Catastrophizing and Pain Perception in Sport Participants

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Two studies were conducted to examine the relation between catastrophizing and pain in sport participants. Study 1 compared the factor structure of the Pain Catastrophizing Scale (PCS; Sullivan et al., 1995) in a sample of 97 individuals who reported engaging in regular sporting activity and 140 sedentary individuals. Confirmatory factor analysis revealed that, in both sport and sedentary samples, a three factor solution, comprising rumination, magnification, and helplessness provided the best fit to the data. Study 2 examined differences in pain perception in 54 (28 women, 26 men) varsity athletes and 54 (27 women, 27 men) sedentary controls who participated in an experimental pain procedure. Participants completed the PCS prior to immersing one arm in ice water for one minute. Athletes reported less pain than sedentary individuals, and men reported less pain than women. For both athlete and sedentary groups, catastrophizing was a significant predictor of pain experience. Regression analyses revealed that although catastrophizing accounted for differences in pain perception between men and women,

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catastrophizing did not mediate differences in pain perception between the athlete and sedentary groups. The discussion addresses how interventions targeting components of catastrophizing may reduce pain and facilitate recovery from sport injury.

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, Brewer, Van Raalte, Linder, Cornelius, & Bart, 1998; Brewer, Van Raalte, & Linder, 1990; Nixon, 1993). It has been shown that individuals who catastrophize in response to painful stimulation experience higher levels of pain and disability than individuals who do not catastrophize (Sullivan, Bishop, & Pivik, 1995; Sullivan, Stanish, Waite, Sullivan, & Tripp, 1998). Catastrophizing has been broadly defined as an exaggerated negative appraisal of pain sensations (Sullivan et al., 1995). Although catastrophic thinking has been discussed as a component of sport pain and injury, the relation between catastrophizing and pain in individuals involved in sport has not been addressed empirically. The aim of the present research was to examine the relation between catastrophizing and responses to an experimental pain procedure in individuals who participate in sport.

**Pain in Sport**

Colloquial expressions such as “no pain no gain” highlight the view that pain is inextricably linked to sport involvement. Sport participants (competitive and recreational) report experiencing three different kinds of pain: that associated with exertion while exercising, delayed onset muscle soreness following exertion, as well as that associated with injury. Pain has also been discussed as an important factor that may impede recovery following sport injury (Fisher, 1990; Weise & Weiss, 1987).

To date, there has been little attention directed toward identifying psychological factors contributing to sport participants’ perceptions of pain intensity. Pain intensity has generally been defined as the degree of discomfort that individuals experience when exposed to painful stimulation (Chapman, 1980). Pain intensity differs from pain tolerance in that pain intensity is considered to be primarily perceptual in nature and pain tolerance is considered to be primarily behavioral in nature (Chapman, 1980).

There are several reasons why more research attention needs to be directed toward examining the psychological predictors of pain perception in sport participants. First, a comprehensive theoretical framework of pain in sporting activity will require knowledge of the psychological factors that influence pain experience. Additionally, research suggests that pain intensity is one of the most powerful predictors of activity tolerance, particularly within the context of rehabilitation (Sullivan et al., 1998). It has also been suggested that effective pain management following sport injury must proceed from a clearer understanding of sport participants’ subjective experience of pain (Taylor & Taylor, 1998).
The Role of Catastrophizing

Clinical and experimental investigations have shown that catastrophizing is associated with heightened pain and emotional distress in response to painful stimulation (Rosenstiel & Keefe, 1983; Sullivan et al., 1995). Catastrophizing has been defined as an appraisal process where individuals focus excessively on pain sensations, exaggerate the threat value of painful sensations, and perceive themselves as unable to cope effectively with the pain situation (Sullivan et al., 1995). Sullivan et al. (1995) developed the Pain Catastrophizing Scale (PCS) as a measure of catastrophizing that could be used across different populations, and different painful situations. On the basis of a factor analytic study, Sullivan et al. (1995) suggested that catastrophizing could be viewed as a conceptually integrated concept that comprised three related components: rumination “I can’t stop thinking about how much it hurts,” magnification “I worry that something serious may happen,” and helplessness “There is nothing I can do to reduce the intensity of the pain” (Sullivan et al., 1995; Study 1). To date, the relation between catastrophizing and pain has been demonstrated in several populations, including undergraduates participating in experimental pain procedures (Sullivan et al., 1995), chronic back pain patients (Rosenstiel & Keefe, 1983), individuals undergoing stressful medical diagnostic procedures (Sullivan et al., 1995), dental procedures (Sullivan & Neish, 1998), and in individuals suffering from chronic headache (Bedard, Reid, McGrath, & Chambers, 1997).

Catastrophizing and Pain Intensity in Sport Participants

It is possible that catastrophizing may be a significant predictor of pain in individuals involved in sport. Meyers, Bourgeois, Stewart, and LeUnes (1992) reported that catastrophizing emerged as one of the factors in a scale designed to assess responses to pain incurred through participation in sporting activities. In an in-depth qualitative examination of responses to injury in elite skiers, Udry, Gould, Bridges, and Beck (1997) noted that negative or catastrophic thoughts were common reactions to injury.

Although catastrophic thinking has been observed in individuals involved in sport, a relation between catastrophic thinking and pain perception has not been demonstrated empirically. Demonstrating a relation between catastrophizing and pain perception in individuals involved in sport would have important implications. From a conceptual perspective, it would increase our understanding of the determinants of pain in individuals involved in sport. Furthermore, examination of the components of catastrophizing most predictive of pain may provide useful insights concerning potential targets of intervention for training or rehabilitation.

The present research examined whether the relation between catastrophizing and pain that has been observed in previous experimental and clinical research could be demonstrated in individuals involved in sport. Study 1 compared the factor structure of the PCS in a sample of individuals involved in sport and a sample of sedentary individuals. In Study 2,
male and female varsity athletes and sedentary individuals participated in an experimental pain procedure where they were asked to immerse one arm in ice water. The design of Study 2 allowed for replication of previous findings showing that athletes report less pain than sedentary individuals (e.g., Ryan & Kovacic, 1966), and examined the value of the PCS in predicting the pain responses of athletes.

Study 1

The primary purpose of Study 1 was to compare the factor structure of the PCS in sport participants and sedentary individuals. As noted earlier, the PCS has been shown to yield three separate but correlated factors measuring rumination, magnification, and helplessness. The factor structure of the PCS has been replicated in non-clinical and clinical samples (Osman, Barrios, Copper, Hauptmann, Jones, & O’Neill, 1997), but has yet to be examined in individuals involved in sport. The prediction for Study 1 was that the three factor solution of the PCS would be stable across sport and sedentary samples.

Method

Participants

Two-hundred thirty-seven introductory psychology students at Dalhousie University volunteered to complete the PCS and a sport/activity questionnaire at the end of class. The sample consisted of 81 men and 156 women. The mean age of the sample was 19.4 years (SD = 3.6). Individuals who reported engaging in sport-related activities once or less per week were included in the sedentary group (40 men; 100 women) and individuals who reported engaging in competitive sport-related activities (swimming, basketball, soccer, track & field, football, rugby, hockey, baseball, volleyball, tennis, and cycling) 5 times or more per week were included in sport group (41 men; 56 women; cf. Blair & Morrow, 1998).

Measures

Sport/activity questionnaire. Participants were asked to indicate the frequency with which they engaged in sport-related activities (“On average, how many times a week do you engage in sport-related activity?”). Participants responded by choosing one of the following options: (0) not at all, (1) once a week, (2) twice a week, (3) three times a week, (4) four times a week, (5) five or more times a week. Participants were then asked to list the different sport-related activities they participated in. Individuals 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 sport sample.

Catastrophizing. The PCS (Sullivan et al., 1995) is a 13-item self-report measure of catastrophic thinking associated with pain. The PCS instructions ask participants to reflect on past painful experiences, and to indicate the degree to which they experienced each of 13 thoughts or feelings
when experiencing pain, on 5-point Likert-type scales ranging from 0 (not at all) to 4 (all the time). The PCS yields a total score and three subscale scores assessing rumination, magnification, and helplessness. The PCS subscales have been shown to have adequate to high internal consistency (coefficient alphas: total PCS = .87, rumination = .87, magnification = .66, and helplessness = .78; Sullivan et al., 1995). The PCS has been shown to correlate with interview-based methods of assessing pain-related catastrophic thinking, and to predict pain intensity and pain behavior in response to aversive stimulation (Sullivan et al., 1995; Sullivan, Tripp, & Santor, in press).

Procedure

Participants were asked to complete the PCS and a sport/activity questionnaire at the end of class. Data collection was conducted as part of a regularly scheduled screening of the undergraduate subject pool. Data were analyzed in two stages using EQS (Bentler, 1989). EQS is a statistical package based on confirmatory factor analysis and structural equation modeling. In the first stage of data analysis, the three factor structure for the PCS proposed by Sullivan et al. (1995) was examined for goodness-of-fit separately in the sport and sedentary groups. Once baseline models for each group were satisfactorily produced, measurement models and factorial stability were examined across groups simultaneously using the tests of model invariance in EQS (Bentler, 1989; Byrne, Shavelson, & Muthen, 1989).

Results

Baseline Models

As shown in Table 1, for the sport group, the Sullivan et al. (1995) three factor model represented a significant improvement compared to the null model and according to most fit indices, a reasonable fit to the data (indices $\geq .90$). However, examination of the fit indices (i.e., NFI) and LM 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 sport group.

For the sedentary group, the Sullivan et al. (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
<table>
<thead>
<tr>
<th>Model by sample</th>
<th>$\chi^2$</th>
<th>df</th>
<th>NFI</th>
<th>CFI</th>
<th>RCFI</th>
<th>IFI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sport Sample</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 Null Model</td>
<td>610.15</td>
<td>78</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1 Hypothesized Model (Sullivan et al., 1995)</td>
<td>94.56**</td>
<td>62</td>
<td>.85</td>
<td>.94</td>
<td>.96</td>
<td>.94</td>
</tr>
<tr>
<td>2 Error correlation between item 2 and 3</td>
<td>87.88**</td>
<td>61</td>
<td>.87</td>
<td>.96</td>
<td>.98</td>
<td>.96</td>
</tr>
<tr>
<td>3 Error correlation between item 11 and 10</td>
<td>74.27**</td>
<td>60</td>
<td>.89</td>
<td>.97</td>
<td>.99</td>
<td>.97</td>
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<tr>
<td><strong>Sedentary Sample</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 Null Model</td>
<td>742.96</td>
<td>78</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1 Hypothesized Model (Sullivan et al., 1995)</td>
<td>133.94**</td>
<td>62</td>
<td>.82</td>
<td>.89</td>
<td>.91</td>
<td>.89</td>
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<tr>
<td>2 Correlate error terms (E1, E3) (E2, E3) (E9, E10)</td>
<td>97.70**</td>
<td>59</td>
<td>.87</td>
<td>.94</td>
<td>.95</td>
<td>.94</td>
</tr>
<tr>
<td>3 Correlate error terms (E1, E2)</td>
<td>88.40*</td>
<td>58</td>
<td>.89</td>
<td>.94</td>
<td>.95</td>
<td>.97</td>
</tr>
<tr>
<td>4 Correlate error terms (E8, E10)</td>
<td>80.40*</td>
<td>57</td>
<td>.90</td>
<td>.97</td>
<td>.98</td>
<td>.97</td>
</tr>
</tbody>
</table>

*Note.* ** indicates significant change in $\chi^2$ ($p < .01$); * ($p < .05$). $\text{SB-}\chi^2$ = Sattora-Bentler scaled statistic (Sattor & Bentler, 1988); NFI = Normed Fit Index (Bentler & Bonnet, 1980); DFI = Comparative Fit Index (Bentler, 1990); RCFI = Robust Comparative Fit Index (Byrne, 1994); IFI = Incremental Fit Index (Bollen, 1989).

A satisfactory value on the CFI index. As indicated by the NFI and the LM test statistics, an improved model would be advanced by correlating error terms (E1, E2). 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 sedentary group.

The standardized parameters for the optimized models for the sport and sedentary groups are shown in Figure 1. All the specified relations among the variables, including the correlated error terms, were significant.
Table 2
Summary tests for invariance across sport and sedentary samples

<table>
<thead>
<tr>
<th>Model</th>
<th>( \chi^2 )</th>
<th>df</th>
<th>( \Delta \chi^2 )</th>
<th>( \Delta \text{df} )</th>
<th>NFI</th>
<th>CFI</th>
<th>IFI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Baseline multi-group model</td>
<td>139.99</td>
<td>116</td>
<td></td>
<td></td>
<td>.90</td>
<td>.98</td>
<td>.98</td>
</tr>
<tr>
<td>2 Pattern of PCS item loadings specified as invariant</td>
<td>146.37</td>
<td>125</td>
<td>6.36**</td>
<td>10</td>
<td>.90</td>
<td>.97</td>
<td>.97</td>
</tr>
<tr>
<td>3 Pattern of PCS factor variances and covariances specified as invariant</td>
<td>152.90</td>
<td>132</td>
<td>6.53**</td>
<td>6</td>
<td>.89</td>
<td>.98</td>
<td>.98</td>
</tr>
</tbody>
</table>

Note. ** indicates a non-significant change in \( \chi^2 \) (\( p > .05 \)). 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).

**Determination of Factorial Stability**

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

As shown in Table 2, the baseline multi-group model (Model 1), simply 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.

**Reliability Indices**

Alpha coefficients were computed for the different subscales of the PCS in both sport and sedentary samples (Cronbach, 1951). For the sedentary sample, the alpha coefficients for the rumination, magnification, and helplessness subscales were .84, .54, and .79, respectively. For the sport sample, the alpha coefficients for the rumination, magnification, and helplessness subscales were .89, .65, and .84, respectively. Alpha coeffi-
coefficients for the total PCS were .84 for the sedentary sample and .87 for the sport sample.

Discussion

The results of Study 1 indicate that the factor structure of the PCS in a sport sample is comparable to the structure that has previously been reported in sedentary and clinical samples (Osman et al., 1997; Sullivan et al., 1995). In other words, across varying levels of sport involvement, catastrophizing appears to consist of three related dimensions reflecting individuals' tendency to focus excessively on pain sensations, to magnify the threat value of pain sensations, and to perceive themselves as unable to control the intensity of their pain.

Reliability analyses revealed that the PCS was internally consistent for both sport and sedentary samples. These data suggest that the PCS may be a useful measure of catastrophizing in individuals who experience pain in response to sport activity or injury. However, reliability coefficients for the magnification scale were not high. In previous work, it has been suggested that the low internal reliability of the magnification scale may be due to the small number of items, and the low degree of item redundancy (Sullivan et al., 1995). For example, it is possible that individuals who engage in one form of magnification (e.g., anticipating negative outcomes), may not engage in other forms (e.g., thinking about other painful experiences), thus constraining the potential magnitude of the reliability coefficient (see Billing & Moos, 1984, for a similar argument).

Although previous reports have pointed to the important role of catastrophizing in athletes' responses to pain, the relation between catastrophizing and response to a painful stimulus has never been addressed empirically in an athlete sample. This was the primary focus of Study 2.

Study 2

Anecdotal, empirical, and clinical reports suggest that there is considerable variability among athletes in their responses to pain and injury (Meyers et al., 1992; Pen & Fisher, 1994; Udry et al., 1997). Proceeding from stress and coping frameworks, a number of investigators have suggested that the manner in which athletes appraise situations associated with pain and injury will impact on their distress responses and their rate of recovery from injury (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 early return to sporting activity.

The primary aim of Study 2 was to examine the value of the PCS in predicting pain responses of athletes participating in an experimental pain procedure. Consistent with previous research, athletes were expected to report less intense pain than sedentary individuals (Ryan & Kovacic, 1966; Scott & Gijsbers, 1981). It was predicted that catastrophizing would
be a significant predictor of pain in both athlete and sedentary samples. The study also explored whether differences in pain ratings made by athletes and sedentary individuals were mediated by level of catastrophizing.

Method

Participants
Fifty-four varsity athletes (26 men, 28 women) and 54 sedentary individuals (27 men, 27 women) 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 sedentary group consisted of individuals who reported engaging in physical activity once or less 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 × 40 cm × 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 degrees Celsius.

Measures
Catastrophizing. The PCS (Sullivan et al., 1995) was used as a measure of catastrophic thinking associated with pain. It is described in more 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 (extreme pain).

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. They were assured that the procedure would not result in physical injury and were made aware that they would receive course credit.
even if they did not complete the study. There were no cases of participant withdrawal. All participants were tested by a female experimenter.

Prior to the pain procedure, participants completed the PCS. To regulate arm temperature, participants immersed their dominant arm in a container of room temperature water for 5 minutes. They rated their level of pain at the end of the 5-minute period. They 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 until they were asked to remove their arm from the ice water. They were signalled, by a voice on a tape recording, to give a verbal rating of their current level of pain at the end of one minute. Participants were then asked to remove their arm from the ice water. Finally, participants were debriefed.

Results

Pain Ratings

Pain ratings were analyzed as a two-way factorial with group (athlete, sedentary) and gender (male, female) as between-groups factors. Pain ratings provided during the room temperature water immersion were 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 less pain ($M = 5.7, SD = 1.6$) than sedentary individuals ($M = 7.0, SD = 1.7$). Men reported less pain ($M = 6.1, SD = 1.7$) than women ($M = 6.8, SD = 1.7$). The group by gender interaction was not significant, $F(1, 103) = .25, ns$.

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 athletes ($M = 17.1, SD = 7.3$) obtained lower PCS scores than sedentary individuals ($M = 20.0, SD = 9.1$). Follow up analyses revealed that athletes scored lower than sedentary individuals 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 3. Consistent with previous research, the total PCS score was significantly correlated with pain ratings, $r = .43, p < .01$, in the sedentary sample (Sullivan et al., 1995). The PCS total score also correlated significantly with pain ratings in the
Table 3
Correlations among PCS subscales for athletes and sedentary individuals

<table>
<thead>
<tr>
<th></th>
<th>Pain</th>
<th>PCS</th>
<th>Rumin</th>
<th>Magni</th>
<th>Helps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>.30*</td>
<td>.43**</td>
<td>.40**</td>
<td>.38**</td>
<td>.37**</td>
</tr>
<tr>
<td>PCS</td>
<td></td>
<td></td>
<td>.90**</td>
<td>.71**</td>
<td>.95**</td>
</tr>
<tr>
<td>Rumin</td>
<td>.27*</td>
<td></td>
<td></td>
<td>.47**</td>
<td>.82**</td>
</tr>
<tr>
<td>Magni</td>
<td>.09</td>
<td>.66**</td>
<td></td>
<td></td>
<td>.54**</td>
</tr>
<tr>
<td>Helps</td>
<td>.33**</td>
<td>.86**</td>
<td>.69**</td>
<td></td>
<td>.27*</td>
</tr>
</tbody>
</table>

Note. Pain = Pain ratings during ice water immersion; PCS = Pain Catastrophizing Scale; Rumin = rumination subscale of the PCS; Magni = magnification subscale of the PCS; Helps = helplessness subscale of the PCS. Correlations above the diagonal are for the sedentary sample, and correlations below the diagonal are for the athlete sample. * = p < .05, ** = p < .01.

athlete 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 athletes and sedentary individuals. For both athlete and sedentary 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 athlete sample, magnification was not significantly correlated with pain.

Mediation Analysis
Baron and Kenny (1986) suggest using three regression equations to test mediational hypotheses; (a) regressing the mediator (catastrophizing) on the independent variable (group), (b) regressing the dependent variable (pain) on the independent variable (group), and (c) regressing 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 water pain ratings were used as control variables in the first step of the analyses.

The results of the first regression revealed that group was a significant predictor of level of catastrophizing, over and above the variance accounted for by gender and room temperature water pain ratings, R² 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, R² 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 cata-
prophizing 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 a marginally 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 markedly reduced (beta $= .08$, $p < .29$).

Discussion

The results of the present study are consistent with previous research showing that athletes report less intense pain than sedentary 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 et al., in press; Unruh, 1996). The present findings extend previous research in showing that catastrophizing is a significant predictor of pain in athletes. Catastrophizing, however, did not mediate the differences in pain ratings between athletes and sedentary individuals. Thus, although the results of the present study indicate that in athletes, catastrophizing is a significant determinant of pain perception, the study does not shed light on the factors that contribute to differences in pain perception between athletes and sedentary 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 athlete sample, magnification was not significantly correlated with pain ratings. It is possible that 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 pain, the procedure is essentially innocuous. Participants are aware that no injury will result from the pain experience. For the athlete sample, the use of ice water may have been particularly non-threatening. Indeed, ice is frequently used to alleviate pain and inflammation following sport injury. A more threatening pain stimulus, and one for which athletes would not hold therapeutic associations, may have produced a more significant 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 sport and sedentary samples, suggesting that the PCS also behaved similarly across the different sport categories contained within the sport sample. In addition, the pattern of inter-correlations among the PCS subscales in Study 2 was similar for the athlete and sedentary 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." Confidence in this perspective however, must await further empirical examination.

**General Discussion**

The present research joins a growing body of literature showing that catastrophizing contributes to heightened pain. The findings of the present research also provide empirical support for previous anecdotal reports that athletes who engage in catastrophic thinking may experience more intense pain in response to aversive stimulation (Pen & Fisher, 1994; Udry et al., 1997).

The different components of catastrophizing have been discussed within the context of appraisal processes (e.g., Lazarus & Folkman, 1984). It has been suggested that magnification and rumination may be related to primary appraisal processes where individuals focus on and exaggerate the threat value of the pain stimulus. The helplessness component may be related to secondary appraisal processes where individuals negatively evaluate their ability to deal effectively with pain.

The observed relation between rumination, helplessness, and pain experience suggests potential targets for interventions. Ruminative cognitions may be targeted by instructing individuals in attention diversion or distraction strategies (Turk, Meichenbaum, & Genest, 1983). Helplessness cognitions may be targeted by training athletes to identify their negative cognitions and change them to more positive cognitions (Brewer, 1994; Vallis, 1984). Helplessness cognitions may also be targeted indirectly by increasing individuals' repertoire of coping strategies. In a recent study, Keefe, et al. (1997) found that the more coping strategies chronic pain patients reported using, the more confident they were in their ability to control their pain.

The impact of interventions targeting rumination and helplessness may go beyond minimizing pain intensity, and influence progress in rehabilitation. Given that pain intensity is an important determinant of activity tolerance, individuals who are better able to minimize their pain experience may be able to persist longer in pain-inducing activities (Lyshon & Wicklander, 1987). Taylor and Taylor (1998) have suggested that pain is frequently an important factor related to successful rehabilitation of athletes, and that the mere expectation of pain can be debilitating to the injured athlete.

It is important to consider that catastrophizing may reflect a dimension of heightened pain expression, as opposed to heightened pain experience.
For example, it has been suggested that catastrophizers may differ from noncatastrophizers in their preference for an interpersonal or communal orientation to coping with stress (Sullivan et al., 2000). In contrast, noncatastrophizers may prefer a more individualistic or stoic orientation to coping with stress. Heightened expression of distress may be a necessary component of an interpersonal or communal approach to coping. In other words, expressions of distress may signal the need for assistance or the wish to maintain proximity. To date however, no research has been conducted addressing the distinction between the experience and expression of pain in catastrophizers and noncatastrophizers.

There are limitations to the present study that caution interpretation and generalization of the findings. For example, pain was induced under controlled laboratory conditions that differ substantively from the naturalistic conditions under which the pain of sport involvement typically occurs. Pen and Fisher (1994) have noted that analogue pain paradigms may not provide and adequate test of the psychological factors related to pain tolerance in athletes. A similar argument can be raised about the adequacy of experimental pain procedures in examining the correlates of perceived pain intensity. Experimental pain procedures have the advantage of allowing for standardization of stimulation, and cold pressor procedures have been advocated as the closest laboratory approximation to clinical pain (Turk et al., 1983). But experimental control is gained at the cost of tenuous ecological relevance. Cold pressor pain is not associated with the same degree of threat, uncertainty, and life disruption that accompanies the pain of injury.

Under more ecologically relevant conditions, such as actual injury, the relation between catastrophizing and pain experience may be even more pronounced. Although athletes may typically experience painful stimulation less intensely than sedentary individuals, the potential consequences of injury may be significantly more negative for athletes than for sedentary individuals. For the sedentary individual, the pain of a shoulder sprain may have few implications; for the athlete, it may signal the termination of competitive activity for the season (Evans & Hardy, 1995).

More research is needed to elucidate the psychological factors that contribute to pain experience in athletes. Although the present research showed that catastrophizing was related to pain experience, it is likely to be only one of several factors contributing to pain experience in athletes. Other variables such as optimism, self-efficacy, goal importance, degree of life interference, and threat to continued athletic involvement may also be significant predictors of pain experience.

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