded to by knee surgery patients (Fujikawa, Iseki, & Seedham,1989; Shelbourne, Whitetaker, Carroll & Retting, 1990). Adequate test-retest reliability of the Lysholm scale has been provided (e.g., alpha variation +/- 2.8% over three day period)(Lysholm & Gillquist, 1982). Further, scores for the Lysholm have been shown to be significantly associated with knee function following ACL surgeries (Draper & Ladd, 1993; Tegner & Lysholm, 1985).

Patient Pain Form.

The pain form used in this study was comprised of two separate visual analog scale (VAS) measures of pain. Patients were asked to rate his or her pain intensity while resting and while moving. VAS used in this study consisted of a 10-cm horizontal line with two endpoints or anchors labeled "no pain" and "worst pain ever". To complete a VAS the patient is required to place a mark across the horizontal line indicating the corresponding pain level of pain intensity he/she is presently experiencing. The distance in centimeters from the low end of the VAS to the area where the patient has marked the scale is measured and used as a numerical index of his/her pain severity.

VAS pain measures provide a simple and efficient measure of pain intensity that has been widely employed in both clinical and experimental pain research where there is a need for a quick assessment of pain that can be represented by a number. VAS is reported to be sensitive to both pharmacological and non-pharmacological interventions designed to reduce pain (Byelanger, Melzack, & Lauzon, 1989) and is highly associated with pain measured on verbal and numeric pain rating scales (Ekblom & Hansson, 1988).

The major advantage to using a VAS as a measure of pain intensity is its ratio scale properties (Price & Harkins, 1987). Compared to other pain assessment tools, the VAS implies equality of ratios, allowing one to speak meaningfully about percentage differences between VAS assessment made over time or from separate samples. Other advantages include its conceptual simplicity, ease in scoring, and speed of administration. All patients were given a full example and explanation on how to use the VAS in assessing their pain and any questions they had were solicited and answered. The patient pain form takes approximately 10 seconds to complete after the scales had been introduced. Pain scores can range from 0-10.

Functional Disability Inventory.

All patients were asked to complete a modified version of the Functional Disability Inventory (FDI; Walker & Greene, 1991), in order to assess the impact of their knee injury and surgery on their daily activities. The FDI was originally designed to assess the amount of difficulty that children experienced in both physical and psychosocial functioning due to physical health problems. Walker and Greene (1991) reported that this measure had high levels of internal consistency, 3-month test-retest reliability that exceeded .60 for children with recurrent abdominal pain and significant correlations in the moderate range with a measure of school absence and somatic symptoms.

Although the FDI was designed and pre-tested for use with children, the items of the FDI tap psychosocial and physical domains that are applicable to both children and adults (e.g., walking to the bathroom, walking up stairs, eating, doing activities or playing sports, engaging in extracurricular activities, etc.). For this reason, the FDI was used to assess perceived disability in this sample.

There was one significant modification to this inventory for this study. In particular, the items were scored with a 10-centimeter VAS instead of a numeric rating scale to provide quick scoring and ratio scale properties. The modified FDI takes approximately 5 minutes to complete. FDI scale reliability averaged over the assessment periods in the present study was .80.

Pain Catastrophizing.

The Pain Catastrophizing Scale (PCS; Sullivan et al., 1995) has been fully described in Study 1. PCS internal consistency averaged over the assessment periods in the present study was .87.

Missing Values and Psychometric Assumptions.

Prior to conducting data analyses, all dependent and independent measures were examined for accuracy of data entry, missing values, and fit between their distributions and the assumptions of multivariate analysis. Missing values were replaced using an intra-case replacement procedure (Tabachnick & Fidell, 1996).

Assumptions of normality were examined across all continuous data by examining measures of skewness and kurtosis. Pain ratings and medication intake were the only variables to depart significantly from normality (i.e., pain medication consumption during the 48-hour postoperative assessment (1.85; Z =

5.69, $p < .001$) and pain while resting assessed at 8-weeks postoperative (2.10; $Z = 6.46$, $p < .001$). It was expected that pain would not be normally distributed following surgery. Indeed, it is quite natural to expect a significant negative skew shortly following surgery followed by a positive skew. The observed positive skewness in pain medication consumption index represents a similar trend wherein patients consume less medication on their second day after their surgery as they become accustomed to their level of physical discomfort.

The topic of transforming raw data has been described in several texts (e.g., Darlington, 1990; Tabachnick & Fidell, 1996). Although pain ratings at 8-weeks postoperative and 48-hour medication consumption departed from normality these data were not transformed. This decision was based on several positions. First, other studies of postoperative pain and catastrophizing have not transformed their data (e.g., Bennett-Branson & Craig, 1993). Second, colleagues with significant experience in pain research suggested that standard practice was to not transform pain data (Dr. P. McGrath; Dr. M. Sullivan). Finally, regression analyses for the 8-week pain data were performed on both transformed and untransformed data showing no difference in regression model results. Further, data assumptions of normality of residuals were examined during all analyses to identify solution-disruptive data points. In all regression analyses the Cook's distance was examined and was shown to be well within normal limits, indicating no violations of normality assumptions for residuals. Cook's distance is a measure of how much the residuals of all cases would change if a particular case were excluded from the calculation of the regression coefficients. A large Cook's value (>1) indicates problematic values affecting the regression residuals (Tabachnick & Fidell, 1996).

Data Analyses.

Data analyses were conducted in several phases to address the hypotheses of this study. During the first phase of the analyses, repeated measures analyses of pain, depression, anxiety, and pain catastrophizing were conducted. Difference in disability from the preoperative and 8-weeks postoperative assessments was examined by a T-test. These analyses were conducted to highlight the changes in these variables over time. This phase of data analysis employed the General Linear Model (GLM) repeated measures MANOVA procedure in SPSS, from which a series of one-way analyses were conducted. This method for repeated measures also allows users to address sphericity assumptions for the variables of interest. Mauchly's test of sphericity is used to test the assumption that measurements on a subject are from a multivariate normal distribution and that the variance-covariance matrices are the same across the cells formed by the subjects effects. The validity of the F statistic used in the univariate approach can be assured if the variance-covariance matrix is circular in form. If the significance of the test is small, an adjustment can be made to both the numerator and denominator degrees of freedom by applying an epsilon index (Tabachnick & Fidell, 1996). Follow-up repeated means comparisons ($p<.05$) were conducted in the separate analyses to examine simple effects. Using this method, each assessment period was compared with the previous in order to keep the number of comparisons limited. As suggested by Tabachnick & Fidell (1996), effect sizes were calculated using eta squared (η^2).

In the second phase, data were examined employing an intra-assessment method where the data of each assessment period were examined in isolation from the others. Within each assessment period (e.g., preoperative, in-hospital, and 8-weeks postoperative), descriptive data and correlational analyses were conducted to examine the distribution of scores and the strength of association among variables (i.e., hypotheses 1 & 2). To explore the relations of predictive ability of pain catastrophizing on VAS pain reports and functional disability, a series of hierarchical multiple regression analyses were performed (i.e., hypothesis 3). These analyses were designed to assess the possible contributions of the PCS subscales in predicting pain and disability at each assessment period. In order to address the issue of measurement redundancy for catastrophizing and affective distress noted in the introduction of this study, all significant regression models were re-run with depression and anxiety entered as covariates in order to examine the unique contribution of catastrophizing (i.e., hypothesis 4). The hierarchical regression models entered the independent variables in three distinct steps. Age and gender were entered in step 1 of the analyses. In step 2, medical status variables were force entered into the regression model. There were no medical status variables used for pain during preoperative assessment because surgery had not occurred. Pain and knee performance were accounted for in regressions examining functional disability because of their proximal qualities. The regression models for pain on day 1 & 2 postoperative, time of operation from start to finish (OR time) and the amount of medications consumed (opioid equivalent) by the patient on that day was accounted for. For the 8-weeks postoperative regression models OR time was accounted for as a medical status variable for pain. As with the pre-operative assessment, pain and subjectively rated knee performance were accounted for in regressions examining functional disability. In the final step, the subscales of the PCS were entered. From a statistical perspective, the hierarchical regression model methodology allows for the evaluation of increases in R^2 (explained variance) and changes in the F value within the steps of the regression model. Basically, this statistic communicates whether or not the addition of each set of variables is significant in explaining the composition of the dependent variable in question. The order of the variables entered follows the rationale that demographic and medical status variables should be accounted for in such regression models before psychological variables (Tabachnick & Fidell, 1996). The third and final phase of data analysis used hierarchical regression models to examine the prospective predictions that preoperative catastrophizing may influence postoperative pain and disability (i.e., hypothesis 5). Regression models were conducted when the zero-order correlations between catastrophizing and the prospective dependent variables were significant. These models were employed in the manner detailed for the intra-assessment analyses.

Results

Sample Homogeneity.

Although all patients experienced the same surgical procedure from the two collaborating surgeons (Dr. W. Stanish, n=40; Dr. C. Coady, n=14), the sample was examined across surgeons for significant differences on the pre and postoperative variables of interest. Comparing patients across the surgeons in the preoperative analyses, there were no significant differences found for age, education, pain, functional disability, depression, or anxiety. There was a significant difference in preoperative pain catastrophizing (t (52) = 2.80, $p<.05$), which was found to be higher in Dr. Coady's patients (n=14).

In regard to postoperative data, at 24-hours postoperative there were no significant differences between pain, OR time, pain medication consumption, or depression. However, there were differences across surgeon for anxiety (t (52) = 2.40, $p<.05$) and catastrophizing (t (52) = 2.70, $p<.05$), with Dr. Coady's patients (n=14) scoring higher. At 48-hours there were no significant differences across surgeons for pain, pain medication consumption, depression, anxiety, or pain catastrophizing. At the final assessment, 8-weeks postoperative, there were no significant differences across surgeons for pain, functional disability, depression, anxiety, or pain catastrophizing.

Differences across surgeons on the variables of interest affected 3/23 (or 13%) of the comparisons across all assessments. Of particular importance, indices most theoretically related to surgical performance (i.e., OR time, postoperative pain medication consumption, pain, and functional disability) were not shown to be different, indicating little divergence in this sample across the performance of the surgeons. Therefore, the sample was considered homogenous in nature and not influenced differentially by surgeons.

Phase 1 of Data Analyses.

As noted, the first phase of data analyses employed the General Linear Model (GLM) repeated measures procedure to perform a series of one-way analyses. These repeated measures analyses were used to address each of the dependent variables (i.e., pain, functional disability) and the psychological variables of interest (i.e., pain catastrophizing, depression, anxiety) for significant changes over the course of the study (i.e., hypothesis 5). Means and standard deviations of the variables of interest across the assessment periods are displayed in Table 2-3.

Insert Table 2-3 about here

Pain[2].

[2] Due to the high correlations between pain while moving and resting in the preoperative (r=.70) and in-hospital assessments (r=.80;.81) and the moderate strength of the correlation at 8-weeks [*Footnotes continued on next page*]

Repeated measures analysis revealed significant changes over time in the amount of pain experienced by participants (Wilk's $\Lambda = .25$, $F^{(3,51)} = 7.07$, $p = .02$). Approximately 61% of the variance is accounted for by time effects ($\eta^2=.61$). As shown in Figure 5-3, follow-up means contrasts indicated that differences in pain were significant across most comparisons. In particular, pain increased dramatically and significantly after surgery (p=.001). The pain reported while in the hospital (i.e., 24 & 48-hour postoperative) was not statistically different (p=.47). Pain at 48-hours postoperative was significantly higher than pain reported at 8-weeks postoperative (p=.04).

Insert Figure 5-3 about here

Pain Catastrophizing.

Repeated measures analysis revealed significant changes over time in the amount of pain catastrophizing reported by participants (Wilk's $\Lambda = .40$, $F^{(3,51)} = 25.10$, p=.000). Approximately 37% of the variance was accounted for by time effects ($\eta^2=.37$). As shown in Figure 6-3, follow-up means contrasts indicated that pain catastrophizing did not differ significantly from the preoperative period

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postoperative (r=.55), pain while moving and resting were collapsed into an averaged pain composite score for repeated measures analyses.

to the 24-hour postoperative assessment (p=.36). However, pain catastrophizing did drop significantly from 24 to 48-hours postoperative (p=.004), and again from 48-hours to 8-weeks postoperative (p=.000).

Insert Figure 6-3 about here

Depression.

Repeated measures analysis revealed significant changes over time for level of depression (Wilk's Λ = .58, $F^{(3,51)}$ = 12.51, p=.000). Approximately 24% of the variance was accounted for by time effects (η^2=.24). As shown in Figure 7-3, follow-up means contrasts indicated that depression scores did differ significantly from the preoperative period to the 24-hour postoperative assessment (p=.000). However, depression scores did not drop significantly from 24 to 48-hours postoperative (p=.06). There was a significant decline in depression scores from the 48-hour to 8-weeks postoperative assessment (p=.000).

Insert Figure 7-3 about here

Anxiety.

Repeated measures analysis revealed significant changes over time for anxiety (Wilk's Λ = .42, $F^{(3,51)}$ = 23.32, p=.000). Approximately 38% of the variance was accounted for by time effects (η^2=.38). As shown in Figure 8-3, follow-up means contrasts indicated that anxiety did increase significantly from the preoperative period to the 24-hour postoperative assessment (p=.007) and did not drop significantly from 24 to 48-hours postoperatively (p=.114). However, from the 48-hour to 8-weeks postoperative, anxiety once again significantly declined (p=.000).

Insert Figure 8-3 about here

Functional Disability.

Functional disability was assessed at two periods. A pairwise t-test was used to examine changes in disability over time. The difference in disability scores shown in Figure 9-3, from the preoperative to 8-weeks postoperative assessment, was not significant (t (53) = -1.66, p=.10).

Insert Figure 9-3 about here

Phase 2 of Data Analyses.

The second phase of data analyses was conducted within each assessment period (e.g., preoperative, in-hospital, and 8-weeks postoperative). In this phase descriptive and correlational data were produced in order to examine the distribution of scores and the strength of association among variables (i.e., hypotheses 1 & 2). In order to examine the predictive ability of pain catastrophizing on pain and functional disability, hierarchical multiple regression analyses were conducted (i.e., hypothesis 3). As well, the issue of measurement redundancy for catastrophizing and affective distress was examined by re-running the catastrophizing regression models that were significant with depression and anxiety included in the analyses (i.e., hypothesis 4).

Preoperative Assessment.

Descriptive Statistics.

In Table 3-3, descriptive statistics for the day before surgery show the mean pain reported while moving was 1.55 / 10 (SD = 1.75; min = 0; max = 7.10) and pain while resting was .81 / 10 (SD = 1.45; min = 0; max = 6.30). The mean pain catastrophizing score was 13.94 (SD = 7.61; min = 0; max = 38) and is similar to those reported for dental patients (Sullivan & Neish, 1997) but lower than those reported for the athlete sample of Study 2 of this work (17.1, SD = 7.3). The mean depression score was 6.43 (SD = 4.31; min = 0; max = 18), while anxiety was 36.48 (SD = 11.67; min = 20; max = 71). The mean functional disability score was 19.34 (SD = 1.45; min = 1.50; max = 59.70).

Insert Table 3-3 about here

Gender Differences.

Individual sample T-tests by gender indicated that there were no significant differences on any of the hypotheses-relevant variables.

Correlational Analyses.

Correlations for the preoperative assessment period are presented in Table 4-3. Reports of pain while moving were positively associated with pain while resting ($r = .70$; $p<.05$). Due to the high correlation between these pain measures, they were collapsed to form a single pain index as suggested by Tabachnick and Fidell (1996). Pain was positively associated with depression (BDI; $r = .28$; $p<.05$), functional disability (FDI; $r = .44$; $p<.05$), and negatively associated with knee performance ratings (LYS; $r = -.42$; $p<.05$). The pain catastrophizing scale was associated with depression ($r = .50$; $p<.05$) and anxiety ($r = .49$; $p<.05$). Depression was associated with anxiety ($r = .71$; $p<.05$) and functional disability ($r = .28$; $p<.05$).

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Insert Table 4-3 about here

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Regression Models.

The first series of hierarchical multiple regression analyses were conducted to explore the relational value of the subscales of the Pain Catastrophizing Scale (PCS). This allows for the examination of the unique contributions of the PCS subscales (i.e., Rumination, Helplessness, and Magnification) to the prediction of the dependent variables of interest (i.e., pain, functional disability). All significant analyses were followed with an examination of the contribution of catastrophizing when variables of affective distress were also controlled (i.e., depression, anxiety).

Pain.

The initial regression model examined preoperative pain. As shown in Table 5-3, the entered demographic variables (i.e., gender & age) accounted for 2% of the variance in pain (i.e., R^2 value[3]) and were non-significant predictors in the model ($F^{(2,51)}$ change = 0.42, p=.65). When the PCS subscales of Rumination, Helplessness, and Magnification were added to the model, the change in model variance was not significant (2% increase; $F^{(5,48)}$ change = 0.27, p=.85.

Insert Table 5-3 about here

Functional Disability.

[3] R^2 is a goodness of fit measure for the regression model. It is considered to be the proportion of variance in the dependent variable explained by the regression model. The R^2 ranges from 0-1. Small values indicate that the model does not fit the data well while larger values indicate a good fitting model (Tabachnick & Fidell, 1996).

As shown in Table 6-3, gender and age accounted for 2% of the variance in functional disability and were non-significant predictors in the model ($F^{(2,51)}$ change = 0.47, p=.63). On the second step of the analysis, knee performance (LYS) was a unique significant predictor (Beta = -.39; p<.01), and the second step of the analysis accounting for a significant addition of 33% in model variance ($F^{(4,49)}$ change = 12.65, p=.000). When the catastrophizing scales were added to the model, Magnification was a unique significant predictor (Beta = .27; p<.04). The addition of the catastrophizing scales accounted for a non-significant change in the variance accounted for in the model (1%; $F^{(7,46)}$ change = 1.85, p=.15).

Insert Table 6-3 about here

As shown in Table 7-3, a hierarchical regression was conducted to address whether catastrophizing contributed to the prediction of functional disability, over and above the variance accounted for by depression and anxiety. This model showed again that gender and age did not contribute to the model and that knee performance ratings was a unique significant predictor. Additionally, in step three, with depression, anxiety and catastrophizing being added to the model, no significant predictors were produced in the model.

Insert Table 7-3 about here

Summary for Preoperative Assessment.

The initial assessment provides a unique opportunity to examine several physical and psychological factors in the ACL injured athlete awaiting reconstructive surgery. The general findings at this assessment indicate patients were experiencing minimal pain, depression, anxiety, or pain catastrophizing. Further, the average patient was found to be relatively functional in activities of daily living. There was however, a clear indication that these individuals were experiencing significant impairment in overall knee function (LYS). There were no differences by gender reported for any measure assessed during this time, indicating that men and women in this sample were equally impaired and psychologically distressed in the preoperative period. Regression analyses showed no significant predictors of preoperative pain and that knee performance ratings and the Magnification scale of the PCS explained significant amounts of variance in preoperative functional disability. Further, the regression model for functional disability, examining the contributions of depression, anxiety, and catastrophizing showed that catastrophizing was no longer a predictor when affective distress was controlled.

24-Hour Postoperative Assessment.

Descriptive Statistics.

In Table 8-3, descriptive statistics assessed 24-hours postoperatively show mean pain while moving was 6.92 out of 10 (SD = 2.11; min = 1.40; max = 10) and pain while resting was 4.96 (SD = 2.47; min = .60; max = 9.40). The mean pain catastrophizing score was 15.06 (SD = 9.19; min = 0; max = 40), depression was 8.91 (SD = 4.90; min = 1; max = 22), and anxiety was 40.26 (SD = 10.23; min = 20; max = 64). Mean time elapsed in minutes for the operation (i.e., OR time) was 76.15 (SD = 13.57; min = 50; max = 107). Mean pain medication consumption (i.e., opioid equivalents) was 3.56 (SD = 2.21; min = .43; max = 9).

Insert Table 8-3 about here

Gender Differences.

Individual sample T-tests by gender indicated that men experienced significantly longer operations (i.e., OR time, time spent on table) than women (t (52) = 2.20, p<.05). Except for this finding, no other significant differences in measures assessed at 24-hours postoperative were found across gender (i.e., depression, anxiety, pain catastrophizing, pain, or medication consumed).

Correlational Analyses.

Correlations for the 24-hour postoperative assessment are presented in Table 9-3. Reports of pain while moving were positively associated with pain while resting (r = .80; p<.01) and were therefore collapsed to form a single pain index. Pain was found to be associated with higher levels of pain catastrophizing (PCS; $r = .61$; $p<.01$), anxiety (STAI-S; $r = .43$; $p<.01$), postoperative medications consumed (Meds; $r = .30$; $p<.01$), and negatively associated with age ($r = -.43$; $p<.01$). The pain catastrophizing scale was associated with depression ($r = .45$; $p<.01$), anxiety ($r = .62$; $p<.01$), OR time ($r = .35$; $p<.01$); and was negatively associated with age ($r = -.42$; $p<.01$). Depression was positively associated with anxiety ($r = .59$; $p<.01$) and negatively associated with age ($r = -.37$; $p<.01$). Anxiety was negatively associated with age ($r = -.47$;$p<.01$). OR time was negatively associated with gender ($r = -.29$; $p<.05$).

Insert Table 9-3 about here

Regression Models.

Pain.

The initial regression model examined pain at 24-hours postoperative. As shown in Table 10-3, at step 1, gender and age accounted for 19% of the variance in pain ($F^{(2,51)}$ change = 5.96, p=.01) but were non-significant predictors in the final model. Step 2, adding the medical status variables, showed that the amount of medications consumed over day 1 postoperative was a significant unique predictor of pain (Beta = .21; $p<.05$) and that this step accounted for an addition of 9% in model variance ($F^{(4,49)}$ change = 3.19, p=.05). Finally, in step 3, the catastrophizing subscales accounted for a significant addition of 26% in model variance ($F^{(7,46)}$ change = 8.78, p=.000). Rumination was found to be a unique significant predictor of pain (Beta = .67; p<.001).

Insert Table 10-3 about here

A hierarchical regression was conducted to address whether catastrophizing contributed to the prediction of pain, over and above the variance accounted for by depression and anxiety. As shown in Table 11-3, gender and age accounted for 19% of the variance ($F^{(2,51)}$ change = 5.94, p=.005). Adding the medical status variables, the amount of medications consumed at day 1 postoperative was a significant predictor (Beta = .21; p<.05), and this step accounted for an addition of 9% in model variance ($F^{(4,49)}$ change = 3.19, p=.05). When depression, anxiety, and catastrophizing were added to the last step of the model, catastrophizing was found to be the lone significant contributor (Beta = .57; p<.01), with this step accounting for an addition of 21% in model variance ($F^{(7,46)}$ change = 6.25, p=.001).

Insert Table 11-3 about here

Summary for 24-hours Postoperative Assessment.

Pain while resting and moving during the 24-hour postoperative were highly correlated and may be better described as a unified construct. Catastrophizing was shown to be positively associated with OR time. With increased pain, the depression, anxiety, and catastrophizing scores also increased. Of the most significant findings at this time, regression analyses indicated that pain was best predicted by the amount of postoperative medications consumed and by ruminatory catastrophizing as assessed by the PCS. The relation between catastrophizing and pain remained significant even after controlling for depression and anxiety. Other analyses showed that increased age was associated with less pain, anxiety, and catastrophizing. Although these relations did not emerge in regression analyses at this assessment, they may be important to understanding the experience of patients in our sample and call attention to differences in age related responses to ACL reconstructive surgery.

48-Hour Postoperative Assessment.

Descriptive Statistics.

In Table 12-3, descriptive statistics at day 2 postoperative show the mean pain while moving was 6.24 (SD = 2.28; min = .60; max = 10) and pain while resting was 4.29 (SD = 2.38; min = 0; max = 9.20). The mean pain catastrophizing score was 12.13 (SD = 8.30; min = 0; max = 36), depression was 7.76 (SD = 5.55; min = 0; max = 26), and anxiety was 38.54 (SD = 10.25; min =

20; max = 67). The mean score of pain medications consumed on the second day postoperative was 2.03 (SD = 1.96; min = 0; max = 9.80).

Insert Table 12-3 about here

Gender Differences.

Individual sample T-tests by gender indicated that men consumed significantly less pain medication during the 48-hour postoperative assessment than did women (t (52) = 2.40, $p<.05$). Except for this finding, no other significant differences in measures assessed during the 48-hour postoperative assessment were found (i.e., depression, anxiety, pain catastrophizing, or pain). OR time was negatively associated with gender ($r = -.29$; $p<.05$) indicating that men experienced longer surgery times. Medications consumed were positively associated with gender ($r = .32$; $p<.05$) indicating that women consumed more medication than men.

Correlational Analyses.

Correlations for the 48-hour postoperative assessment are presented in Table 13-3. Reports of pain while moving were associated with pain while resting ($r = .83$; $p<.01$), and therefore were collapsed into one pain index. Pain was associated with pain catastrophizing (PCS; $r = .58$; $p<.01$), anxiety (STAI-S; $r = .39$; $p<.05$), 48-hour postoperative medications consumed (Meds; $r = .34$; $p<.05$), and was negatively associated with age ($r = -.41$; $p<.01$). The pain catastrophizing scale was associated with depression ($r = .46$; $p<.01$), anxiety ($r = .62$; $p<.01$), OR time ($r = .39$; $p<.01$); and was negatively associated with age ($r = -.30$; $p<.05$). Depression was positively associated with anxiety ($r = .64$; $p<.01$) and negatively associated with age ($r = -.35$; $p<.01$). Anxiety was associated with postoperative medications consumed ($r = .39$; $p<.01$), and negatively associated with age ($r = -.39$; $p<.01$).

Insert Table 13-3 about here

Regression Models.

Pain.

The initial regression model examined the variance accounted for by catastrophizing on 48-hour postoperative pain. As shown in Table 14-3, on step 1, gender and age contributed significant variance to the prediction of pain (18%; $F^{(2,51)}$change = 5.42, p=.007). Step 2, adding the medical status variables, showed that the amount of time spent in surgery and the medications consumed at day 2 postoperative accounted for an additional of 14% in model variance ($F^{(4,49)}$change = 4.99, p=.01). In step 3, when the subscales of the pain catastrophizing scales were added to the model, Rumination was found to be a unique significant predictor of pain (Beta = .46; $p<.01$) over and above the variance accounted for by the demographic, medical status variables. This step accounted for a significant addition of 10% in model variance ($F^{(7,46)}$change = 5.39, p=.003).

Insert Table 14-3 about here

A hierarchical regression was conducted to address whether catastrophizing contributed to the prediction of pain, over and above the variance accounted for by depression and anxiety. The regression model was significant. As shown in Table 15-3, age was a unique significant predictor (Beta = -.32; p<.01), and the first step of the model accounted for 18% of the variance ($F^{(2,51)}$change = 5.42, p=.007). Adding step 2, the medical status variables, accounted for an addition of 14% in model variance ($F^{(4,49)}$change = 4.99, p=.01). Again, the amount of medications consumed was a significant predictor at this step. When depression and anxiety were added to the model, Rumination remained the significant model contributor (Beta = .52; p<.01), with the final step accounting for an addition of 17% in model variance ($F^{(7,46)}$change = 4.95, p=.005).

Insert Table 15-3 about here

Summary for 48-Hour Postoperative Assessment.

This assessment showed pain in the moderate to high range at 48-hours postoperative in spite of pain medication consumption. Anxiety and depression were reported below the clinical cutoffs for the average patient. Medication usage was also shown to have dropped from the 24-hour assessment. In general, pain was associated with higher anxiety, greater medication usage, and higher catastrophizing. Age was shown to have negative associations to pain, catastrophizing, depression, and anxiety. Catastrophizing at the 48-hour period was associated with OR time. With respect to gender differences, men were shown to consume less medication than did women. Regression analyses for pain showed that age and medication consumption are important variables in predicting pain at 48-hours postoperative. Further, the catastrophizing subscale Rumination was found to account for significant variance in pain over and above the contributions of age, medication consumption, depression, and anxiety.

Eight-Week Postoperative Assessment.

During the eight-week assessment period all patients were ambulating without the use of crutches allowing overall knee function (LYS) and functional disability to be assessed. Therefore, regression models examined both functional disability and pain during this assessment.

Descriptive Statistics.

In Table 16-3, descriptive statistics at eight-weeks postoperative show the mean pain while moving was 1.01 (SD = 1.06; min = 0; max = 4.60) and pain while resting was .27 (SD = .58; min = 0; max = 3.40). The mean pain catastrophizing score was 5 (SD = 5.20; min = 0; max = 23), depression was

4.31 (SD = 4.43; min = 0; max = 17), and anxiety was 27.54 (SD = 8.61; min = 20; max = 52). The mean score of functional disability was 23.42 (SD = 12.65; min = 3.10; max = 63.30). The mean knee rating score was 71.30 (SD = 14.55; min = 35; max = 100).

Insert Table 16-3 about here

Gender Differences.

Individual sample T-tests by gender showed that males reported better knee performance ratings (LYS) than women did ($\underline{t}$ (52) = 2.29, $p<.05$). No significant differences were found for any other measures for the eight-week postoperative assessment (i.e., depression, anxiety, pain catastrophizing, or pain). Knee ratings were negatively associated with gender ($r = -.30$; $p<.05$) indicating that men reported less knee difficulties than women.

Correlational Analyses.

Correlations for the eight-week postoperative assessment period are presented in Table 17-3. Reports of pain while moving were positively associated with pain while resting ($r = .55$; $p<.01$) but were not high enough to justify grouping the variables together to form a single measure (Tabachnick & Fidell, 1996). Pain while moving was associated with functional disability (FDI; $r = .31$; $p<.05$), and negatively associated with knee rating scores (LYS; $r = -.38$; $p<.01$). The pain catastrophizing scale was associated with depression ($r = .49$;

p<.01), anxiety (r = .47; p<.01), and functional disability (r = .28; p<.05). Depression was positively associated with anxiety (r = .71; p<.01) and functional disability (r = .49; p<.01), and was negatively associated with knee ratings (r = -.36; p<.01). Anxiety was associated with functional disability (r = .44; p<.01), and negatively associated with knee ratings (r = -.43; p<.01). Functional disability was negatively associated with knee ratings (r = -.42; p<.01).

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Insert Table 17-3 about here

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Regression Models.

Pain while Moving.

As shown in Table 18-3, age or gender were not significant predictors of pain while moving and did not account for significant model variance (4%; $F^{(2,51)}$change = .94, p=.40). Adding OR time on the second step of the analyses showed that it was not a significant predictor and this step did not account for additional significant variance ($F^{(3,50)}$change = .17, p=.68). When the catastrophizing subscales were added to the model in step 3, Rumination (Beta = .43; p<.05) and Helplessness (Beta = .47; p<.05) were unique significant predictors of pain while moving, and this step accounted for an additional 14% in model variance ($F^{(6,47)}$change = 2.77, p=.05).

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Insert Table 18-3 about here

The hierarchical regression conducted to address whether catastrophizing contributed to pain while moving, over and above the variance accounted for by depression and anxiety, was non-significant. As shown in Table 19-3, age or gender were not significant predictors of pain while moving, accounting for 4% in model variance ($F^{(2,51)}$change = .94, p=.40). Adding the medical status variable of OR time showed that it was not significant, accounting for no additional variance ($F^{(3,50)}$change = .17, p=.68). In the final step of the model, catastrophizing was no longer significant when the effects of depression and anxiety were accounted for. Further, none of the psychological predictors were significant.

Insert Table 19-3 about here

Pain while Resting.

As shown in Table 20-3, gender and age accounted for 1% of the variance in pain while resting ($F^{(2,51)}$change = .31, p=.74) and were non-significant in the final model. Adding OR time resulted in a non-significant contribution, accounting for an addition of 1% in model variance ($F^{(3,50)}$change = .15, p=.70). In the final step of the model, when the catastrophizing subscales were examined, Helplessness (Beta = .47; p<.05) was shown to be the lone significant predictor of pain while resting, and this step accounted for an addition of 14% in model variance ($F^{(6,47)}$change = 2.64, p=.06).

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Insert Table 20-3 about here

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The hierarchical regression conducted to address whether catastrophizing contributed to pain while resting, over and above the variance accounted for by depression and anxiety was non-significant. As shown in Table 21-3, gender and age did not contribute significant variance to the prediction of pain. This step accounted for 1% of the variance and was not significant ($F^{(2,51)}$change = .31, p=.74). OR time was not a significant predictor of pain while resting and contributed 1% in variance ($F^{(3,50)}$change = .15, p=.70). When the depression and anxiety were added to the model, catastrophizing was no longer a significant contributor. The final step of the model accounted for an addition of 7% in model variance ($F^{(6,47)}$change = 1.25, p=.30).

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Insert Table 21-3 about here

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Functional Disability.

As shown in Table 22-3, gender and age accounted for 4% of the variance in functional disability and were non-significant predictors in the analysis ($F^{(2,51)}$change = 1.06, p=.35). Adding pain while resting and moving and the knee rating scale resulted in a significant contribution in model variance of 27% ($F^{(5,48)}$change = 6.08, p=.001). Of the variables added at step 2, the Lysholm knee rating scale was the unique significant predictor (Beta = -.41; p<.01). In the final step of the model, the contributions of catastrophizing were found to be non-significant in predicting functional disability. The final step of the analysis accounted for an additional non-significant 7% in model variance ($F^{(7,46)}$change = 1.56, p=.21).

Insert Table 22-3 about here

Summary for Eight-Week Postoperative Assessment.

This assessment indicates that the average level of pain, depression, anxiety, and catastrophizing was reported to be minimal. It was also shown that knee performance ratings increased slightly from the preoperative assessment. Higher pain was related to increased functional disability and lower knee performance scores. Anxiety and depression were associated with poorer knee performance ratings and higher catastrophizing. There were significant gender differences for knee performance ratings with women reporting lower values than men. Although pain while moving was significantly predicted by catastrophizing (i.e., Rumination and Helplessness scales of the PCS), these effects were not found when levels of depression and anxiety were controlled for. Pain while resting was significantly predicted by catastrophizing (i.e., Helplessness scale of the PCS), but this effect was not found when levels of depression and anxiety were controlled in the analyses. Impairment in activities of daily living was best explained by poorer knee performance (LYS).

Phase 3 of Data Analyses.

The third phase of data analyses employed hierarchical regression analyses to examine the prospective predictions that the preoperative, 24 and 48-hour assessments of catastrophizing may influence future postoperative pain and disability into the future (i.e., hypothesis 5). Before conducting these regression analyses, zero-order correlations between catastrophizing and the dependent variables of interest were examined. If there were no significant relationships evident in these correlation analyses the regression analysis was not conducted. All regression models were employed in the manner detailed for the intra-assessment analyses.

Briefly, catastrophizing assessed preoperatively was examined for pain at 24-hours, 48-hours, and 8-weeks postoperative. Catastrophizing assessed at 24-hour postoperative was examined for pain and disability at 48-hours and 8-weeks postoperative. Finally, catastrophizing assessed at 48-hours postoperatively was examined for pain and disability at 8-weeks postoperative.

Future Postoperative Pain and Disability with Preoperative Catastrophizing.

As shown in Table 23-3, correlations between catastrophizing assessed preoperatively and pain assessed at 24-hours, 8-weeks postoperative, and functional disability at 8-weeks postoperative were not significant. However, there was a significant association between the preoperative Rumination catastrophizing subscale and pain at 48-hours postoperative ($r = .27$; $p<.05$). Therefore, regression analyses examining preoperative catastrophizing and pain at 48-hours postoperative were conducted.

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Insert Table 23-3 about here

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Preoperative Catastrophizing Predicting Pain at 48-hours Postoperative.

As shown in Table 24-3, on step 1, age was a significant predictor of pain at 48-hours postoperative (Beta = -.42; $p<.001$). Entering gender and age into the regression model accounted for a significant increase in the variance in pain (19%; $F^{(2,51)}$change = 5.90, $p=.005$). Step 2, adding the preoperative catastrophizing subscales, indicated no significant predictors of pain at 48-hours postoperative. The additional variance of this step was also non-significant (6%; $F^{(5,48)}$change = 1.32, $p=.28$).

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Insert Table 24-3 about here

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Predicting Future Postoperative Pain and Disability with Catastrophizing Assessed at 24-Hours Postoperative.

As shown in Table 25-3, correlations between catastrophizing assessed at 24-hours with pain and disability at 8-weeks postoperative were not significant. However, there was a significant association between all catastrophizing subscales and pain at 48-hours postoperatively (Rumination, $r = .54$; $p<.05$; Helplessness, $r = .33$; $p <.05$; Magnification, $r = .37$; $p<.05$). Therefore, regression analyses examining 24-hour postoperative catastrophizing and pain at 48-hours postoperative were conducted.

Insert Table 25-3 about here

Catastrophizing at 24-Hours Postoperative Predicting Pain at 48-Hours Postoperative.

The initial regression analysis examined the contribution of the 24-hours postoperative catastrophizing catastrophizing subscales in predicting pain at 48-hours postoperative. As shown in Table 26-3, on step 1, age was a significant predictor of pain at 48-hours postoperative (Beta = -.26; $p<.05$). Entering gender and age into the regression model accounted for a significant increase in the variance in pain (19%; $F^{(2,51)}$change = 5.90, $p=.005$). Step 2, adding the preoperative catastrophizing subscales, indicated that Rumination was a significant predictor of pain at 48-hours postoperative. The additional variance of this step was also significant (19%; $F^{(5,48)}$change = 5.00, $p=.004$).

Insert Table 26-3 about here

<u>All Psychological Variables at 24-Hours Postoperative Predicting Pain at 48-Hours Postoperative</u>.

This regression analysis examined the contribution of depression, anxiety, and catastrophizing assessed at 24-hours postoperatively in predicting pain at 48-hours postoperative. As shown in Table 27-3, on step 1, age was a significant predictor of pain at 48-hours postoperative (Beta = -.31; p<.05). Entering gender and age into the regression model accounted for a significant increase in the variance in pain (19%; $F^{(2,51)}$change = 5.90, p=.005). Step 2, adding 24-hour depression, anxiety, and catastrophizing, indicated that depression (Beta = .34; p<.05) and catastrophizing (Beta = .43; p<.01) were significant predictors of pain at 48-hours postoperative. The additional variance of this step was also significant (19%; $F^{(5,48)}$change = 4.90, p=.005).

Insert Table 27-3 about here

<u>Predicting Future Postoperative Pain and Disability with Catastrophizing Assessed at 48-Hours Postoperative.</u>

As shown in Table 28-3, the correlation between catastrophizing assessed at 48-hours with pain while resting was not significant. However, there was a significant association between the Rumination catastrophizing subscale assessed at 48-hours and pain while moving at 8-weeks postoperative (r = .38; p<.05). There was also a significant association between the catastrophizing subscale of Magnification assessed at 48–hours and disability at 8-weeks postoperative (r = .36; p<.05). Therefore, regression analyses examining 48-hour postoperative catastrophizing and pain while moving and disability at 8-weeks postoperative were conducted.

Insert Table 28-3 about here

Catastrophizing at 48-Hours Postoperative Predicting Pain while Moving at 8-weeks Postoperative.

As shown in Table 29-3, on step 1, neither age or gender were significant predictors of pain while moving at 8-weeks postoperative. Entering gender and age into the regression analysis accounted for a non-significant increase in the variance in pain (4%; $F^{(2,51)}$change = .95, p=.40). Step 2, adding the catastrophizing subscales assessed at 48-hours postoperative, indicated that Rumination was a marginally significant predictor for pain while moving at 8-weeks postoperative (Beta = .34; p=.053). The additional variance of this step was also marginally significant (14%; $F^{(5,48)}$change = 2.65, p=.059).

Insert Table 29-3 about here

All Psychological Variables at 48-Hours Postoperative Predicting Pain while Moving at 8-weeks Postoperative.

As shown in Table 30-3, on step 1, neither age or gender were significant predictors of pain while moving at 8-weeks postoperative. Entering gender and age into the regression model accounted for a non-significant increase in the variance in pain (4%; $F^{(2,51)}$ change = .95, p=.40). Step 2, adding depression, anxiety, and catastrophizing assessed at 48-hours postoperative, showed that catastrophizing was the lone significant predictor for pain while moving at 8-weeks postoperative (Beta = .35; p=.045). The additional variance of this step was not significant (13%; $F^{(5,48)}$change = 2.41, p=.08).

Insert Table 30-3 about here

Catastrophizing at 48-Hours Postoperative Predicting Functional Disability at 8-Weeks Postoperative.

As shown in Table 31-3, on step 1, neither age or gender were significant predictors of functional disability at 8-weeks postoperative. Entering gender and age into the regression model, age was shown to be a significant predictor (Beta = .40; p<.05). This step accounted for a non-significant increase in the variance in pain (4%; $F^{(2,51)}$change = 1.06, p=.35). Step 2, adding the 48-hour postoperative measure of pain, indicated significant prediction (Beta = .42; p<.05). The additional variance of this step to the model was also significant

(18%; $F^{(3,50)}$change = 11.70, p=.001). Step 3, adding the catastrophizing subscales of the 48-hour postoperative assessment, indicated that Magnification was a significant predictor of functional disability at 8-weeks postoperative (Beta = .34; p<.05). The additional variance of this step was non-significant (9%; $F^{(6,47)}$change = 2.15, p=.10).

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Insert Table 31-3 about here

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All Psychological Variables at 48-Hours Postoperative Predicting Functional Disability at 8-Weeks Postoperative.

As shown in Table 32-3, on step 1, age (Beta = 49; p<. 01) was a significant predictor of functional disability at 8-weeks postoperative. Entering gender and age into the regression model accounted for a non-significant increase in the variance in functional disability (4%; $F^{(2,51)}$change = 1.06, p=.35). Step 2, adding the 48-hour postoperative measure of pain, indicated significant prediction (Beta = .39; p<.05). The additional variance of this step to the model was also significant (18%; $F^{(3,50)}$change = 11.70, p=.001). Step 3, adding depression, anxiety, and catastrophizing of the 48-hour postoperative assessment, indicated no significant predictors of functional disability at 8-weeks postoperative. The additional variance of this step was also non-significant (9%; $F^{(6,47)}$change = 2.01, p=.13).

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Insert Table 32-3 about here

Discussion

Overall, the present data support all hypotheses of Study 3. To be parsimonious and direct in discussing these findings, the hypotheses of Study 3 will be reviewed in turn.

The correlational data of the present study support the first hypothesis that catastrophizing is positively associated with pain following ACL surgery. In fact, the correlations between catastrophizing and pain were robust for both the 24 and 48-hour postoperative periods. These data support suggestions of the general post-operative surgical literature, that catastrophizing is significantly associated with greater postoperative pain (e.g., Bennett-Branson & Craig, 1993; Butler et al., 1989; Jacobsen & Butler, 1996). These data are an important addition to the ACL injury and surgical recovery research because this is the first empirical report to show that athletic individuals reporting greater catastrophizing following ACL surgery are more likely to experience higher pain than those reporting less catastrophizing.

Both the clinical and experimental pain literatures show that catastrophizing is associated with heightened pain and emotional distress in response to pain (e.g., Heyneman et al., 1990; Jensen et al., 1991; Keefe et al., 1989; Spanos et al., 1979; Spanos et al., 1981; Sullivan & D'Eon, 1990; Sullivan et al., 1995). The current findings support these previous findings and extend them to an athletic population.

The present correlational data are also the first empirical evidence that catastrophizing and pain are significantly associated in athletic participants following orthopedic reconstructive knee surgery. There are few empirical reports of the associated psychological factors for pain following surgeries in the orthopedic literature but the available research indicates that catastrophizing may be an important factor in recovery. For example, Keefe et al. (1991) found that catastrophizing, as assessed by the CSQ, was a significant component of a higher pain at the 1-year follow-up in arthritis patients who had experienced knee replacement surgery. Although the work of Keefe et al. (1991) is important in understanding the effects of catastrophizing and pain following orthopedic knee surgeries at the 1-year period postoperative, their methodology did not allow for the examination of catastrophizing during the acute phase of recovery.

The second hypothesis stated that catastrophizing would correlate positively with disability following ACL surgery. Catastrophizing assessed at 8-weeks postoperative was shown to correlate positively with functional disability following ACL surgery at 8-weeks postoperative. These data suggest that those who report greater frequency of catastrophic thinking are more likely to report increased disability in performing activities of daily living (e.g., shopping, walking, or showering) at 8-weeks following ACL surgery.

Previous ACL surgery research has not examined disruption in functional activities of daily living for athletic individuals; therefore, there is no direct comparison for the present findings. However, recent clinical studies suggest that catastrophizing and indices of life-related disability are significantly related. For example, Sullivan et al. (1998) examined catastrophizing, pain, and disability with patients who had recently (approximately 1-year) sustained soft tissue injuries to the neck, shoulders, or back following work or motor vehicle accidents. Their data indicated that greater catastrophizing was significantly correlated with patients' reported pain intensity and perceived disability. Further, Robinson et al. (1997) showed that the catastrophizing scale of the CSQ was significantly correlated with measures of life activity drawn from pain scales. Finally, Martin et al. (1996) showed that catastrophizing was positively correlated with the total disability scale of the Sickness Impact Profile (SIP; Bergner et al., 1981) for a sample of patients diagnosed with primary fibromyalgia. Considering these data, the positive association between catastrophizing and disability 8-weeks after ACL surgery is concordant with the general trend exhibited in a growing body of health research.

The third hypothesis stated that the Rumination subscale of the PCS would be the strongest predictor of pain and disability following ACL surgery. This hypothesis was based on the data of Sullivan et al. (1995) and was <u>not</u> drawn from the findings of Study 2 where the Helplessness subscale of the PCS predicted cold pressor pain ratings. The third hypothesis will be discussed in separate sections, with Rumination predicting pain and then Rumination predicting disability.

Rumination and Pain.

The current set of regression analyses, examining pain during each of the preoperative and postoperative assessments, showed that Rumination was the sole significant psychological predictor of pain for the 24 and 48-hour postoperative assessments over and above depression and anxiety. The Rumination scale was also a significant predictor in the regression model examining pain while moving at 8-weeks postoperative. However, it was the Helplessness subscale that most strongly predicted pain while moving at 8-weeks postoperative. Further, Helplessness and not Rumination, was shown to be the sole significant predictor of pain while resting at the 8-week postoperative assessment.

The current finding, that catastrophizing predicts postoperative pain following ACL surgery, supports previous research showing that catastrophizing is an important individual differences factor in postoperative pain (e.g., breast cancer surgeries, Jacobsen & Butler, 1996; abdominal surgeries in adolescents; Bennett-Branson & Craig, 1993). Catastrophizing is also important in understanding heightened pain experience in a variety of other stressful procedures. For example, catastrophizing has been shown to predict pain intensity in individuals undergoing stressful medical diagnostic procedures (Sullivan et al., 1995), dental procedures (Chaves & Brown, 1978/1987; Sullivan

& Neish, 1998), and in individuals suffering from chronic headache (Bedard et al., 1998).

The particular finding that Rumination accounted for significant unique variance in acute pain supports earlier data. As shown by Sullivan et al. (1995), the Rumination subscale of the PCS is the strongest contributor in the prediction of pain, accounting for the largest proportion of variance following acute pain inductions. The powerful association between Rumination and pain may be best understood in terms of the item content of the Rumination subscale. Sullivan et al. (1995), suggests that the items of the Rumination subscale reflect an inability to suppress or divert attention away from pain-related thoughts. Therefore, ruminatory thoughts may be intricately tied to the acute pain experience because of the proximal nature of the stimulus.

There has been speculation as to how catastrophizing may affect pain. For example, Heyneman et al. (1990) suggested that catastrophic pain-related thoughts are significant in elevating pain experience because they might impair one's ability to make effective use of distraction strategies. As elaborated upon by Sullivan et al. (1995), ruminatory pain-related thoughts may be the particular aspect of catastrophizing that ultimately interferes with catastrophizers attempt to use pain coping strategies. Although the present research is unable to address whether Rumination reduces one's ability to use other pain coping strategies, the 24 and 48-hour data indicate that Rumination is the strongest contributor in predicting higher pain responses following ACL surgery.

In contrast to the acute postoperative data, the 8-week postoperative data shows that Helplessness and not Rumination was the strongest predictor of pain while moving and resting. These data were unexpected, but may indicate that the PCS subscales are affected by a time-based shift in pain "appraisals" over the assessments of this study. The catastrophizing subscales (i.e., Magnification, Rumination, and Helplessness) share several characteristics with the primary and secondary appraisal processes related to the coping and stress literatures (Jensen et al., 1991; Lazarus & Folkman, 1984). As suggested by Sullivan et al. (1995), the Magnification and Rumination subscales may be best conceptualized as a part of a primary appraisal process in which the individual focuses or exaggerates the threat value of pain that is more immediate or acute. The Helplessness subscale however, may be more appropriately conceptualized as cognition related to a secondary appraisal process in which the individual tends to reflect upon and negatively evaluate his/her ability to deal effectively with pain.

A "pain-appraisal hypothesis" does offer one explanation for the present pain and catastrophizing regression results because such a model predicts that as pain increases acutely following surgery patients would be focused on the threat value of their pain (i.e., a primary appraisal, Rumination & Magnification). Thus, patients may interpret their pain as a warning signal that something is wrong leading to an excessive focus on their pain sensations. This appraisal formulation lends support to the findings that the Rumination subscale accounts for the most variance when predicting acute postoperative pain.

Following the acute 24 and 48-hour postoperative period, healing continues and active rehabilitation has been well established. At the 8-week assessment, pain is drastically reduced compared to the acute postoperative period. With respect to the pain data at 8-weeks postoperative, it is reasonable to suggest that most pain experience occurs when the individual is moving or engaged in physiotherapy. Therefore, this reduced and more infrequent "pain occurrence profile" is a drastic change when compared to strong and consistent acute postoperative pain. These different contexts may be experienced as more painful based upon how the individual appraises his/her pain. It may be that this more sporadic and rehabilitation or movement-based pain threaten an individual's sense of control over his/her pain. This threat to control may then lead to thoughts of helplessness in regard to managing or understanding his/her pain during rehabilitation.

As suggested by Heil (1993), athletes in the later stages of rehabilitation from a severe injury often have difficulty in understanding the differences between pain that is a normal part of exercise exertion and pain that used to signal that damage is occurring. Speculatively, the misinterpretation of pain cues in rehabilitation suggested by Heil (1993) might partially explain the shift from a ruminatory to helpless orientation toward pain exhibited between the acute and 8-week postoperative assessments. At the 8-week point in rehabilitation, the athletes continue to feel heightened pain and may develop a sense of gaining little control over the pain. These perceptions may then lead to a more helpless orientation toward the pain experienced during rehabilitation.

With the regression data showing that the predictive nature of catastrophizing for pain changes from the acute to 8-week postoperative periods (i.e., from Rumination to Helplessness), different foci in managing pain at these assessment periods may be warranted. For example, during the acute postoperative period, presurgical counseling on the average or expected pain experience following surgery is suggested. As Anderson (1987) suggests, patients who are better prepared for the specifics of their immediate postoperative experiences report less anxiety and complications. This has important implications for the current data because anxiety was significantly correlated to catastrophizing in the acute postoperative period.

Although there was very little pain experienced at 8-weeks postoperative, patient education may be a primary intervention for those expressing higher levels of discomfort. Heil (1993) suggests that educating the patient about the expected course of pain in rehabilitation may act to reduce the discrepancy between pain as a warning signal or as a progress signal. This education should not be delivered only at a preoperative meeting but should be utilized when issues of motivation, progress in rehabilitation, and pain become pertinent. Such an intervention could lead to less overall distress and might specifically affect helplessness catastrophizing by the patient.

In summary, a cognitive appraisal model of pain catastrophizing appears to be useful for understanding individual differences in pain following ACL surgery and recovery, especially in the area of directing actual intervention techniques.

Rumination and Disability.

The second component of the third hypothesis was that the Rumination subscale of the PCS would predict functional disability at 8-weeks postoperative. This hypothesis is supported by research showing the Rumination subscale of the PCS to be a significant predictor of disability in patients following significant soft tissue injuries (Sullivan et al., 1998). In the present study, regression analysis showed that the PCS subscales were not significant predictors of disability and the hypothesis was not supported. The analysis did show however, that the Lysholm knee rating scale was a significant predictor of functional disability at 8-weeks postoperative. These data indicate that general knee function accounts for significant variance in predicting disability at 8-weeks post ACL reconstruction. In contrast, disability assessed at the preoperative assessment was significantly predicted by the Magnification subscale of the PCS over and above the variance accounted for by the Lysholm knee rating scale.

To facilitate explanation of the current findings, research shows that the relation between specific components of catastrophizing (i.e., Magnification, Rumination, and Helplessness) and perceived disability may vary as a function of time and the duration of pain. For example, Sullivan et al. (in press) has reported that the Magnification subscale of the PCS was the best predictor of pain and disability in patients who had recently sustained whiplash injuries within the last year. As well, Sullivan et al. (1998) found that the Rumination subscale was the best predictor of disability and pain in those suffering from musculoskeletal pain for approximately three years. Finally, Vienneau et al. (1999) found that the Helplessness subscale of the PCS was the best predictor of disability in long standing low back pain patients (approx. 9 years). This data pattern may indicate that as pain continues for these patient groups, catastrophizing provides varied influence, with Magnification being most influential during an early "disability adjustment phase" and Helplessness being more significant over longer periods.

In the present study, pain and functional disability both decreased drastically from the acute to the 8-week postoperative assessments. It is speculated that these decreases might have disrupted the pattern of catastrophizing found in the longer disability adjustment research. The fact that Magnification was a significant predictor of functional disability preoperatively (i.e., short-term disability) and that catastrophizing did not predict disability at 8-weeks postoperative (i.e., long-term) lends some tentative weight to this position. Further, and possibly more telling, most of the data on catastrophizing and disability have been drawn from chronic pain populations and simply may not be applicable to this sample of ACL-operated athletic individuals.

Another possible reason for the null findings of catastrophizing at 8-weeks postoperative may be related to the number of medical status variables accounted for in the regression analyses. The decision to include pain and overall knee performance data in the regression analyses before examining the contributions of psychological variables may be construed as conservative. However, from a medical perspective one would expect a primary relation between pain, knee function ratings, and functional disability. Therefore, the analysis was designed to examine the possible effect of psychological variables on functional disability after the appropriate variance contributions of pain and knee function have been accounted for.

The fourth hypothesis stated that the relation between catastrophizing (i.e., PCS) and pain-related outcomes would be independent of emotional distress (i.e., anxiety & depression) following ACL surgery. Regression analyses were conducted on all significant regression models where catastrophizing was significant in predicting pain. There were follow-up analyses conducted for the 24-hour, 48-hour, and 8-week postoperative assessment periods.

For both the 24 and 48-hour postoperative assessments, regression analyses showed that catastrophizing accounted for significant variance in pain over and above the effects of depression, anxiety, medical status, and demographic variables. However, the analyses of pain while moving and resting at 8-weeks postoperative showed that catastrophizing no longer predicted pain when the variance attributable to depression and anxiety were accounted. These findings will be discussed in turn.

The acute 24 and 48-hour postoperative data support previous reports that catastrophizing is not a redundant construct with depression and anxiety in predicting pain (Keefe et al., 1989; Sullivan et al., 1995). Although the present data show catastrophizing to be correlated with anxiety and depression during these assessments, catastrophizing contributes unique variance to the prediction of pain.

The present findings, that catastrophizing predicts pain over and above affective distress at 24 and 48-hours postoperatively, have important implications for the sport and rehabilitation literature. It is currently recognized by coaches, physicians, and physiotherapists that athletes differ in their capacity to function with pain (e.g., Heil, 1993; Taylor & Taylor, 1997). There is also a growing awareness among sports medicine providers of the need to consider psychological factors as significant not only in sports performance, but also in sports injuries, postoperative rehabilitation, and pain management (e.g., Flint, 1998; Weiss & Troxel, 1986; Wiese & Weiss, 1987; Wiese-Bjornstal et al., 1998). When considering pain management following ACL surgery, the present data show that catastrophizing is a significant individual difference factor in postoperative pain in an athletic sample.

In suggesting that catastrophizing is an important variable following ACL surgery, it must be emphasized that athletes do experience a wide range of emotions in response to pain and injury such as anger, frustration, confusion and depression (e.g., Rotella, 1982; Wiese & Weiss, 1987). Coakley (1983) suggests that athletes may suffer widespread distress when injured, with inter and intrapersonal adjustments forced upon them that can be very stressful and difficult to deal with. Further, Danish (1986) adds that injuries are particularly stressful for athletes. The present catastrophizing data should not detract from the significance of negative emotional states following ACL surgery. These issues of affective distress for further clinical investigation and must be reviewed on an individual basis for athletes recovering from ACL surgery. It would be interesting to have future research examine whether or not catastrophizing may be responsible for heightened emotional distress seen in athletes post-injury. Such research may illuminate the appraisal process involved with pain and emotional distress following serious sport injury in athletes.

The present data indicate that catastrophizing is a robust factor in understanding pain after ACL surgery and should be specifically targeted when attempting to manage pain. The pain management literature describes a wide variety of self-regulation skills that have been empirically shown to be beneficial in general pain management. For example, Fernandez and Turk (1986) have acknowledged six categories of pain management techniques including: 1) external focus of attention (i.e., directing one's attention away from the pain toward events in the environment); 2) pleasant imaginings (i.e., internal focus of attention on pleasant images); 3) neutral imaginings (i.e., internal focus on neutral events); 4) rhythmic cognitive activity (i.e., performing a routine or repetitive cognitive task such as repetitive phrases); 5) pain acknowledging (i.e., a reinterpretation of pain or a shift away from an ordinary style of attention); and 6) dramatized coping (i.e., creating an imaginary scenario where pain is under control).

Although these general strategies are supported in the chronic pain management literature, acute pain coping strategies tend to predominantly employ analgesic medications. Therefore, the pain regression models at 24 and 48-hours postoperative used a hierarchical design where the variance attributable to the pain medications consumed was accounted for. This methodology allows researchers to document the effect of cognitive factors after accounting for the association between pain intensity and the amount of pain medication consumed by participants. The current pain regression models show that catastrophizing accounts for significant variance in pain over and above demographic variables, pain medication usage, surgery duration, depression, and anxiety.

The processes linking catastrophizing to pain experience are presently unclear. Several investigators have appealed to attention-related explanations, arguing that individuals who catastrophize may be unable to successfully divert attention away from painful sensations (Heyneman et al., 1990; Spanos et al., 1979; Sullivan et al., 1995). It has also been suggested that the inability to divert attention away from painful stimulation may interfere with the efficacy of cognitive coping strategies (Turk & Rudy, 1992). In support of these suggestions, there are data to suggest that distraction is an effective coping strategy for individuals who do not catastrophize, but is ineffective for individuals who catastrophize (Heyneman et al., 1990). It has also been shown that when individuals who catastrophize are asked to suppress thoughts about pain, they experience more pain-related thought intrusions than individuals who do not catastrophize (Sullivan, Rouse, Bishop & Johnston, 1997).

Within the chronic pain literature, there have been several successful attempts at reducing pain and catastrophizing. For example, using either cognitive or relaxation treatment combinations designed to increase health behaviors and activity levels was more effective in decreasing the occurrence of catastrophizing than treatment aimed at either health behavior or activity levels alone (Vlaeyen et al., 1995). Further, headache research has shown that catastrophizing can be significantly reduced by cognitive behavioral treatment (ter Kuile, Spinhoven, Liussen, & Von Houweliugen, 1995). Finally, there have been specific cognitive-based strategies shown to reduce catastrophizing and increase pain tolerance in experimental acute pain. Conducting a complete component analysis of stress inoculation training (SIT) with cold pressor pain, Vallis (1984) showed that increased use of relaxation strategies and decreased catastrophizing were mediated by the skills acquisition stage of SIT. During the skills acquisition stage of Vallis' (1984) study, subjects were instructed in relaxation and deep breathing exercises and cognitive restructuring techniques (i.e., identifying negative self-statements and replacing them with coping statements).

The particular form of cognitive restructuring identified by Vallis (1984) uses self-statements drawn from Meichenbaum (1977). For example, Vallis (1984) asked participants preparing for the painful stressor to replace their thoughts that they would not be able to deal with the situation with more optimistic and goal directed thoughts such as, "you can develop a plan to deal with it", "just think about what you have to do", or "just think about what you can do about it". When confronting and handling the pain experience, participants were instructed to think, "you can meet the challenge", this tenseness can be an ally, a cue to cope", or "this anxiety is what the trainer said you might feel". In regard to coping with feelings at critical moments, "when pain comes, just pause; keep focused on what you have to do", "don't try to eliminate pain totally; just keep it under control", or "when the pain mounts you can switch to a different strategy; you're in control". For success in dealing with their pain, participants were asked to congratulate themselves with self-statements such as, "you handled it pretty well", "you knew you could do it", or "wait until you tell the trainer about which procedures worked best".

Examining psychological interventions in sport injury prevention and rehabilitation, Durso-Cupal (1998) argued that psychological intervention made a statistically significant difference for recovering athletes whether it was earlier strength gains, increased physical functioning, state anxiety, or pain reduction.

For example, her unpublished doctoral thesis showed that instruction in relaxation and guided imagery (i.e., having patient imagine difficulties in rehabilitation and new ways to cope with them), resulted in significant gains in reducing state anxiety and a quicker return to desired activities for the control group in patients experiencing ACL reconstructive surgery (Durso-Cupal, 1996). Further, reflecting the inherent value of Vallis' (1984) work, the use of Stress Inoculation Techniques is helpful for athletes following arthroscopic knee surgery. Ross and Berger (1996) examined two groups of athletes, using a Stress Inoculation treatment condition versus a control condition. Both groups experienced arthroscopic meniscal repair. The experimental group reported less post-surgical pain and anxiety and required fewer days to return to physical functioning than those in the control group. Considering Vallis's (1984) and Ross and Berger's (1996) findings together, it is suggested that SIT treatment may be an effective treatment in reducing postoperative catastrophizing and emotional distress following ACL reconstructive surgery. This suggestion is speculative but does combine research showing that SIT can reduce pain and catastrophizing in experimental pain as well as pain and anxiety following arthroscopic knee surgery. Future research is required to examine this issue. It should also be noted that the present findings do not alter the intervention approach that has been used in the past.

The analyses of pain while moving and resting at 8-weeks showed that catastrophizing no longer predicted pain when the variance attributable to depression and anxiety were accounted for in those analyses. The most straightforward explanation may be that pain scores were just too minimal to allow for appropriate variance for examining relations with other constructs such as catastrophizing. In other words, the low pain scores had created a restricted range. It is also possible that with decreased variance, the cumulative effect of the variance accounted for by anxiety and depression may have accounted for enough variance to dilute the effects of catastrophizing.

The fifth hypothesis stated that catastrophizing would predict pain and disability in cross-sectional and prospective analyses. In these analyses each assessment period of catastrophizing was regressed on future assessments of pain and disability. Each set of analyses is discussed in turn.

Preoperative Catastrophizing Predicting Future Pain.

Initial data showed that preoperative catastrophizing scores were not associated with future pain or functional disability ratings. These data indicate that preoperative catastrophizing has little future predictive value with pain and functional disability. These data are somewhat surprising given the strength of correlations provided by Sullivan et al. (1995) in their suggestion that catastrophizing may act in a trait-like manner. It may be possible that catastrophizing following a surgical intervention in athletic people may be more a situation-specific reactive stance than the trait-like response observed by Sullivan et al. (1995) with undergraduate students.

24-hour Catastrophizing Predicting Future Pain.

The results of regression analyses showed that the Rumination subscale of the PCS assessed at 24-hours postoperatively was a significant predictor of pain reported at 48-hours postoperative. This finding is not unexpected because of the strong correlation between pain and catastrophizing at 24 and 48-hour postoperative assessments. When including depression and anxiety in the regression model catastrophizing assessed at 24-hours postoperative continued to add unique variance to the prediction of pain at 48-hours postoperative. These data indicate that those individuals higher in catastrophizing at 24-hours after ACL surgery will likely report higher pain at 48-hours than those lower in catastrophizing. These data may be most useful for anticipating those who may experience greater pain during the acute recovery phase from ACL surgery. These data also highlight the need for intervention with catastrophizing and pain throughout the acute recovery period. These findings are important regard to pain management following ACL surgery. In particular, hospital staff may be able to monitor ACL patients on the first day postoperative for catastrophizing and distress and implement an appropriate treatment to reduce catastrophizing, such as the SIT intervention discussed earlier.

It is also a possibility that patients during the 24-hour preoperative period may be too heavily sedated by narcotic consumption to benefit from psychological intervention. Anecdotally, very few (2) of the patients in the present research needed any delay in being able to complete all assessment measures. These individuals complained of nausea, not an inability to think or carry on discussion. However, this issue was not directly assessed in the present study and such a question must be examined in future research.

48-hour Catastrophizing Predicting Future Pain and Functional Disability.

Regression analyses examining the predictive ability of 48-hour catastrophizing to predict 8-week postoperative pain was not significant. However, catastrophizing's prediction of disability at 8-weeks was significant. In particular, the Magnification subscale of the PCS assessed at 48-hours postoperative was a significant predictor of functional disability at 8-weeks postoperative. These data show that those higher in Magnification of their pain at the end of their acute postoperative stay in hospital were more likely to show higher functional disability at 8-weeks postoperative than those reporting less catastrophic thought. This finding is somewhat surprising given that 8-week catastrophizing does not predict 8-week disability. However, understanding the course of distress and rehabilitation following ACL surgery may provide an appropriate backdrop from which to view these findings.

Although supported by anecdotal and some empirical suggestion, the following rationale for the predictive relation between 48-hour catastrophizing and 8-week disability must be considered speculative. Following the acute postoperative hospitalization, ACL patients are sent home to recover on their own or with the aid of family members. It is possible that those patients higher in catastrophizing may display greater pain and distress after leaving the hospital. This time during recovery might be very anxiety provoking for those high in catastrophizing because affective distress (i.e., anxiety and depression) has been shown to be significantly associated with catastrophizing. It is logical to suggest that those higher in catastrophizing experience greater anxiety as they await and then start their rehabilitation regimen at 2-weeks postoperative. This anxiety may then lead to feelings of doubt and trepidation before physiotherapy begins, leaving the individual with feelings of losing control.

One of the most pressing problems that injured athletes have to face during rehabilitation may be feelings of helplessness and lack of control due to pain. As Taylor and Taylor (1998) comment, these feelings act to increase the perception of pain, decrease the quality of rehabilitation, and slow the recovery process. If those leaving the hospital higher in catastrophizing did indeed experience this cascade of negative emotions, they would be more likely to experience lower quality rehabilitation of their knee, resulting in poorer functional outcomes at 8-weeks postoperative. This effect would be expected to show itself in later functional markers in spite of the level of catastrophizing occurring later. Indeed, this may explain why catastrophizing at 8-weeks does not predict disability at 8-weeks but catastrophizing at 48-hours postoperative does. Such speculation awaits further direct research.

The final hypothesis was that catastrophizing would remain stable in value across the 8-weeks assessment period of this study. This hypothesis was made on the basis of claims of construct stability similar to a trait-like conceptualization for the PCS (Sullivan et al., 1995). Along with the analysis of change in catastrophizing over time, pain, affective distress, and functional disability were included. Each finding will be discussed in turn.

Pain Catastrophizing.

Repeated measures analysis revealed significant changes over time in pain catastrophizing. This data is the first empirical report to examine such effects in athletes with the PCS. These data show that catastrophizing remains statistically similar at the preoperative and 24-hour postoperative assessments. However, catastrophizing decreases significantly over the recovery process (i.e., 24 to 48-hour and 48-hour to 8-weeks postoperative).

Sullivan et al. (1995) have suggested that catastrophizing may be a temporally stable or trait-like construct among asymptomatic pain populations such as undergraduate students. In particular, they report test-retest correlations for the PCS across six and ten-week periods at .75 and .70 respectively. In the present study however, the test-retest correlation for catastrophizing across an eight-week period is .19 ($p. > .05$). Such a low correlation along with the significant changes in catastrophizing observed over the assessment times of this study are contradictory to claims of temporal stability for the catastrophizing, at least as assessed by the PCS in athletes following reconstructive ACL surgery. As discussed earlier, perhaps pain catastrophizing is better conceptualized as a negative cognitive appraisal process (Jensen et al., 1991), fluctuating with the amount of pain experienced, behaving more like a state-like construct. Whether or not catastrophizing functions in a state-like manner for athletes following general types sport-injury (e.g., bruises, sprains) or presents a positive correlation with injury severity should be investigated in the future. Although this position is an attractive one and the data would seem to support the general theme, it should be evaluated as tentative because there was no significant change in catastrophizing from preoperative to 24-hour postoperative periods. But as often is the case with proposing possible theories for your data, not all data can be expected to conform perfectly.

Pain.

Repeated measures analyses for pain showed that pain increased after surgery and remained high while in hospital. However, pain was significantly lower at the 8-week postoperative assessment. These data follow the pattern expected in surgery, that pain is elevated after the invasive surgical procedure and decreases as healing takes place (Stoudemire, 1995).

Affective Distress.

Repeated measures analyses revealed significant changes over time for both depressive and anxiety symptoms. Although the depressive and anxious symptoms from the preoperative to the 24-hour postoperative assessment increased significantly they remained statistically stable from 24 to 48-hours postoperative. These symptoms significantly decreased from the 48-hour to 8-weeks postoperative assessment.

These data correspond with those of Morrey et al. (1999), who suggest that ACL patients demonstrate elevated psychological distress in the first weeks following surgery. As suggested by Morrey et al. (1999), the negative emotion detected after surgery may be attributable to the consequences of the injury, such as the surgical experience, pain, lack of sleep and concerns about rehabilitation. Further, Morrey et al. (1999) suggests that the significant decrease in depressive and anxious symptoms at the mid-rehabilitation interval (i.e., from 48-hours to 8-weeks postoperative) may be due to the individual realizing some of his/her rehabilitation goals and increased feelings of self-efficacy in activities.

Functional Disability.

The analysis examining differences in functional disability over the time of the study showed that the average person in the study returned to the level of functional disability initially reported during the preoperative period. These data indicate that although the ability to function in many areas of life may be compromised following ACL surgery (e.g., walking, sleeping, eating, self-care, etc.) by the 8-week point in rehabilitation the average patient can be functioning at preoperative levels. Functional disability data need to be assessed during the intervals following the acute postoperative stay and the 8-week postoperative period by future research to examine how levels of disability might progress. This data should not be misinterpreted as indicating that ACL injury has no functional implications for injured athletes. Clearly, there are many functional handicaps following ACL injury especially when sporting activities are concerned. Future research should examine the extent of activities of daily living disability compared to sport-related disability to obtain a better understanding of such possible differences for the athlete.

Various clinical specialties that create pain in the course of providing a patient service (e.g., surgeons, dentists) are recognizing the importance of psychosocial factors in delivering satisfactory medical services (Williams, 1999). To the best of my knowledge, no previous empirical efforts have documented the longitudinal changes in pain, catastrophizing, depression, anxiety, and functional disability for the ACL reconstructed patient. These data have implications for patient information pamphlets as well as for surgeons because they act to establish a preliminary baseline for comparing acute and mid-rehabilitation pain, catastrophizing, affective distress, and disability in recreational athletes who have had ACL reconstruction.

Longitudinal postoperative data may be most useful in prepatory communications with patients concerning the expected course of recovery from arthroscopically assisted patella-tendon-autograft ACL reconstructive surgery. There is considerable data indicating that preparatory surgical information can play a significant role in reducing postoperative distress. In particular, individuals who know what to expect before surgery are better able to cope with stress than people who do not know what lies ahead. Many surgical patients, for example, suffer unnecessarily because they have not been warned that they will have considerable pain after the operation (Stoudemire, 1995). It has been shown that patients are less anxious and recover faster when the surgery and recovery process are explained to them before the operation takes place. For example, Anderson (1987) examined the effect of preoperative information on distress following surgery in coronary bypass patients. Before surgery, Anderson split his patients into a control and an experimental condition. The control group received the hospital's standard preparatory surgical brochure during a short visit from a nurse. The experimental group received the brochure and visit but also watched a video that followed a patient through the operation and recovery. The data showed that 75 % of those in the control group (i.e., the standard surgical preparation) experienced acute hypertension following surgery. Less than 45 % of the experimental group (i.e., who viewed the tape) experienced acute hypertension. The patients who viewed the tape also reported less stress and were reported to be more relaxed based upon nurses' ratings during the week following surgery.

As a final point, results showed age inversely correlated with pain and catastrophizing. Bondareff (1980) suggests that age-related physiological changes, such as the loss of synapses and neurons, atrophy of dendrites, and reductions in neurotransmitters may interfere with the processing of pain. Perhaps, age-related social norms may limit the expression of distress in older patients (Neugarten, 1977). Although plausible these suggestions await specific examination.

Closing the discussion, the present data are correlational and not cause and effect. Cause and effect relations are best examined in experimental designs. This study was not designed for such questions, but future research employing control and treatment groups may provide insights. Short of experimental design, several authors have supported using larger sample sizes and high-level statistical modeling techniques to examine causality (Tabachnick & Fidell, 1996); both methods are reasonable.

Future research may also examine Rumination's suppressing effect upon the use of pain coping strategies post ACL surgery. The present study did not assess pain coping. The CSQ (Rosenstiel & Keefe, 1983) is the most referenced in the pain literature. It would be interesting to examine pain coping strategies and catastrophizing in our sample to see if the Heyneman et al. (1990) suggestion that catastrophizing interferes with distraction strategies is correct.

Generalisability of the present findings is an important issue for comment. The current results are drawn from a sample of recreational athletes across ages. A population of elite athletes may not show similar findings in pain, affective distress, or catastrophizing. Future research with elite athletes undergoing ACL surgery may illuminate a variety of other influences to rehabilitation. Speculatively, one could argue that money and such other incentives may actually sensitize the athlete to his/her pain and disability, raising levels of pain catastrophizing. Such questions await future research.

Table 1-1.

Summary of Model Fit Statistics for Athletic and Non-Athletic Samples.

Model by Sample	X^2 / SB-X^2	df	NFI	CFI	RCFI	IFI
Athletic Sample						
0 Null Model	610.15	78	—	—	—	—
1 Hypothesized Model (Sullivan, Bishop, & Pivik, 1995)	94.56** 79.24**	62	.85	.94	.96	.94
2 Error correlation between item 2 and 3	87.88** 70.82**	61	.87	.96	.98	.96
3 Error correlation between item 11 and 10	74.27** 63.15**	60	.89	.97	.99	.97
Non-Athletic Sample						
0 Null Model	742.96	78	—	—	—	—
1 Hypothesized Model (Sullivan, Bishop, & Pivik, 1995)	133.94** 118.66**	62	.82	.89	.91	.89
2 Correlate error terms (E1,E3)(E2,E3) (E9,E10)	97.70** 87.26**	59	.87	.94	.95	.94
3 Correlate error terms (E1,E2)	88.40* 78.62*	58	.89	.94	.95	.97
4 Correlate error terms (E8,E10)	80.40* 71.72*	57	.90	.97	.98	.97

Note. ** indicates significant change in X^2 ($p<.001$); * ($p<.05$). SB-X^2 = Sattora-Bentler scaled statistic (Sattorra & Bentler, 1988); NFI = Normed Fit Index (Bentler & Bonnet, 1980); CFI = Comparative Fit Index (Bentler, 1990); RCFI = Robust Comparative Fit Index (Byrne, 1994); IFI = Incremental Fit Index (Bollen, 1989).

Table 2-1.

Summary Tests for Invariance across Athletic and Non-Athletic Samples.

Model	X^2	df	Models	X^2	df	NFI	CFI	IFI
1 Baseline multi-group model	139.99	116	—	—	—	.90	.98	.98
2 Pattern of PCS item loadings specified as invariant	146.37	125	2 vs. 1	6.36 ^{Ns}	10	.90	.97	.97
3 Pattern of PCS Factor variances and covariances specified as invariant	152.90	132	3 vs. 2	6.53 ^{Ns}	6	.89	.98	.98

Note. ^{Ns} indicates a non-significant change in X^2 ($p > .05$). NFI = Normed Fit Index (Bentler & Bonnet, 1980); CFI = Comparative Fit Index (Bentler, 1990); IFI = Incremental Fit Index (Bollen, 1989).

Table 1-2.

Correlations Among PCS Subscales for Athletic and Non-Athletic Samples.

	Pain	PCS	Rumin	Magni	Helpless.
Pain		.43**	.40**	.38**	.37**
PCS	.30*		.90**	.71**	.95**
Rumin.	.27*	.90**		.47**	.82**
Magnif.	.09	.66**	.52**		.54**
Helpless.	.33**	.86**	.69**	.27*	

Note: Pain = Pain ratings during ice water immersion; PCS = Pain Catastrophizing Scale; Rumin. = Rumination subscale of the PCS; Magnif. = Magnification subscale of the PCS; Helpless. = Helplessness subscale of the PCS. Correlations above the diagonal are for the non-athletic sample, and correlations below the diagonal are for the athletic sample. *=p<.05, **=p<.01

Table 1-3.

Sports Played by ACL-Injured Recreational Athletes.

Sport	Frequency	Percentage
Soccer	11	20%
Hockey	9	17%
baseball	2	4%
basketball	13	24%
martial arts	1	2%
Skiing	4	7%
Racquet sports	4	7%
Rugby	2	4%
volleyball	2	4%
Football	5	9%
equestrian	1	1%
Total	54	100%

Table 2-3.

Descriptive Statistics for Psychological & Physical Variables Assessed Over Time.

Variable	Time 1 Pre -surgery (N=54) M (SD)	Time 2 24 hr Post-op (N=54) M (SD)	Time 3 48 hr Post-op (N=54) M (SD)	Time 4 8 wks Post-op (N=54) M (SD)
Pain (while moving)	1.55 (1.75)	6.92 (2.11)	6.24 (2.28)	1.00 (1.06)
Pain (while resting)	.80 (1.44)	4.96 (2.46)	4.29 (2.38)	.27 (.58)
Depression (BDI)	6.43 (4.32)	8.91 (4.90)	7.76 (5.55)	4.31 (4.43)
State Anxiety Inventory (STAI-S)	36.48 (11.67)	40.26 (10.23)	38.54 (10.25)	27.53 (8.61)
Pain Catastrophizing Scale (PCS)	13.94 (7.61)	15.06 (9.19)	12.13 (8.30)	5.50 (5.20)
Functional Disability (FDI)	19.34 (14.36)	-	-	23.42 (12.65)

Table 3-3.

Descriptive Statistics for Variables Assessed at Preoperative Period (Preoperative Assessment).

	Mean	Median	SD	Min.	Max.
Pain (moving)	1.55	.60	1.75	0	7.1
Pain (resting)	.81	.10	1.45	0	6.3
Pain Catastrophizing (PCS)	13.94	13.5	7.61	0	38
Depression (BDI)	6.43	6	4.31	0	18
State Anxiety (STAI-S)	36.48	35	11.67	20	71
Functional Disability (FDI)	19.34	17.4	1.45	1.5	59.7
Knee Rating Scale (Lysholm)	61.96	63	15.01	28	95

Table 4-3.

Correlations Among Preoperative Psychological , Functional, and Demographic Measures (Preoperative Assessment).

	PAIN	PCS	BDI	STAI-S	FDI	LYS	Gender
PCS	.10						
BDI	.28*	.50*					
STAI-S	.24	.48*	.71*				
FDI	.44*	.20	.28*	.20			
LYS	-.42*	-.20	-.26	-.05	-.24		
Gender	-.11	.04	.01	.14	-.13	-.08	
Age	-.07	-.13	-.19	-.26	-.02	.03	.05

Note. Pain while resting and moving were collapsed into one Pain value because of high correlation between the two variables. PCS=Pain Catastrophizing Scale; BDI=Beck Depression Inventory; STAI-S=Speilberger State-Trait Anxiety Inventory; FDI=Functional Disability Inventory; LYS=Lysholm Knee Rating Scale. *=p<.05, **=p<.01.

Table 5-3.

Regression Analyses of PCS Subscales on Pain (Preoperative Assessment).

Variables	Standardized Beta	R^2 Total	R^2 Change	F Change	P
Step 1		.02	.02	.42	.65
Gender	-.06				
Age	-.12				
Step 2		.04	.02	.27	.85
Rumin.	.09				
Helpless.	.17				
Magnif.	.03				
Residuals	**Min**	**Max**	**Mean**	**SD**	
Cook's Dis.	.00	.43	.02	.06	

Note. Rumin.= Rumination subscale; Helpless.= Helplessness subscale; Magnif.= Magnification subscale; All regression steps used a forced enter procedure; Beta weights are from the final regression equation; * = p<.05; ** = p<.01; Values in parentheses are Beta weights of excluded variables; Cook's Dis.= Cook's Distance.

Table 6-3.

Regression Analyses of PCS Subscales on Functional Disability (Preoperative Assessment).

Variables	Standardized Beta	R^2 Total	R^2 Change	F Change	P
Step 1		.02	.02	.47	.63
Gender	-.13				
Age	-.01				
Step 2		.35	.33	12.65	.000
LYS	-.39**				
PAIN	.24				
Step3		.42	.07	1.86	.15
Rumin.	.22				
Helpless.	.16				
Magnif.	.27*				

Residuals	Min	Max	Mean	SD
Cook's Dis.	.00	.44	.03	.06

Note. LYS = Lysholm Knee Rating Scale; PAIN-R = VAS Pain while Resting; PAIN-M = VAS Pain while Moving; Rumin.= Rumination subscale; Helpless.= Helplessness subscale; Magnif.= Magnification subscale; All regression steps used a forced enter procedure; Beta weights are from the final regression equation; * = $p<.05$; ** = $p<.01$; Values in parentheses are Beta weights of excluded variables; Cook's Dis.= Cook's Distance.

Table 7-3.

Regression Analyses of Psychological Variables on Functional Disability (Preoperative Assessment).

Variables	Standardized Beta	R^2 Total	R^2 Change	F Change	P
Step 1		.02	.02	.47	.63
Gender	-.17				
Age	.06				
Step 2		.35	.33	12.65	.000
LYS	-.44**				
PAIN	.19				
Step 3		.38	.03	.67	.58
BDI	.01				
STAI-S	.17				
PCS	.03				
Residuals	**Min**	**Max**	**Mean**	**SD**	
Cook's Dis.	.00	.38	.02	.06	

Note. LYS = Lysholm Knee Rating Scale; PAIN-R = VAS Pain while Resting; PAIN-M = VAS Pain while Moving; STAI-S = Speilberger State Anxiety Inventory; PCS = Pain Catastrophizing Scale; BDI = Beck Depression Inventory; All regression steps used a forced enter procedure; Beta weights are from the final regression equation; * = $p<.05$; ** = $p<.01$; Values in parentheses are Beta weights of excluded variables; Cook's Dis.= Cook's Distance.

Table 8-3.

Descriptive Statistics for Variables Assessed at 24-hours Postoperative Assessment.

	Mean	Median	SD	Min.	Max.
Pain (moving)	6.92	7.50	2.11	1.40	10
Pain (resting)	4.96	5.50	2.47	.60	9.4
Pain Catastrophizing (PCS)	15.06	13	9.19	0	40
Depression (BDI)	8.91	8	4.90	1	22
State Anxiety (STAI-S)	40.26	40	10.23	20	64
OR Time (Mins.)	76.15	73.5	13.57	50	107
Pain Medication Consumption (Opioid equivalents)	3.56	3.28	2.21	.43	9

Table 9-3.

<u>Correlations Among Psychological , Functional, and Demographic Measures</u> (24-hours Postoperative).

	PAIN	PCS	BDI	STAI-S	OR	Meds	Gender
PCS	.61**						
BDI	.15	.45**					
STAI-S	.43**	.62**	.59**				
OR	.21	.35**	-.11	.09			
Meds	.30*	.09	.08	.18	.05		
Gender	-.08	-.13	.21	.12	-.29*	.11	
Age	-.43**	-.42**	-.37**	-.47**	.04	-.19	.05

Note. PAIN = is averaged pain value due to high correlation between pain while moving and resting (.80); PCS= Pain Catastrophizing Scale; BDI= Beck Depression Inventory; STAI-S= Speilberger State-Trait Anxiety Inventory; OR= time of operation duration (mins); Meds= Pain medication consumption (Opioid equivalents). *=p<.05, **=p<.01.

Table 10-3.

Regression Analyses of PCS Subscales on Pain (24-hours Postoperative).

Variables	Standardized Beta	R^2 Total	R^2 Change	F Change	P
Step 1		.19	.19	5.96	.005
Gender	-.02				
Age	-.16				
Step 2		.28	.09	3.19	.05
OR Time	.03				
Meds Cons.	.21*				
Step 3		.54	.26	8.78	.000
Rumin.	.67**				
Helpless.	.02				
Magnif.	.15				
Residuals	**Min**	**Max**	**Mean**	**SD**	
Cook's Dis.	.00	.32	.03	.05	

Note. OR Time = Amount of time (minutes) from start of procedure to end; Meds Cons. = Amount of Postoperative pain medication consumed (in Opioid equivalent dose); Rumin.= Rumination subscale; Helpless.= Helplessness subscale; Magnif.= Magnification subscale; All regression steps used a forced enter procedure; Beta weights are from the final regression equation; * = $p<.05$; ** = $p<.01$; Values in parentheses are Beta weights of excluded variables; Cook's Dis.= Cook's Distance.

Table 11-3.

Regression Analyses of Psychological Variables on Pain (24-hours Postoperative).

Variables	Standardized Beta	R^2 Total	R^2 Change	F Change	P
Step 1		.19	.19	5.96	.005
Gender	.01				
Age	-.20				
Step 2		.28	.09	3.19	.05
OR Time	.03				
Meds Cons.	.22*				
Step 3		.49	.21	6.25	.001
BDI	.25				
PCS	.57**				
STAI-S	.10				
Residuals	**Min**	**Max**	**Mean**	**SD**	
Cook's Dis.	.00	.13	.02	.03	

Note. OR Time = Amount of time (minutes) from start of procedure to end; Meds Cons. = Amount of Postoperative pain medication consumed (in Opioid equivalent dose); STAI-S = Speilberger State Anxiety Inventory; PCS = Pain Catastrophizing Scale; BDI = Beck Depression Inventory; All regression steps used a forced enter procedure; Beta weights are from the final regression equation; * = p<.05; ** = p<.01; Values in parentheses are Beta weights of excluded variables; Cook's Dis.= Cook's Distance.

Table 12-3.

Descriptive Statistics for Variables Assessed at 48-hours Postoperative.

	Mean	Median	SD	Min.	Max.
Pain (moving)	6.24	6.7	2.28	.60	10
Pain (resting)	4.29	4.2	2.38	0	9.2
Pain Catastrophizing (PCS)	12.13	10.5	8.3	0	36
Depression (BDI)	7.76	7	5.55	0	26
State Anxiety (STAI-S)	38.54	39	10.25	20	67
Pain Medication Consumption (Opioid equivalents)	2.03	1.19	1.96	0	9.8

Table 13-3.

Correlations Among Psychological , Medical, and Demographic Measures (48-hours Postoperative).

	PAIN	PCS	BDI	STAI-S	OR	Meds	Gender
PCS	.58**						
BDI	.20	.46**					
STAI-S	.39**	.62**	.64**				
OR	.19	.39**	.07	.05			
Meds	.34*	.21	.30	.39**	-.09		
Gender	.05	-.04	.10	.05	-.29*	.32*	
Age	-.41**	-.30*	-.35**	-.39**	.04	-.11	.05

Note. PCS = Pain Catastrophizing Scale; BDI = Beck Depression Inventory; STAI-S = Speilberger State-Trait Anxiety Inventory; OR = time of operation duration (mins); Meds = Pain medication consumption (Opioid equivalents); $p<.05$, **=$p<.01$.

Table 14-3.

Regression Analyses of PCS Subscales on Pain (48-hours Postoperative).

Variables	Standardized Beta	R^2 Total	R^2 Change	F Change	P
Step 1		.18	.18	5.42	.007
Gender	.04				
Age	-.22				
Step 2		.32	.14	4.99	.01
OR Time	.04				
Meds Cons.	.22				
Step 3		.49	.18	5.39	.003
Rumin.	.46**				
Helpless.	.08				
Magnif.	.01				
Residuals	**Min**	**Max**	**Mean**	**SD**	
Cook's Dis.	.00	.58	.04	.09	

Note. OR Time = Amount of time (minutes) from start of procedure to end; Meds Cons. = Amount of Postoperative pain medication consumed (in Opioid equivalent dose); Rumin.= Rumination subscale; Helpless.= Helplessness subscale; Magnif.= Magnification subscale; All regression steps used a forced enter procedure; Beta weights are from the final regression equation; * = p<.05; ** = p<.01; Values in parentheses are Beta weights of excluded variables; Cook's Dis.= Cook's Distance.

Table 15-3.

Regression Analyses of Psychological Variables on Pain (48-hours Postoperative).

Variables	Standardized Beta	R^2 Total	R^2 Change	F Change	P
Step 1		.18	.18	5.42	.007
Gender	.04				
Age	-.32*				
Step 2		.32	.14	4.99	.01
OR Time	.06				
Meds Cons.	.26*				
Step 3		.49	.17	4.95	.005
PCS	.52**				
BDI	.23				
STAI-S	.02				
Residuals	**Min**	**Max**	**Mean**	**SD**	
Cook's Dis.	.00	.40	.03	.07	

Note. OR Time = Amount of time (minutes) from start of procedure to end; Meds Cons. = Amount of Postoperative pain medication consumed (in opioid equivalent dose); STAI-S = Speilberger State Anxiety Inventory; PCS = Pain Catastrophizing Scale; BDI = Beck Depression Inventory; All regression steps used a forced enter procedure; Beta weights are from the final regression equation; * = $p<.05$; ** = $p<.01$; Values in parentheses are Beta weights of excluded variables; Cook's Dis.= Cook's Distance.

Table 16-3.

<u>Descriptive Statistics for Variables at 8-weeks Postoperative</u>.

	Mean	Median	SD	Min.	Max.
Pain (moving)	1.01	.70	1.06	0	4.6
Pain (resting)	.27	0	.58	0	3.4
Pain Catastrophizing (PCS)	5	3	5.2	0	23
Depression (BDI)	4.31	2	4.43	0	17
State Anxiety (STAI-S)	27.54	22.5	8.61	20	52
Functional Disability (FDI)	23.42	21.8	12.65	3.1	63.3
Knee Rating Scale (Lysholm)	71.30	72	14.55	35	100

Table 17-3.

Correlations Among Psychological, Functional, and Demographic Measures (8-weeks Postoperative).

	Pain-M moving	Pain-R resting	PCS	BDI	STAI-S	FDI	LYS	Gender	Age
Pain-R	.55**								
PCS	.19	.19							
BDI	.15	.06	.49**						
STAI-S	.23	-.01	.47**	.71**					
FDI	.31*	.14	.28*	.49**	.44**				
LYS	-.38**	-.18	-.13	-.36**	-.43**	-.42**			
Gender	.10	.13	.12	.07	.16	-.09	-.30*		
Age	-.16	.11	-.12	-.03	-.16	.17	.02	.05	
OR	.02	-.08	.05	-.13	-.08	.14	.18	.29*	.04

Note. PCS = Pain Catastrophizing Scale; BDI = Beck Depression Inventory; STAI-S = Speilberger State-Trait Anxiety Inventory; LYS = Lysholm Knee Rating Scale; OR= time of operation duration (mins); *=p<.05, **=p<.01.

Table 18-3.

Regression Analyses of PCS subscales on Pain while Moving (8-weeks Postoperative).

Variables	Standardized Beta	R^2 Total	R^2 Change	F Change	P
Step 1		.04	.04	.94	.40
Gender	.12				
Age	-.18				
Step 2		.04	.00	.17	.68
OR Time	.06				
Step 3		.18	.14	2.77	.05
Rumin.	.43*				
Helpless.	.47*				
Magnif.	.20				
Residuals	**Min**	**Max**	**Mean**	**SD**	
Cook's Dis.	.00	.18	.02	.04	

Note. OR Time = Amount of time (minutes) from start of procedure to end; PCS = Pain Catastrophizing Scale; Rumin.= Rumination subscale; Helpless.= Helplessness subscale; Magnif.= Magnification subscale; All regression steps used a forced enter procedure; Beta weights are from the final regression equation; * = p<.05; ** = p<.01; Values in parentheses are Beta weights of excluded variables; Cook's Dis.= Cook's Distance.

Table 19-3.

Regression Analyses of Psychological variables on Pain while Moving (8-weeks Postoperative).

Variables	Standardized Beta	R^2 Total	R^2 Change	F Change	P
Step 1		.04	.04	.94	.40
Gender	.08				
Age	-.13				
Step 2		.04	.00	.17	.68
OR Time	.06				
Step 3		.08	.04	.73	.54
PCS	.09				
STAI-S	.17				
BDI	.02				

Residuals	**Min**	**Max**	**Mean**	**SD**
Cook's Dis.	.00	.21	.02	.04

Note. OR Time = Amount of time (minutes) from start of procedure to end; PCS = Pain Catastrophizing Scale; Rumin.= Rumination subscale; Helpless.= Helplessness subscale; Magnif.= Magnification subscale; All regression steps used a forced enter procedure; Beta weights are from the final regression equation; * = p<.05; ** = p<.01; Values in parentheses are Beta weights of excluded variables; Cook's Dis.= Cook's Distance.

Table 20-3.

Regression Analyses of PCS Subscales on Pain while Resting (8-weeks Postoperative).

Variables	Standardized Beta	R^2 Total	R^2 Change	F Change	P
Step 1		.01	.01	.31	.74
Gender	.04				
Age	.05				
Step 2		.02	.01	.15	.70
OR Time	.08				
Step 3		.16	.14	2.64	.06
Rumin.	-.26				
Helpless.	.47*				
Magnif.	.15				

Residuals	Min	Max	Mean	SD
Cook's Dis.	.00	.34	.03	.06

Note. OR Time = Amount of time (minutes) from start of procedure to end; Rumin.= Rumination subscale; Helpless.= Helplessness subscale; Magnif.= Magnification subscale; All regression steps used a forced enter procedure; Beta weights are from the final regression equation; * = p<.05; ** = p<.01; Values in parentheses are Beta weights of excluded variables; Cook's Dis.= Cook's Distance.

Table 21-3.

Regression Analyses of Psychological Variables on Pain while Resting (8-weeks Postoperative).

Variables	Standardized Beta	R^2 Total	R^2 Change	F Change	P
Step 1		.01	.01	.31	.74
Gender	.08				
Age	.05				
Step 2		.02	.01	.15	.70
OR Time	.07				
Step 3		.09	.07	1.25	.30
PCS	.25				
STAI-S	.17				
BDI	.13				
Residuals	**Min**	**Max**	**Mean**	**SD**	
Cook's Dis.	.00	.38	.03	.06	

Note. OR Time = Amount of time (minutes) from start of procedure to end; STAI-S = Speilberger State Anxiety Inventory; PCS = Pain Catastrophizing Scale; BDI = Beck Depression Inventory; All regression steps used a forced enter procedure; Beta weights are from the final regression equation; * = p<.05; ** = p<.01; Values in parentheses are Beta weights of excluded variables; Cook's Dis.= Cook's Distance.

Table 22-3.

Regression Analyses of PCS Subscales on Functional Disability (8-weeks Postoperative).

Variables	Standardized Beta	R^2 Total	R^2 Change	F Change	P
Step 1		.04	.04	1.06	.35
Gender	.27				
Age	-.26				
Step 2		.31	.27	6.08	.001
LYS	-.41**				
PAIN-R	.01				
PAIN-M	.18				
Step 3		.38	.07	1.56	.21
Rumin.	.19				
Helpless.	.01				
Magnif.	.13				
Residuals	Min	Max	Mean	SD	
Cook's Dis.	.00	.22	.03	.04	

Note. LYS = Lysholm Knee Rating Scale; PAIN-R = VAS Pain while Resting; PAIN-M = VAS Pain while Moving; PCS = Pain Catastrophizing Scale; Rumin.= Rumination subscale; Helpless.= Helplessness subscale; Magnif.= Magnification subscale; All regression steps used a forced enter procedure; Beta weights are from the final regression equation; * = p<.05; ** = p<.01; ^{m} = marginal significance; Values in parentheses are Beta weights of excluded variables; Cook's Dis.= Cook's Distance.

Table 23-3.

Correlations Among Preoperative Catastrophizing Subscales with Prospective Pain and Disability Measures.

	PAIN 24-hrs	PAIN 48-Hrs	PAIN (moving) 8-wks	PAIN (resting) 8-wks	Func Dis 8-wks
P-Help.	.04	.23	.06	.22	.22
P-Rumin.	.13	.27*	.05	.11	.01
P-Mag.	.17	.19	.07	.04	.11

Note. P-Help. = Preoperative Pain Catastrophizing Helplessness Subscale; P-Rumin. = Preoperative Pain Catastrophizing Rumination Subscale; P-Mag. = Preoperative Pain Catastrophizing Magnification Subscale; Func Dis = Functional Disability; * $p<.05$, **= $p<.01$.

Table 24-3.

Correlations Among Preoperative Catastrophizing Subscales with Prospective Pain and Disability Measures.

Variables	Standardized Beta	R^2 Total	R^2 Change	F Change	P
Step 1		.19	.19	5.90	.005
Gender	.07				
Age	-.42**				
Step 2		.25	.06	1.32	.28
P-Rumin.	.12				
P-Helpless.	.02				
P-Magnif.	.16				
Residuals	**Min**	**Max**	**Mean**	**SD**	
Cook's Dis.	.00	.09	.02	.02	

Note. P-Rumin.= Preoperative Rumination subscale of the PCS; P-Helpless.= Preoperative Helplessness subscale of the PCS; P-Magnif.= Preoperative Magnification subscale of the PCS; All regression steps used a forced enter procedure; Beta weights are from the final regression equation; * = p<.05; ** = p<.01; Values in parentheses are Beta weights of excluded variables; Cook's Dis.= Cook's Distance.

Table 25-3.

Correlations Among 24-Hour Catastrophizing Subscales with Prospective Pain and Disability Measures.

	PAIN 48-Hrs	**PAIN** (moving) **8-wks**	**PAIN** (resting) **8-wks**	**Func Dis 8-wks**
24-Help.	.33*	.03	.05	.07
24-Rumin.	.54**	.16	.02	.07
24-Mag.	.37**	.09	.12	.04

Note. 24-Help. = 24-hour Postoperative Pain Catastrophizing Helplessness Subscale; 24-Rumin. = 24-hour Postoperative Pain Catastrophizing Rumination Subscale; 24-Mag. = 24-hour Postoperative Pain Catastrophizing Magnification Subscale; Func Dis = Functional Disability; * p<.05, **=p<.01.

Table 26-3.

Regression Analyses of PCS Subscales Assessed at 24-Hours Predicting Pain at 48-hours Postoperative.

Variables	Standardized Beta	R^2 Total	R^2 Change	F Change	P
Step 1		.19	.19	5.90	.005
Gender	-.04				
Age	-.26*				
Step 2		.38	.19	5.01	.004
24-Rumin.	.53**				
24-Helpless.	.19				
24-Magnif.	.11				
Residuals	**Min**	**Max**	**Mean**	**SD**	
Cook's Dis.	.00	.14	.02	.03	

Note. 24-Rumin.= 24-Hour Postoperative Rumination subscale of the PCS; 24-Helpless.= 24-Hour Postoperative Helplessness subscale of the PCS; 24-Magnif.= 24-Hour Postoperative Magnification subscale of the PCS; All regression steps used a forced enter procedure; Beta weights are from the final regression equation; * = $p<.05$; ** = $p<.01$; Values in parentheses are Beta weights of excluded variables; Cook's Dis.= Cook's Distance.

Table 27-3.

Regression Analyses of Psychological Variables Assessed at 24-Hours Predicting Pain at 48-hours Postoperative.

Variables	Standardized Beta	R^2 Total	R^2 Change	F Change	P
Step 1		.19	.19	5.90	.005
Gender	.17				
Age	-.31*				
Step 2		.38	.19	4.90	.005
24-PCS	.43**				
24-BDI	.34*				
24-STAI-S	.16				
Residuals	**Min**	**Max**	**Mean**	**SD**	
Cook's Dis.	.00	.24	.02	.04	

Note. 24-PCS = 24-Hour Postoperative PCS; 24-BDI = 24-Hour Postoperative Beck Depression Inventory; 24-STAI-S = 24-Hour Postoperative State Anxiety Inventory; All regression steps used a forced enter procedure; Beta weights are from the final regression equation; * = p<.05; ** = p<.01; Values in parentheses are Beta weights of excluded variables; Cook's Dis.= Cook's Distance.

Table 28-3.

Correlations Among 48-Hour Catastrophizing Subscales with Prospective Pain and Disability Measures.

	PAIN (moving) **8-wks**	**PAIN** (resting) **8-wks**	**Func Dis 8-wks**
48-Help.	.24	.05	.23
48-Rumin.	.38**	.07	.23
48-Mag.	.27	.04	.36**

Note. 48-Help. = 48-hour Postoperative Pain Catastrophizing Helplessness Subscale; 48-Rumin. = 48-hour Postoperative Pain Catastrophizing Rumination Subscale; 48-Mag. = 48-hour Postoperative Pain Catastrophizing Magnification Subscale; Func Dis = Functional Disability; * p<.05, **=p<.01.

Table 29-3.

Regression Analyses of PCS Subscales Assessed at 48-Hours Postoperative Predicting Pain While Moving at 8-Weeks Postoperative.

Variables	Standardized Beta	R^2 Total	R^2 Change	F Change	P
Step 1		.04	.04	.95	.40
Gender	.11				
Age	-.03				
Step 2		.17	.13	2.65	.059
48-Rumin.	$.34^M$				
48-Helpless.	.04				
48-Magnif.	.13				
Residuals	Min	Max	Mean	SD	
Cook's Dis.	.00	.24	.02	.05	

Note. 48-Rumin.= Rumination subscale of the PCS assessed at 48-hours postoperative; 48-Helpless.= Helplessness subscale of the PCS assessed at 48-hours postoperative; 48-Magnif.= Magnification subscale of the PCS assessed at 48-hours postoperative; All regression steps used a forced enter procedure; Beta weights are from the final regression equation; * = p<.05; ** = p<.01; Values in parentheses are Beta weights of excluded variables; Cook's Dis.= Cook's Distance; ^{M} = marginal significance (p=.051).

Table 30-3.

Regression Analyses of All Psychological Variables Assessed at 48-Hours Postoperative Predicting Pain While Moving at 8-Weeks Postoperative.

Variables	Standardized Beta	R^2 Total	R^2 Change	F Change	P
Step 1		.04	.04	.95	.40
Gender	.13				
Age	-.08				
Step 2		.17	.13	2.41	.08
48-PCS	.35*				
48-BDI	.19				
48-STAI-S	.12				
Residuals	**Min**	**Max**	**Mean**	**SD**	
Cook's Dis.	.00	.25	.02	.05	

Note. 48-PCS = total PCS assessed at 48-hours postoperative; 48-BDI = Beck Depression Inventory assessed at 48-hours postoperative; 48-STAI-S = State Anxiety Inventory assessed at 48-hours postoperative; All regression steps used a forced enter procedure; Beta weights are from the final regression equation; * = p<.05; ** = p<.01; Values in parentheses are Beta weights of excluded variables; Cook's Dis.= Cook's Distance; M = marginal significance (p=.053).

Table 31-3.

Regression Analyses of PCS Subscales Assessed at 48-Hours Postoperative Predicting Functional Disability at 8-weeks Postoperative.

Variables	Standardized Beta	R^2 Total	R^2 Change	F Change	P
Step 1		.04	.04	1.06	.35
Gender	-.14				
Age	-.40**				
Step 2		.22	.18	11.70	.001
48-PAIN	.42*				
Step 3		.32	.10	2.15	.11
48-Rumin.	.04				
48-Helpless.	.03				
48-Magnif.	.34*				
Residuals	**Min**	**Max**	**Mean**	**SD**	
Cook's Dis.	.00	.19	.02	.04	

Note. 48-PAIN = VAS Pain index assessed at 48-hours postoperative; 48-Rumin. = Rumination Scale of the PCS assessed at 48-hours postoperative; 48-Helpless. = Helplessness Subscale of the PCS assessed at 48-hours postoperative; 48-Magnif. = Magnification Subscale of the PCS assessed at 48-hours postoperative; All regression steps used a forced enter procedure; Beta weights are from the final regression equation; * = p<.05; ** = p<.01; Values in parentheses are Beta weights of excluded variables; Cook's Dis.= Cook's Distance.

Table 32-3.

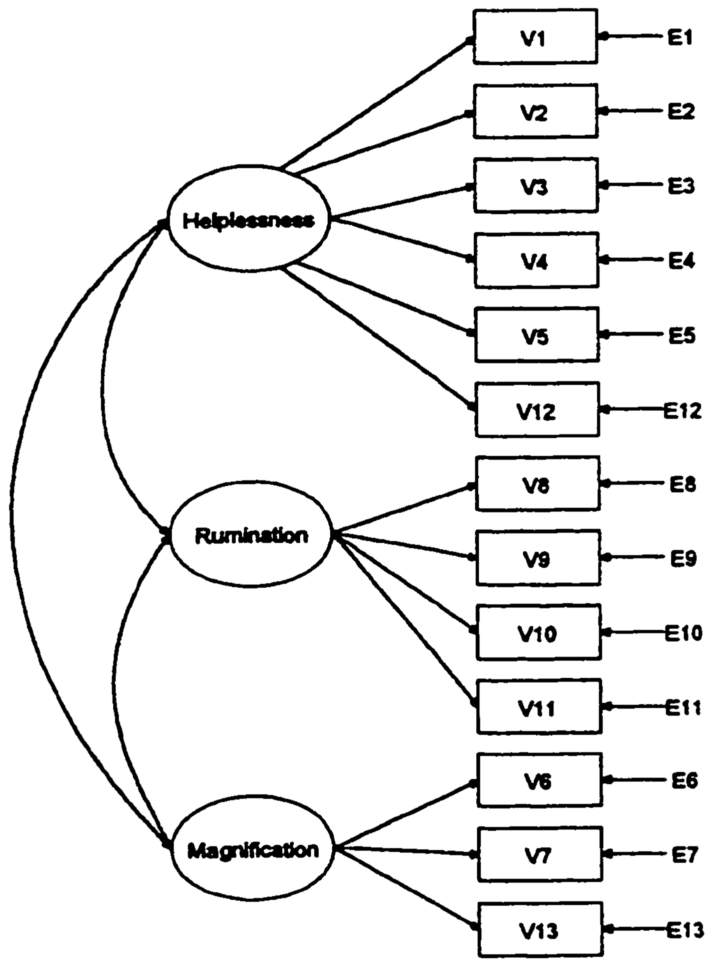
Regression Analyses of All Psychological Variables Assessed at 48-Hours Postoperative Predicting Functional Disability at 8-weeks Postoperative.

Variables	Standardized Beta	R^2 Total	R^2 Change	F Change	P
Step 1		.04	.04	1.06	.35
Gender	-.15				
Age	-.49**				
Step 2		.22	.18	11.70	.001
48-PAIN	.39**				
Step 3		.31	.09	2.01	.13
48-PCS	.24				
48-BDI	.13				
48-STAI-S	.23				

Residuals	Min	Max	Mean	SD
Cook's Dis.	.00	.19	.02	.04

Note. 48-PAIN = VAS Pain index assessed at 48-hours postoperative; 48-PCS = total PCS assessed at 48-hours postoperative; 48-BDI = Beck Depression Inventory assessed at 48-hours postoperative; 48-STAI-S = State Anxiety Inventory assessed at 48-hours postoperative; All regression steps used a forced enter procedure; Beta weights are from the final regression equation; * = p<.05; ** = p<.01; Values in parentheses are Beta weights of excluded variables; Cook's Dis.= Cook's Distance.

Figure 1-1. Factor structure of Pain Catastrophizing Scale (PCS; Sullivan, Bishop, & Pivik, 1995).



Note: V1 to V13 represent the different items of the PCS. E1 to E13 represent the error terms associated with each item.

Figure 2-1. Optimized PCS baseline models for Athletic and Non-Athletic samples.

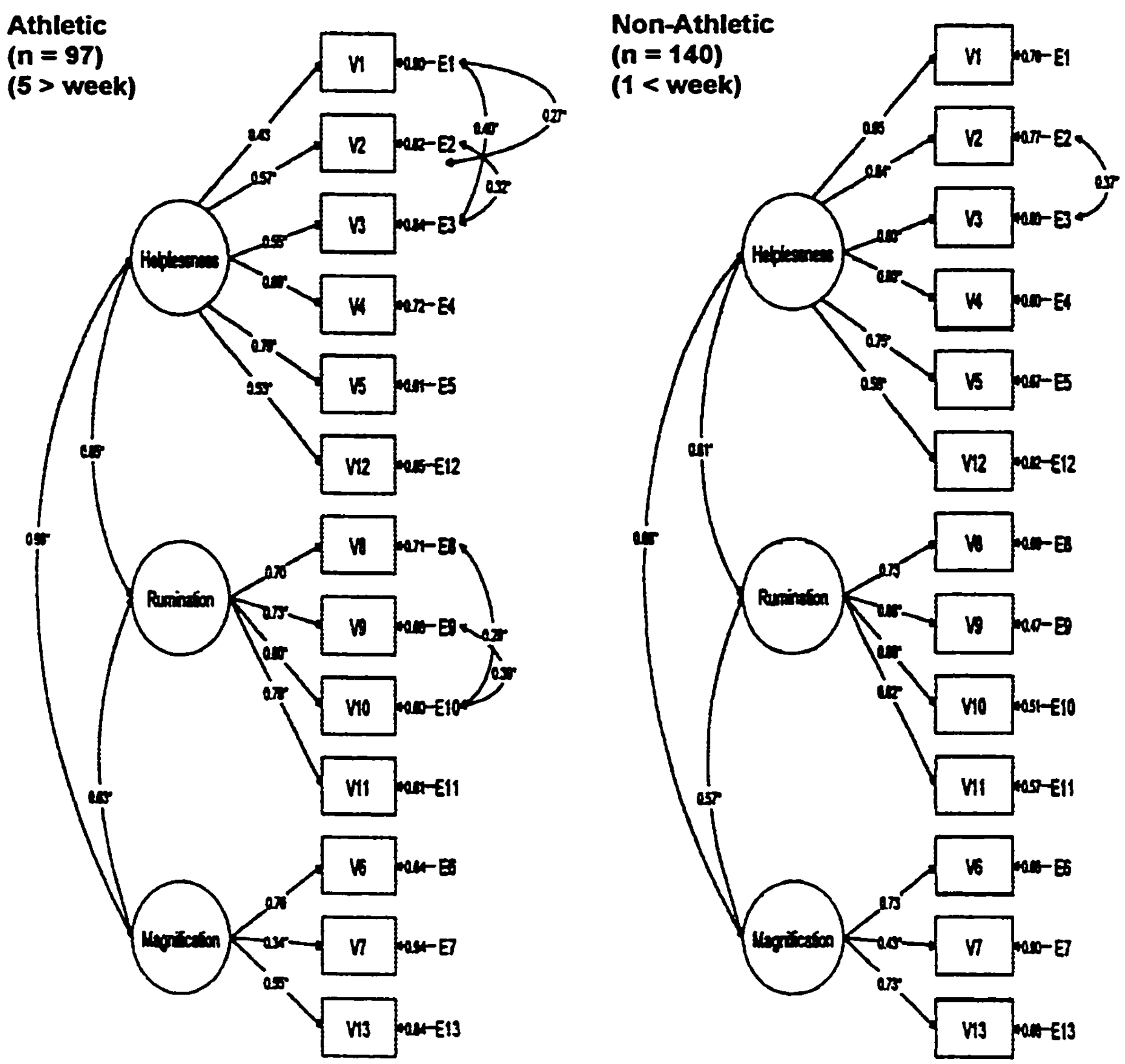


Figure 1-3. Anterior Cruciate Ligament (ACL) and General Knee Anatomy.

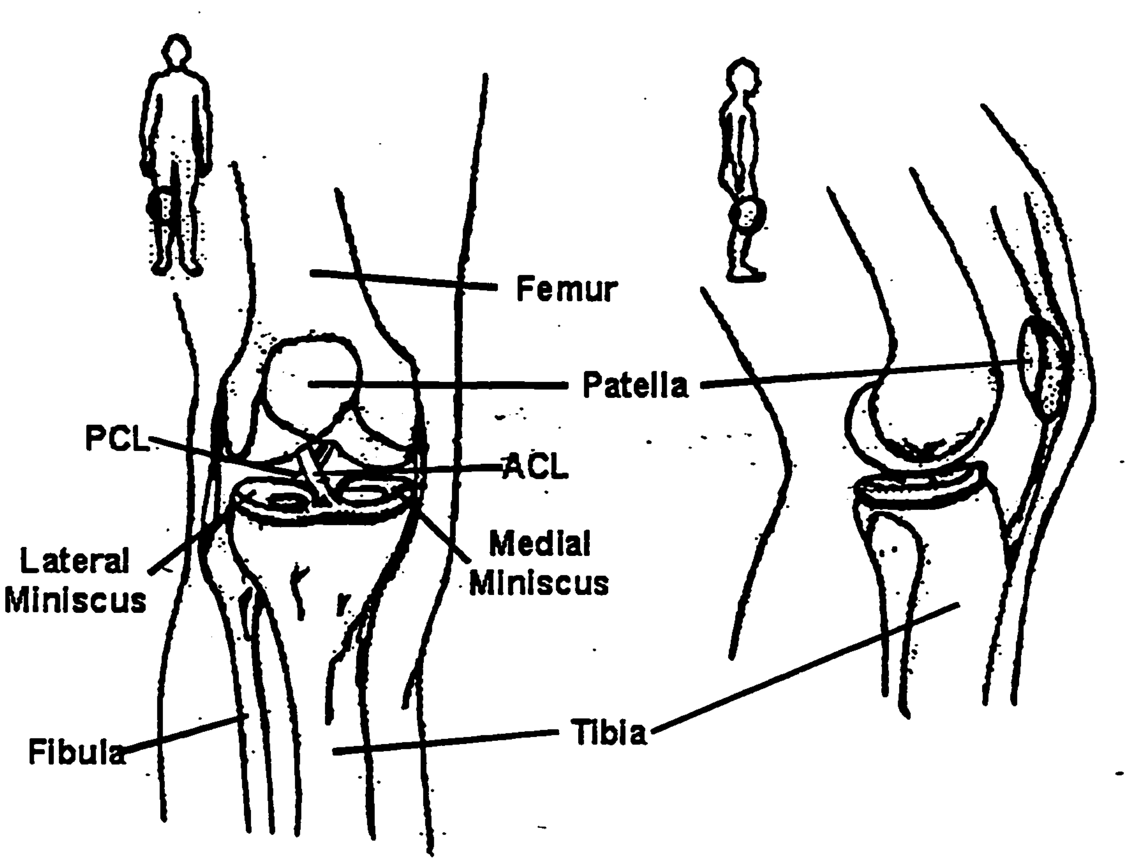


Figure 2-3. Patella-tendon Graft Sight for Anterior Cruciate Ligament (ACL) Reconstruction.

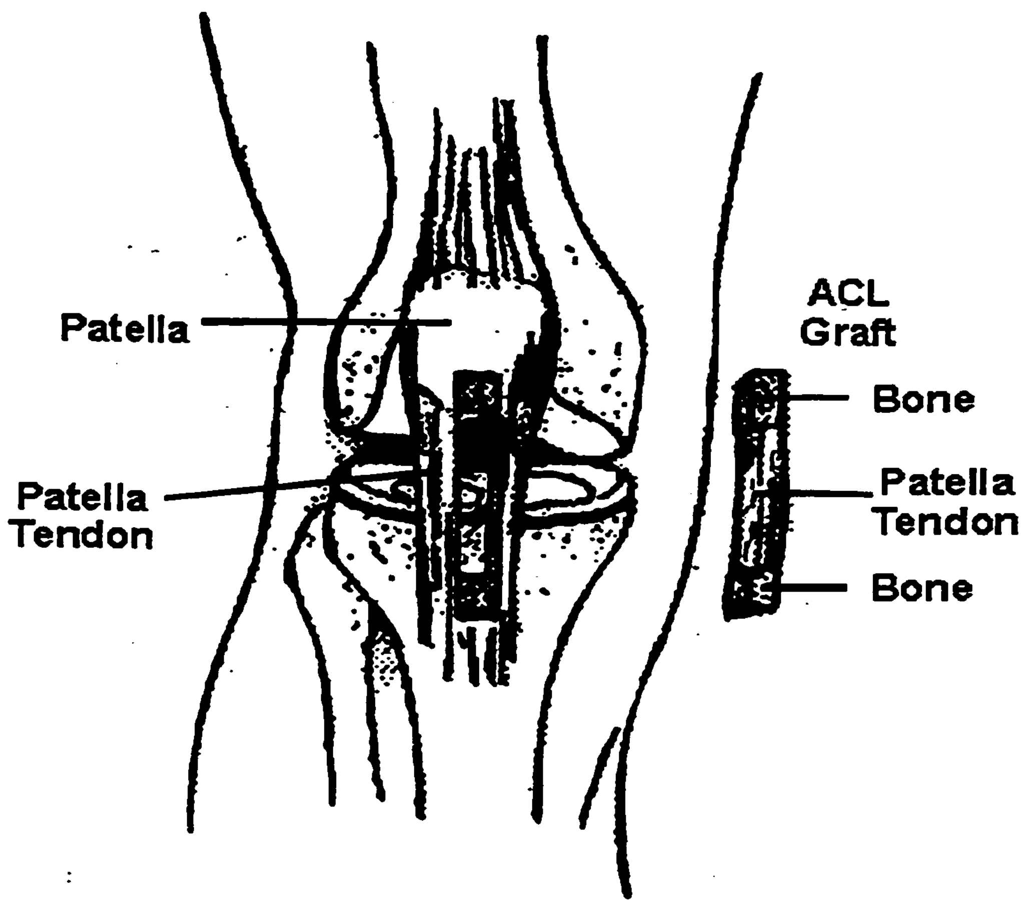


Figure 3-3. Pre and Postoperative Anterior Cruciate Ligament (ACL) Reconstructed Knee.

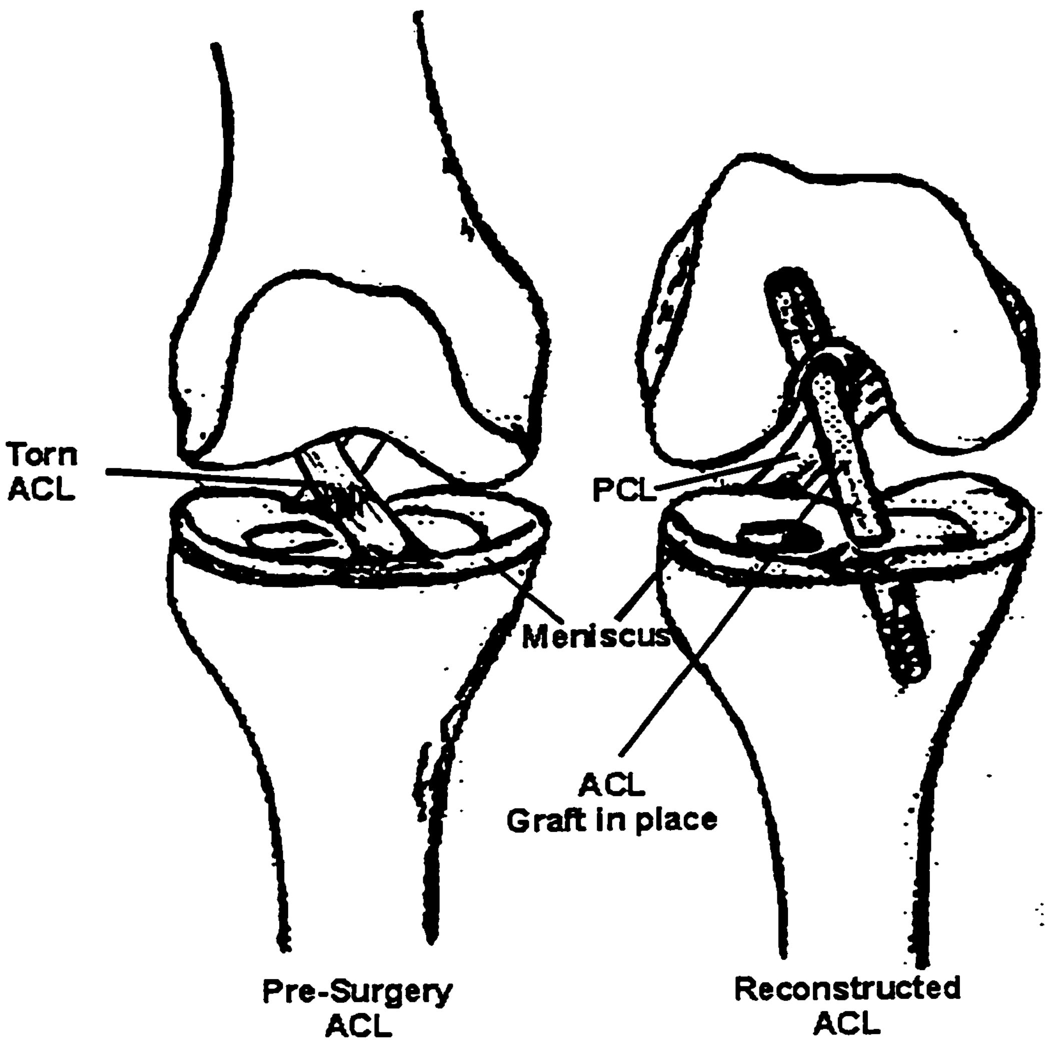
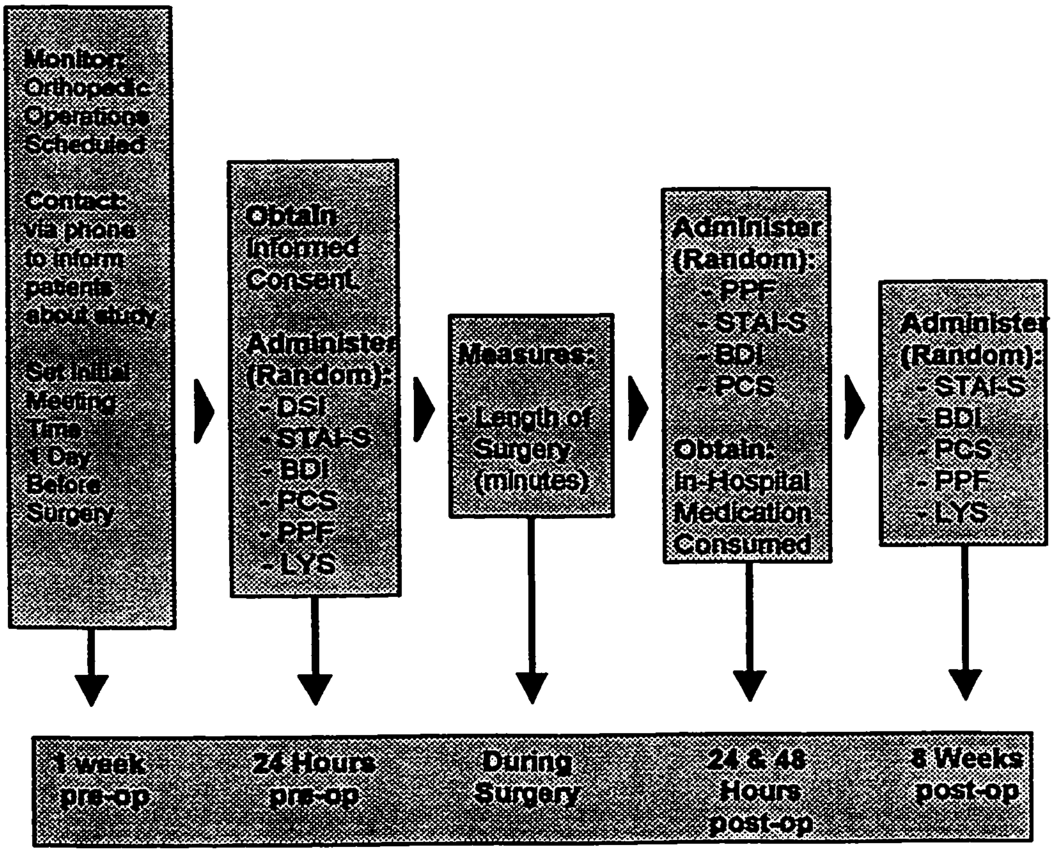


Figure 4-3. Data Collection Methodology for Study 3.



Note. DSI = Demographics and Surgery Information Form; STAI-S = State Anxiety Inventory; BDI = Beck Depression Inventory; PCS = Pain Catastrophizing Scale; PPF = VAS Pain Intensity Scales; LYS = Lysholm Knee Scale.

Figure 5-3. Visual Analogue Scale (VAS) Pain Intensity Ratings Following Anterior Cruciate Ligament (ACL) Reconstructive Surgery.

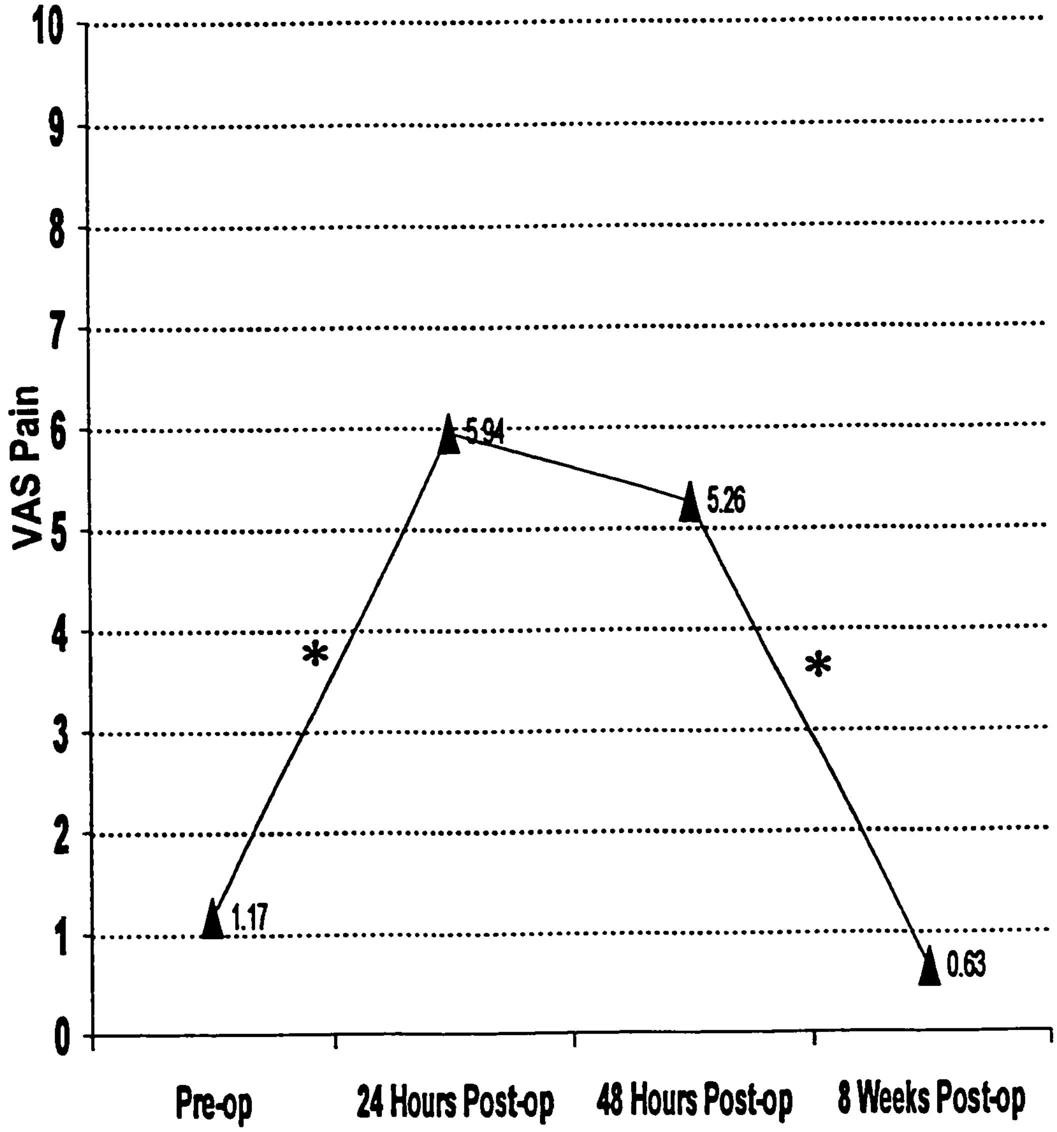


Figure 6-3. Pain Catastrophizing Following Anterior Cruciate Ligament (ACL) Reconstructive Surgery.

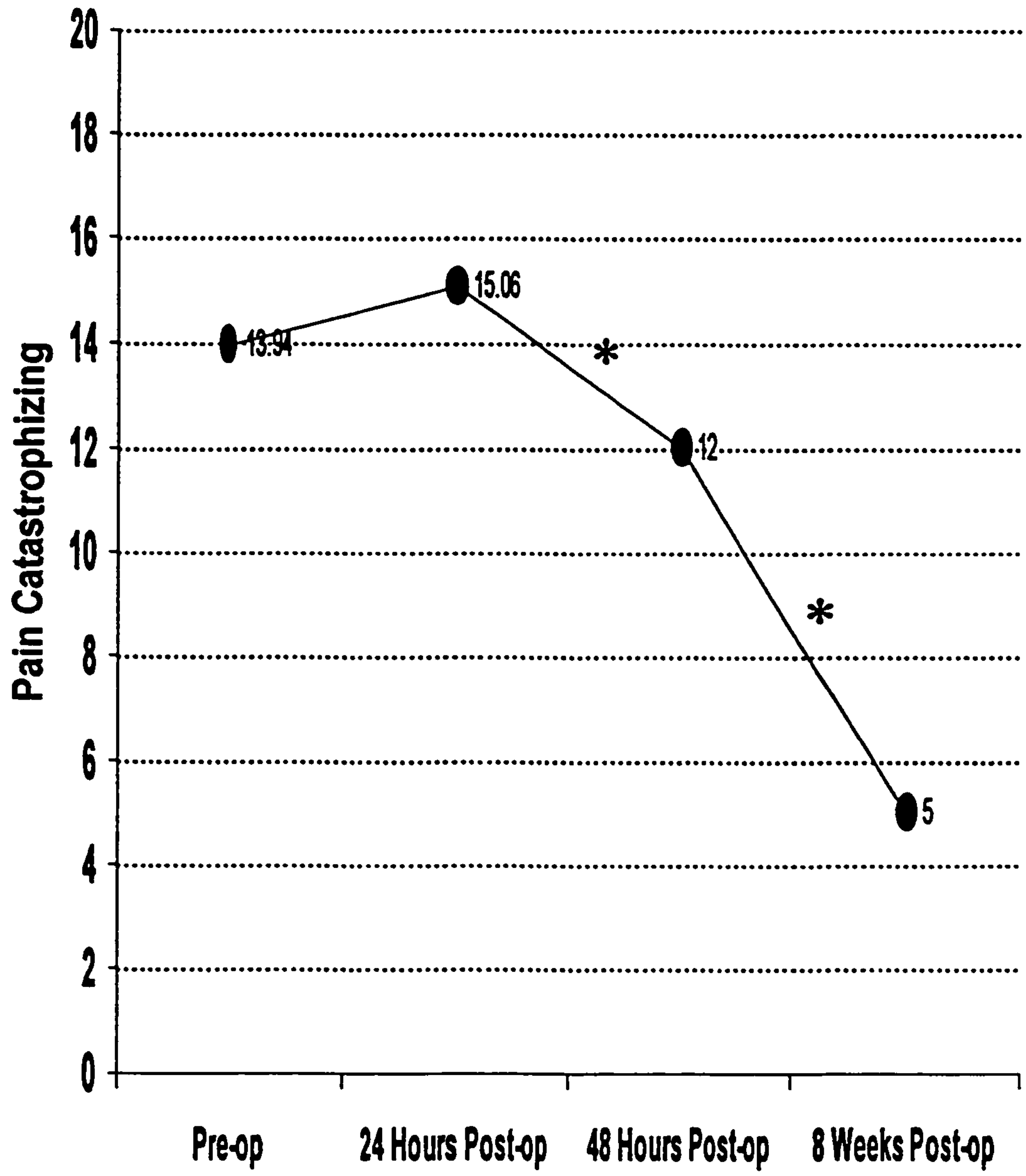


Figure 7-3. Depression Following Anterior Cruciate Ligament (ACL) Reconstructive Surgery.

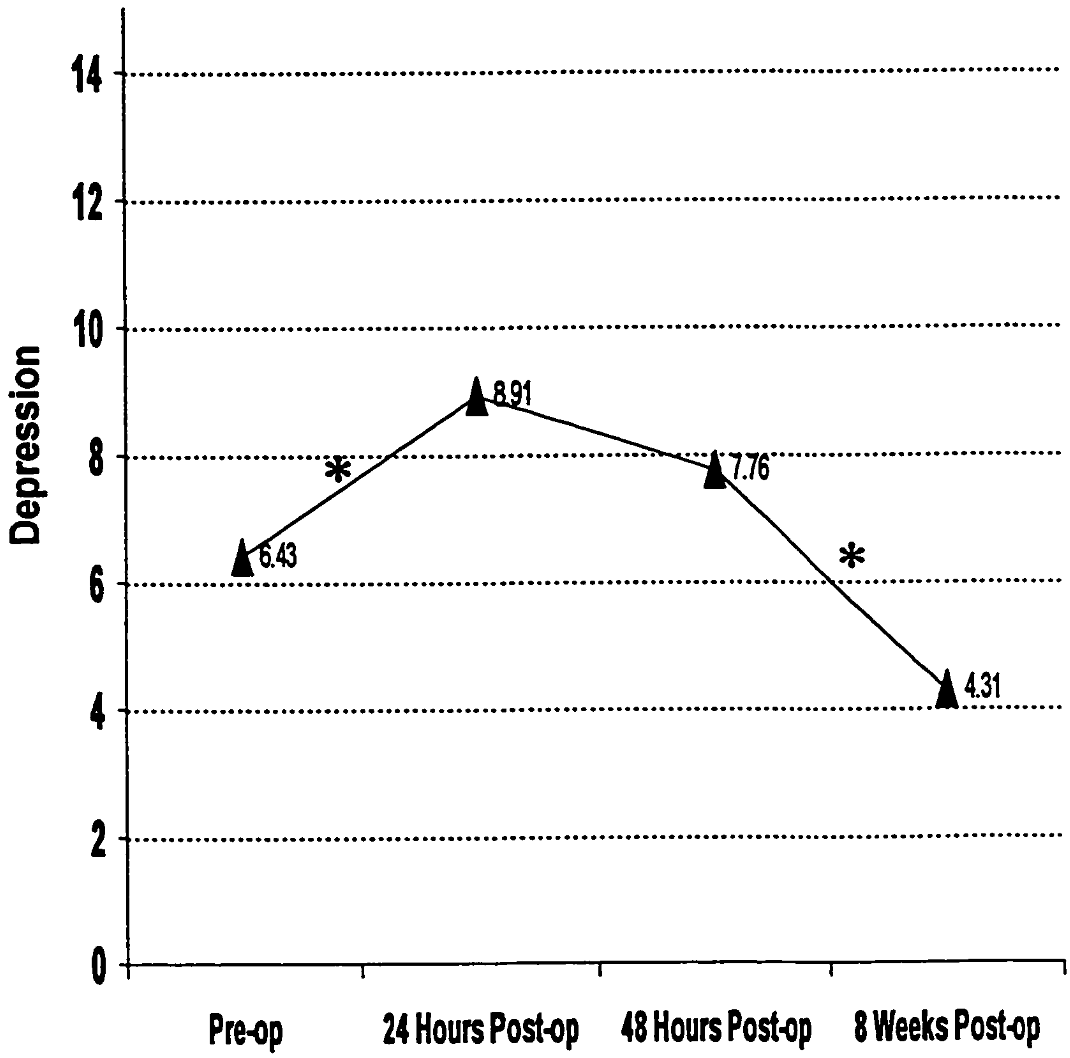


Figure 8-3. Anxiety Following Anterior Cruciate Ligament (ACL) Reconstructive Surgery.

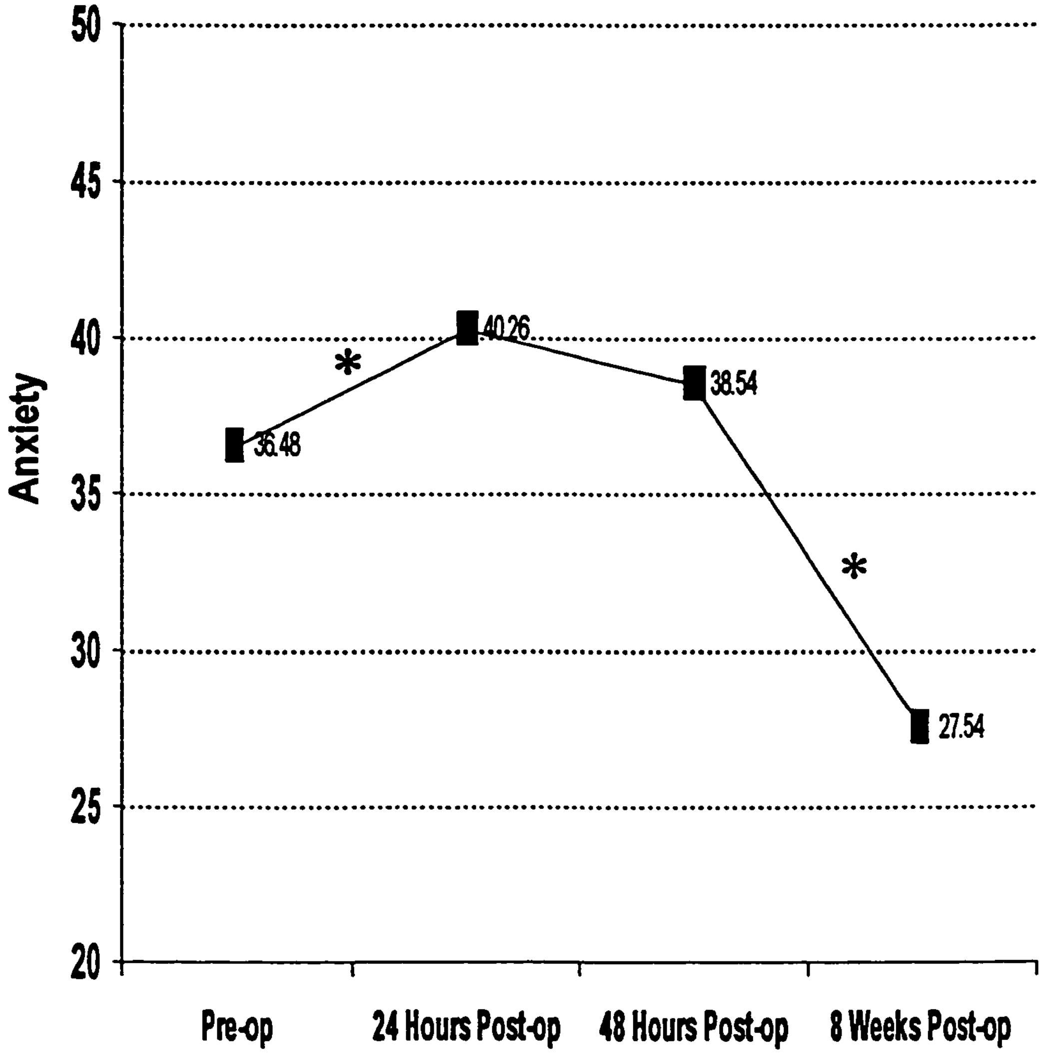
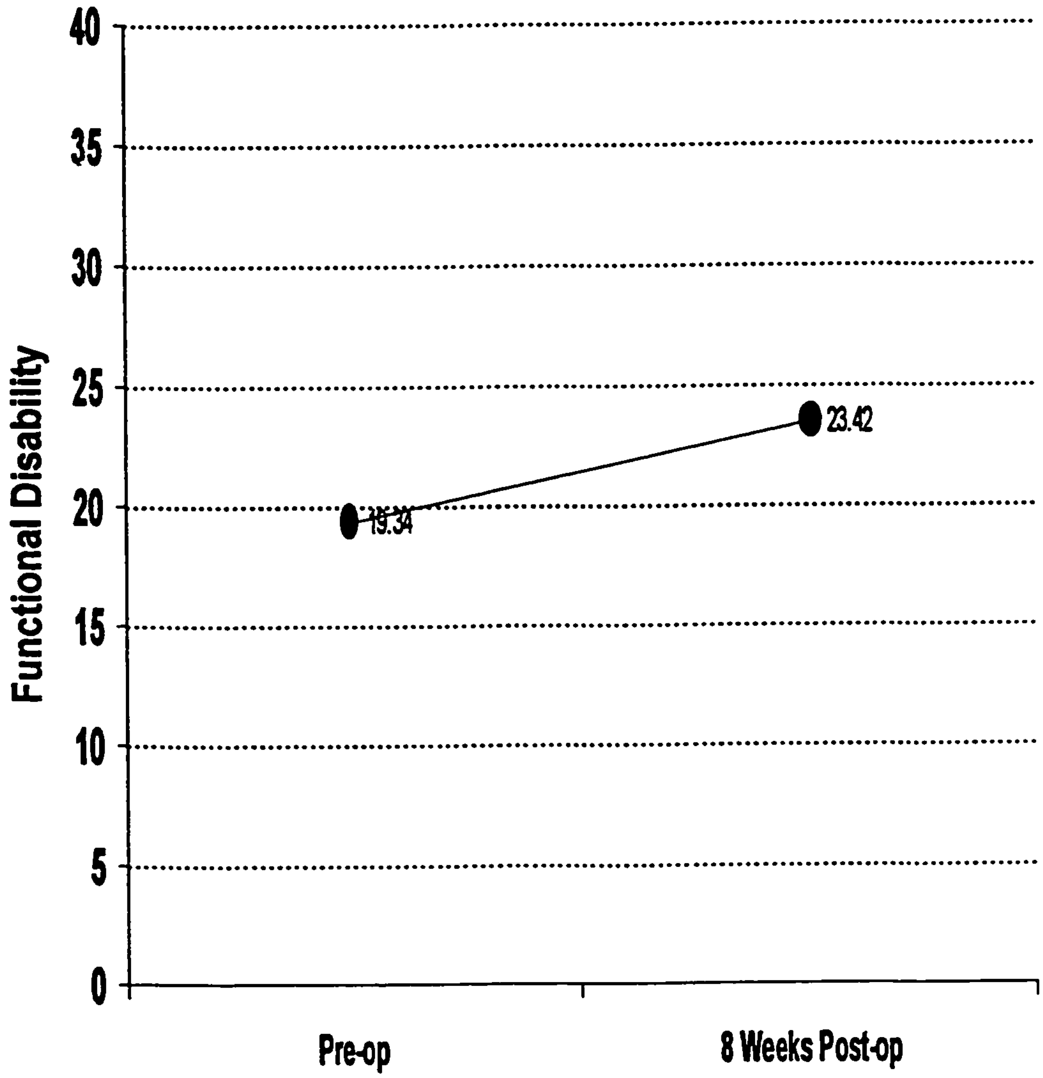


Figure 9-3. Functional Disability Following Anterior Cruciate Ligament (ACL) Reconstructive Surgery.



Appendix A

PCS:	ID#________	Date_______	Time_______ am/pm

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 B

Sport/Activity Questionnaire:	ID#____ Date____Time____ am/pm

Directions: Please answer the following questions.

On average, how many times a week do you engage in sport-related activity?

__ once per week
__ twice per week
__ three time per week
__ four times per week
__ five times per week
_______ other

Please list the primary sport you are involved with

____

If you play other sports, please specify

____
____

Appendix C

"The Relation between Thoughts and Physical Discomfort"

Local Principal Investigator:

Dean A. Tripp, M.Sc., Ph.D. Candidate
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Associate Investigators:

Michael J.L. Sullivan, Ph.D.
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Introduction:
You have been invited to take part in a Psychology research study at Dalhousie University. *Taking part in this study is voluntary and you can withdraw from participation or from answering any questions at any time.* Participating in this study might not benefit you, but the information you provide may aid researchers in understanding the relation between thoughts and physical discomfort. The study is described below. This description tells you about the risks, inconveniences, or discomforts which you might experience. You should discuss any questions you have about the study with the individual explaining it to you.

Purpose of the Study:
You have been asked to participate in a study examining how different thoughts may affect physical discomfort. This research hopes to understand some of the different thoughts that people may have prior to feeling discomfort. The discomfort you will be exposed to will require you to place your arm in a container of cold water.

Who can Participate in this Study:
You may participate if you are 17 years or older. You may not participate if you have been experiencing a recent history of chronic pain (I.e., pain syndrome greater than 6 months in duration) or have a history of heart or neurological disease, or frostbite. If you have medical conditions that require taking medication please inform us (e.g., diabetes).

Screening for your Participation:
All potential participants are asked to provide their age and will be asked questions based upon the study criteria in the preceding paragraph by a member of the research team. All answers are strictly confidential. Your name will not appear on any of the forms, it is replaced by an ID number instead.

Procedures of the Study:

This study concerns the relation between thoughts and physical discomfort. We want to assure you that the following procedure will not result in physical injury and that you can withdraw from the study at any time or remove your arm from the water at any time.

Prior to placing your arm in the cold water, we will ask you to complete a brief questionnaire about how you typically think when experiencing discomfort. We will also want to record your age and gender. To regulate arm temperature, you will be asked to immerse your dominant arm in a container of room temperature water for 5 minutes. Your discomfort experience during this period will be examined by having you verbally reporting a number that matches your discomfort. You will then be asked to place your arm on the moveable armrest of the cold water container, to lower your arm into the cold water, and to keep your arm immersed for a period of one minute. You will be instructed, by a voice on a tape recording, to provide verbal ratings of your current level of discomfort at the 30-second and one-minute interval during the water immersion. At the end of one minute, you will be signaled to remove your arm from the water. Following the water immersion you will be fully debriefed about the study and have any questions you may have answered.

Risks and Discomforts:

Placing your arm in the cold water may be experienced as unpleasant, uncomfortable, or even painful. For some participants, it is possible that interviews and/or questionnaire administration can be upsetting or distressing.

Possible Benefits:

Although you may not personally benefit from participation in this study, your efforts may benefit researchers examining the relation between thinking and discomfort.

Compensation:

The compensation for participating in this study will be class credit points for the Introductory Psychology course you are registered in. In light of this reward, the investigators, the study sponsor, and Dalhousie University still have to abide by their legal and professional responsibilities.

Confidentiality:

All information obtained in this study is completely confidential and you will not be identified as a participant in any reports or publications of this research. The information you provide will be identified by a code number and kept in a locked file cabinet. Only the research staff involved directly with the study will have access to any information you provide.

Questions or Problems:

If you have any questions regarding your rights as a research patient, you can contact the Chairperson of the Dalhousie at 494-1580. Any other questions you have concerning this research may be answered by contacting Dean A. Tripp at 494-5178 or Dr. Michael Sullivan at 494-5177.

Other Pertinent Information:

You will be told about any new information which might affect your decision about being in this research study. A personal copy of this consent form has been offered to me.

Signatures:

I have read and understood the above description of the study. I have been given the opportunity to discuss it and my questions have been answered to my satisfaction. I hereby consent to take part in this study

Signature of Participant ____________________ **Date** ________________

Investigator's Signature ____________________ **Date** ________________

Witness's signature ________________________ **Date** ________________

Appendix D

The Relation between Thoughts and Physical Discomfort

First and foremost let us take this opportunity to thank you for participating in this research. Literally, we could not complete such a study without you.

As described to you during the initial phase of your participation in this study, our research group is examining how various thoughts affect physical discomfort during cold water immersion. As you may have gathered from the types of questionnaires you completed, we are particularly interested in examining the effects of catastrophic thinking (e.g., negative thinking). Research has shown that individual's who employ catastrophic thinking in regard to cold pain also tend to report greater amounts of pain. The primary aim of this study is examine these effects in athletic and nonathletic people. We are interested in how these groups of people may differ in pain intensity and to see if catastrophizing has any differential influence on these reports.

Understanding catastrophic thinking and its relations with discomfort during cold-water immersion is the second step in a proposed series of research projects. Our next project will examine catastrophizing and its affect on pain following surgery for a serious sport-injury in athletes.

If you have any questions or comments concerning this research, please feel free to contact **Dean A. Tripp** at the Dalhousie University Psychology Department (phone:
494-5178)(e-mail: dtripp@IS2.DAL.CA).

Once again our research group thanks you ...

D.A. Tripp, MSc

M. Sullivan, Ph.D.

Appendix E

"Pain and Recovery Following Anterior Cruciate Ligament (ACL) Surgery"

Local Principal Investigator:

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Professor of Surgery, Dalhousie University, Halifax. N.S.

Michael J.L. Sullivan, Ph.D.
Psychology Department, Dalhousie University, Halifax, N.S.

Introduction:

You have been invited to take part in a research study at the QEII Health Sciences Centre. *Taking part in this study is voluntary and you can withdraw from participation or from answering any questions at any time without a change in the quality of your health care.* Participating in this study might not benefit you, but the information you provide may benefit future patients. The study is described below. This description tells you about the risks, inconveniences, or discomforts which you might experience. You should discuss any questions you have about the study with the individual explaining it to you.

Purpose of the Study:

You have been asked to participate in a study examining how different pre/post-operative physical and psychological factors impact recovery from ACL reconstructive surgery. This study examines several physical (i.e., pain, disability, medication consumption, and the extent and length of surgery) and psychological factors (i.e., anxiety, depression, how you cope with your pain) that may affect recovery. If you decide to participate, your surgery will be performed as usual and there will be no changes in the type, amount, or quality of care you receive before, during, or after surgery.

Who can Participate in this Study:

You may participate if you are 17 years or older older and have been scheduled for unilateral ACL reconstructive surgery using a patella-tendon autograft procedure which must have incurred through sporting participation. You may not participate if you have been experiencing a recent history of chronic pain (pain syndrome > 6 months in duration) unrelated to the knee to be operated upon, have experienced acute psychopathology, or have a history of neurological disease. If you develop significant postoperative complications, like deep infection or require additional corrective surgery to their ACL, your assessment data may be excluded from analyses.

Screening for your Participation:

All potential participants are asked to provide their age and will be asked questions based upon the study criteria in the preceding paragraph by a member of the research team. All answers are strictly confidential. Your name will not appear on any of the forms, it is replaced by an ID number instead.

Procedures of the Study:
Approximately, 1 day before your surgery, you will meet with one of the researchers for about 35 minutes to an hour. At this time you will complete several questionnaires that measure pain, disability, the types of strategies you use in coping with pain, and how you are feeling (i.e., anxious, depressed). During your surgery, information about the extent and length of the procedure is recorded along with the usual medical information, such as the amount of medication you consume while in the hospital. You are asked to give permission to the attending surgeon to gather this information from your health records for the period of your participation in this study only. On days 1 and 2 following surgery, a member of the research team will visit you for about 10-20 minutes and will administer short questionnaires assessing your pain and your anxiety and depression. At 8 weeks postoperative, during your return visit to see your surgeon, you will meet with a researcher either before or after your scheduled appointment. Here, you will be asked to complete the questionnaires that you had completed before, indicating your pain, disability, anxiety, depression, and how you have been coping with your pain. This meeting will take about 35 minutes.

Risks and Discomforts:
Your participation in this study does not require any change in your proposed treatment before or after surgery so there are no added physical risks in participating. For some participants, it is possible that interviews and/or questionnaire administration can be upsetting or distressing.

Possible Benefits:
Although you may not personally benefit from participation in this study, your efforts may benefit future patients undergoing ACL reconstructive surgery by helping researchers understand how certain aspects of recovering from ACL surgery impact the process.

Compensation:
There will be no compensation for participating in this study. None of your legal rights are waived. The investigator, the research doctor, the study sponsor, the hospital, and Dalhousie University still have to abide by their legal and professional responsibilities.

Confidentiality:

All information obtained in this study is completely confidential and you will not be identified as a participant in any reports or publications of this research. The information you provide will be identified by a code number and kept in a locked filing cabinet. Only the research staff involved directly with the study will have access to any information you provide. As outlined in the "procedures of the study" section, during your surgery, information about the extent and length of the procedure is recorded along with the amount of medication you consume while in the hospital. The access to your health records by Research Staff will be limited to the period of your participation in the study.

Questions or Problems:

If you have any questions regarding your rights as a research patient, you can contact the Patient Representative, Eleanor Givner at 473-2133. Any other questions you have concerning this research may be answered by contacting Dean A. Tripp at 494-5178 or Dr. Michael Sullivan at 494-5177.

Other Pertinent Information:

You will be told about any new information which might affect your decision about being in this research study. A personal copy of this consent form has been offered.

Signatures:

I have read and understood the above description of the study. I have been given the opportunity to discuss it and my questions have been answered to my satisfaction. I hereby consent to take part in this study

Signature of Participant ____________________ **Date** ________________

Investigator's Signature ____________________ **Date** ________________

Witness's signature ______________________ **Date** ________________

Appendix F

Demographics Form: ID#________Date________Time_______ am/pm

Directions: Please answer all questions below by either checking (✓) a response or by providing the appropriate information. If you have any problems, please ask for help.

Sex: __ Male __ Female **Age:** __ **Ht:** __ **Wt:** __

Marital Status: __ Married __ Single __ Separated __ Divorced

Education Completed:_____
(Years: High School=12)

Primary Sport: ______________________

Cause of injury: __ ADL __ Traffic __ Contact __ Non contact

Involved Knee: R __ L __

Date of injury: ___/___/___

Date of Operation: ___/___/__

Procedure:
____

Previous injuries to this knee? Yes__ No__ If Yes, describe
____

Describe PREINJURY sports activity?

____Level 1 (participates 4-7 days / week)
____Level 2 (participates 1-3 days / week)
____Level 3 (participates 1-3 times /mth)
____Level 4 (No sports)

Do you plan to play sports after your operation: Yes__ No __
If Yes what sports ____

Do you wear a sports brace? Yes__ No __ **If Yes what type?** ___ soft support brace (ace, neoprene sleeve)
__ hinged brace
__ ACL/PCL deterioration brace

When do you wear your brace?
__All the time
__Sporting activities only
__With sports that involve cutting or pivoting
__Rarely or never

Appendix G

Patient Pain Form: ID#________ Date________ Time_______ am/pm

Directions: Using the scale below, place a mark across the line to show your pain. Rate your pain under the following circumstances ...

Pain while RESTING? NO PAIN |———————————————| WORST PAIN EVER

Pain while MOVING? NO PAIN |———————————————| WORST PAIN EVER

Appendix H

BDI: **ID#________ Date________ Time________ am/pm**

This questionnaire consists of 21 groups of statements. After reading each group of statements carefully, circle the number (0,1,2,3) next to the one statement in each group which best describes the way you have been feeling the past week, including today. If several statements within a group seem to apply equally well, circle each one. Be sure to read all the statements in each group.

1 0 I do not feel sad.
1 I feel sad.
2 I am sad all the time and I can't snap out of it.
3 I am so sad or unhappy that I can't stand it.

2 0 I am not particularly discouraged about the future.
1 I feel discouraged about the future.
2 I feel that I have nothing to look forward to.
3 I feel that the future is hopeless and that things cannot improve.

3 0 I do not feel like a failure.
1 I feel that I have failed more than the average person.
2 As I look back on my life, all I can see is a lot of failures.
3 I feel I am a complete failure as a person.

4 0 I get as much satisfaction out of things as I used to.
1 I don't enjoy things the way I used to.
2 I don't get real satisfaction out of anything anymore.
3 I am dissatisfied or bored with everything.

5 0 I don't feel particularly guilty.
1 I feel guilty a good part of the time.
2 I feel guilty most of the time.
3 I feel guilty all of the time.

6 0 I don't feel I am being punished.
1 I feel I may be punished.
2 I expect to be punished.
3 I feel I am being punished.

7 0 I don't feel disappointed in myself.
1 I am disappointed in myself.
2 I am disgusted with myself.
3 I hate myself.

8 0 I don't feel I am any worse than anybody else.
1 I am critical of myself for my weaknesses or mistakes.
2 I blame myself all the time for my faults.
3 I blame myself for everything bad that happens.

9 0 I don't have any thoughts of killing myself.
1 I have thoughts of killing myself, but I would not carry them out.
2 I would like to kill myself.
3 I would kill myself if I had the chance.

10 0 I don't cry any more than usual.
1 I cry more now than I used to.
2 I cry all the time now.
3 I used to be able to cry, but now I can't cry even though I want to.

11 0 I am no more irritated now than I ever am.
1 I get annoyed or irritated more easily than I used to.
2 I feel irritated all the time now.
3 I don't get irritated at all by the things that used to irritate me.

12 0 I have not lost interest in other people.
1 I am less interested in other people than I used to be.
2 I have lost most of my interest in other people.
3 I have lost all of my interest in other people.

13 0 I make decisions about as well as I ever could.
1 I put off making decisions more than I used to.
2 I have greater difficulty in making decisions than before.
3 I can't make decisions at all anymore.

Please turn over to complete page 2 ...

Page 2 ...

After reading each group of statements carefully, circle the number (0,1,2,3) next to the one statement in each group which best describes the way you have been feeling the past week, including today. If several statements within a group seem to apply equally well, circle each one. Be sure to read all the statements in each group before making your choice.

14 0 I do not feel that I am worthless.
1 I don't consider myself as worthwhile and useful as I used to.
2 I feel more worthless as compared to other people.
3 I feel utterly worthless.

15 0 I can work about as well as before.
1 It takes an extra effort to get started at doing something.
2 I have to push myself very hard to do anything.
3 I can't do any work at all.

16 0 I can sleep as well as usual.
1 I don't sleep as well as usual.
2 I wake up 1-2 hours earlier than usual and find it hard to get back to sleep.
3 I wake up several hours earlier than I used to and cannot get back to sleep.

17 0 I don't get more tired than usual.
1 I get tired more easily than I used to.
2 I get tired from doing almost anything.
3 I am too tired to do anything.

18 0 My appetite is no worse than usual.
1 My appetite is not as good as it used to be.
2 My appetite is much worse now.
3 I have no appetite at all anymore.

19 0 I haven't lost much weight, if any, lately.
1 I have lost more than 5 pounds.
2 I have lost more than 10 pounds.
3 I have lost more than 15 pounds.

I am purposely trying to lose weight by eating less.
Yes__ No__ (check one)

20 0 I am no more worried about my health than usual.
1 I am worried about physical problems such as aches and pains; or upset stomach; or constipation.
2 I am very worried about physical problems and it's hard to think of much else.
3 I am so worried about my physical problems that I cannot think about anything else.

21 0 I have not noticed any recent change in my interest in sex.
1 I am less interested in sex than I used to be.
2 I am much less interested in sex now.
3 I have lost interest in sex completely.

Appendix I

Self-Evaluation Form-S: ID#________ Date________ Time_______ am/pm

Directions: A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you feel ***right now***, that is, ***at this moment***. There are no right or wrong answers. Do not spend much time on any one statement but give the answer which seems to describe your present feelings best.

	NOT AT ALL	SOMEWHAT	MODERATELY SO	VERY MUCH SO
1) I feel calm	1	2	3	4
2) I feel secure	1	2	3	4
3) I am tense	1	2	3	4
4) I feel strained	1	2	3	4
5) I am at ease	1	2	3	4
6) I feel upset	1	2	3	4
7) I am presently worrying over possible misfortunes	1	2	3	4
8) I feel satisfied	1	2	3	4
9) I feel frightened	1	2	3	4
10) I feel comfortable	1	2	3	4
11) I feel self-confident	1	2	3	4
12) I feel nervous	1	2	3	4
13) I am jittery	1	2	3	4
14) I feel indecisive	1	2	3	4
15) I am relaxed	1	2	3	4
16) I feel confident	1	2	3	4
17) I am worried	1	2	3	4
18) I feel confused	1	2	3	4
19) I feel steady	1	2	3	4
20) I feel pleasant	1	2	3	4

Appendix J

Lysholm Knee Rating Scale: ID#________ Date________ Time________ am/pm

Directions: Please answer the following questions.

Do you walk with a Limp?

None	5
Slight or periodical	3
Severe or constant	0

Do you walk with a Support?

None	5
Stick or crutch	2
Weight bearing impossible	0

Do you experience Locking in your knee?

No locking or catching sensations	15
Catching sensation but no locking	10
Locking	
Occasionally	6
Frequently	2
Locked joint on exam	0

Do you experience Instability in your knee?

Never giving way	25
Rarely during athletics or other severe exertion	20
Frequently during athletics or other severe exertion (or incapable of participation)	15
Occasionally in daily activities	10
Often in daily activities	5
Every step	0

When do you feel Pain in your knee?

None	25
Inconstant and slight during severe exertion	20
Marked during severe exertion	15
Marked on or after walking more than 2 KM	10
Marked on or after walking less than 2 KM	5
Constant	0

When do you experience Swelling?

None	10
On severe exertion	6
On ordinary exertion	2
Constant	0

Any difficulty in Stair Climbing?

No problems	10
Slightly impaired	6
One step at a time	2
Impossible	0

Any difficulty in Squatting down?

No problems	5
Slightly impaired	4
Not beyond 90 degrees	2
Impossible	0

Appendix K

Functional Disability Inventory: ID#____ Date____ Time____am/pm

Directions: After surgery on your knee you may experience interference in doing or completing some regular activities. In the last week, would you have any physical trouble or difficulty doing these activities? Indicate the trouble you experience with a mark (/) across the scales below.

1) Walking to the Bathroom.

NO TROUBLE |————————————| IMPOSSIBLE

2) Walking up stairs.

NO TROUBLE |————————————| IMPOSSIBLE

3) Doing something with a friend (e.g., playing a game, going out).

NO TROUBLE |————————————| IMPOSSIBLE

4) Your regular chores at home.

NO TROUBLE |————————————| IMPOSSIBLE

5) Eating regular meals.

NO TROUBLE |————————————| IMPOSSIBLE

6) Being up all day without a nap or rest.

NO TROUBLE |————————————| IMPOSSIBLE

7) Riding bus or travelling in a car.

NO TROUBLE |————————————| IMPOSSIBLE

Page 1 of 2

Remember, you are being asked about difficulty due to physical health. Indicate with a mark across the line.

8) Being at work or school all day.

NO TROUBLE ———————————————— IMPOSSIBLE

9) Doing activities or Playing sports.

NO TROUBLE ———————————————— IMPOSSIBLE

10) Reading or doing other mental tasks (family budget).

NO TROUBLE ———————————————— IMPOSSIBLE

11) Watching the TV.

NO TROUBLE ———————————————— IMPOSSIBLE

12) Walking to length of a football field.

NO TROUBLE ———————————————— IMPOSSIBLE

13) Running the length of a football field.

NO TROUBLE ———————————————— IMPOSSIBLE

14) Going shopping.

NO TROUBLE ———————————————— IMPOSSIBLE

15) Getting to sleep at night and staying asleep.

NO TROUBLE ———————————————— IMPOSSIBLE

16) Sexual behavior.

NO TROUBLE ———————————————— IMPOSSIBLE

Appedix L

Opioid Analgesic Doses Equivalencies.
(Drug Facts and Comparisons. St. Louis, MO: J.B. Lippincott, 1996).

Morphine IM/IV	10 mg	=	1.00	opioid dose
MS Contin™ (MS-SR)	30 mg	=	1.00	opioid dose
MS IR Elixir/Tablets	30 mg	=	1.00	opioid dose
Hydromorphone IV (Dilaudid)	1.5 mg	=	1.00	opioid dose
Hydromorphone oral (Dilaudid)	7.5 mg	=	1.00	opioid dose
Fentanyl IV	100 mg	=	1.00	opioid dose
Methadone oral	20 mg	=	1.00	opioid dose
Meperidine IM/IV (Demerol)	75 mg	=	1.00	opioid dose
Meperidine oral (Demerol)	300 mg	=	1.00	opioid dose
Codeine oral	200 mg	=	1.00	opioid dose
Codeine oral	60 mg	=	.30	opioid dose
Codeine oral	30 mg	=	.15	opioid dose
Tylenol #3™ (Acetaminophen + Codeine)	1 Tablet	=	.23	opioid dose
Hydrocodone (oral)	30 mg	=	1.00	opioid dose
Oxycodone IR oral (Elixir / Tablets)	30 mg	=	1.00	opioid dose
Oxycodone IR oral	10 mg	=	.33	opioid dose
Oxycodone IR oral	5 mg	=	.16	opioid dose
Oxycodone/Acetaminophen (Percocet)	1 Tablet	=	.24	opioid dose
Oxycontin™ SR	20 mg	=	1.33	opioid dose
Oxycontin™ SR	40 mg	=	2.66	opioid dose
Acetaminophen (Tylenol)	4062.5 mg	=	1.00	opioid dose
Acetaminophen (oral/rectal)	650 mg	=	1.00	opioid dose
Ibuprofen (oral)	1600 mg	=	1.00	opioid dose
Ibuprofen (oral)	400 mg	=	.25	opioid dose
ASA (oral)	360 mg	=	.25	opioid dose
Talwin (Pentazocine)	45 mg	=	1.00	opioid dose
Voltaren™	75 mg	=	2.50	opioid dose

To calculate the oral Hydromorphone (Dilaudid) opioid equivalents, divide the dose administered by 7.5

Example: 16 mg of oral Hydromorphone was given for wound care.
16/7.5 = 2.13 opioid equivalents.

Appendix M

ACL Postoperative Schedule

Week #1: (Surgery - your first Postoperative visit)
- After surgery the compression bandage is removed within day 1 and knee is placed in a supporting splint. The splint can be removed to sleep and bathe. Patients are recommended to put ice on knee to prevent predictable swelling.
- Do not be reluctant to move the knee so that it is fully straight and then bend it until it is comfortable.
- Straight leg raises (S.L.R.=s) should be done daily, minimum being 50.
- Use of crutches and avoidance of full weight bearing for first couple of weeks with weight bearing gradually started thereafter.

Week #2: (Beginning of Physiotherapy)
- Use knee brace during this time, except for bathing or sleeping.
- Patients are told that they should push their knee to full extension so that the knee at no time has a chance to become permanently fixed (several times a day).
- Sterile strips can be soaked off and replaced if patient desires.
- Patients are warned not to be surprised at the small size of the operated leg and the condition of the skin.
- Blood blisters may appear but will go away.
- Be careful not to slip in tub or shower.
- Physiotherapy is scheduled daily for the first month then three times a week (depending on how well the knee is doing).
- Patients are told to work on gentle range of motion (ROM) - prone knee bends, knee swinging in sitting position. At this stage of recovery work in pain free range only and the knee fully.
- Electric muscle stimulation (EMS), leg lifts actively with available extension. No resistance against tibia, 15 minutes initially.
- Patella mobilizations should commence.
- Pain / swelling relief modalities should be actively used.
- Active exercises: hip abduction, adduction, extension, hamstrings S.L.R.=s (at 0 degrees), 3x10 repetitions, twice a day.

Week #3:
- Progress as tolerated.
- Increase E.M.S. to 20 minutes if desired. Patient may sit over the edge of bed extending: 90 degrees to -10 degrees extension (if comfortable). Weight may be added to proximal tibia as tolerated - begin with two pounds, moving up to 5-6 pounds over a 2-3 week period.

- As effusion settles down, progress to the use of heat before exercise.
- Commence patellar mobilizations, if needed.
- Start calf raises in standing 3x10 reps: use EMS. If calf is significantly atrophied or inhibited; Move from active exercises to resistance exercises using free weights.
- No more than 5-6 pounds for knee extensions.
- Start on stationary bike with no resistance. Start with arcs as there will not be enough flexion to complete full revolutions. 5-10 minutes may be done twice a day.
- Ice following treatment PRN (as needed).
- Patients should expect soreness behind their knee because muscles have been working hard keeping your leg slightly bent (this will disappear).

Week #4:
- Increase weight for active exercises.
- As knee flexion increases, add resistance to stationary bike. (10-20 minutes).
- Discontinue modalities as indicated.
- Passive extension is continued. This may be achieved by therapist or patient pushing on the knee. This should be done 6X day and be left in extended position for 2-3 minutes. Active quads should be used to achieve the extension at this stage of rehabilitation.

Week #4-8: - Progress as above activities are tolerated.

Week # 8:
- Start balancing on one leg with brace on; 1/3 squats against wall: 20 reps 3X day.
-- May start ski fitter / balance board / proprioceptive activities; 3-5 minutes.
- Start swimming: no whip kick/breaststroke. Flutter kick only.
- The brace may come off in the house for light activities.

Week #9-12:
- Progress activity level as tolerated.
- May start heavier muscle work for hamstrings. May use Cybex, KinCom, Hydragym, Nautilis, etc. for this work. Emphasis should be on endurance work (low weight and high reps) for 2-3 weeks. If no problems, then strength workout may be begun (high weight/low repetition).

Approximately - **Week #12:**
- If patient has good ROM and no pain, you can start heavier work on the quads. Again, progress through endurance work first, then strength. Exercise quads to full range; Straight ahead jogging with brace.
- May start cycling outdoors with brace.
- OK to test isometrically on Orthotron, Hydragym.

Approximately - **Week #16:**
- Straight ahead jogging - no brace; Diagonal jogging / cutting with brace.
- May cycle outdoors with brace; Physiotherapy based exercises performed on own.

Appendix N

"Pain and Recovery Following Anterior Cruciate Ligament (ACL) Surgery"

First and foremost let us take this opportunity to thank you for participating in this research. Literally, we could not complete such a study without you.

As described to you during the initial phase of your participation in this study, our research group is examining how various pre/post-operative physical and psychological factors impact patient recovery. As you may have gathered from the types of questionnaires you completed, we are particularly interested in examining the effects of catastrophic thinking (e.g., negative thinking) in regard to pain and how it affects your experience of pain (in our case, especially post-operative and recovery from disability pain). Research has shown in the past that individual's who employ catastrophic thinking in regard to post-operative pain report greater amounts of pain, use more medication post-operatively, and take longer to recovery, than those who do not. The primary aim of this study is to closely examine catastrophic thinking, especially in the pre-operative period, attempting to identify those who may go on to have have more difficult with post-operative pain during their recovery.

Understanding catastrophic thinking and its relations with post-operative pain and physical functioning are the first step in a proposed series of research projects. Depending upon the results of this research, our next project will be an intervention study in which pre-operative catastrophizing patients will be instructed in specific cognitive coping strategies designed to reduce their amount of catastrophizing.

If you have any questions or comments concerning this research, please feel free to contact **Dean A. Tripp** at the Dalhousie University Psychology Department (phone: **494-5178**)(e-mail: dtripp@IS2.DAL.CA).

Once again our research group thanks you ...

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