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Fear of Pain, Pain Catastrophizing, and Acute Pain Perception: Relative Prediction and Timing of Assessment

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Abstract

Pain-related fear and catastrophizing are important variables of consideration in an individual's pain experience. Methodological limitations of previous studies limit strong conclusions regarding these relationships. In this follow-up study, we examined the relationships between fear of pain, pain catastrophizing, and experimental pain perception. One hundred healthy volunteers completed the Fear of Pain Questionnaire (FPQ-III), Pain Catastrophizing Scale (PCS), and Coping Strategies Questionnaire-Catastrophizing scale (CSQ-CAT) before undergoing the cold pressor test (CPT). The CSQ-CAT and PCS were completed again following the CPT, with participants instructed to complete these measures based on their experience during the procedure. Measures of pain threshold, tolerance, and intensity were collected and served as dependent variables in separate regression models. Sex, pain catastrophizing, and pain-related fear were included as predictor variables. Results of regression analyses indicated that after controlling for sex, pain-related fear was a consistently stronger predictor of pain in comparison to catastrophizing. These results were consistent when separate measures (CSQ-CAT vs. PCS) and time points (pre-task vs. "in-vivo") of catastrophizing were used. These findings largely corroborate those from our previous study and are suggestive of the absolute and relative importance of pain-related fear in the experimental pain experience.

Perspective—Although pain-related fear has received less attention in the experimental literature than pain catastrophizing, results of the current study are consistent with clinical reports highlighting this variable as an important aspect of the experience of pain.

Keywords

fear; catastrophizing; assessment; pain; experimental

Introduction

The fear-avoidance model (FAM) posits that a chronic pain condition develops via the interaction of fear, avoidant behavior, and disability.[20] Specifically, an initial injury results in an elevated fear of pain, which leads to avoidance of potentially pain-inducing activities.

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Persistent avoidance is hypothesized to result in a disuse syndrome characterized by heightened pain perception, psychological distress, and chronic disability. The FAM was subsequently modified to include pain catastrophizing – the tendency to exaggerate the threat value of pain and negatively evaluate one's ability to deal with pain[17,32,36] – in this process.[19,41] The elaborated model and subsequent reports in the literature, then, have emphasized the importance of both pain-related fear and catastrophizing in the development and maintenance of chronic pain and disability.

The Catastrophizing scale of the Coping Strategies Questionnaire (CSQ-CAT) is a commonly used measure of pain catastrophizing. Despite its popularity, conceptual and measurement limitations have been raised (eg, Hirsh et al[15]). The CSQ-CAT is a unidimensional conceptualization that emphasizes helpless and pessimistic cognitions. A more recently developed measure, the Pain Catastrophizing Scale (PCS),[36] encompasses a broader conceptualization that includes the cognitive processes of rumination, magnification, and helplessness. The PCS may thus be a more appropriate measure of catastrophizing in experimental settings. Indeed, it has previously been shown to be related to pain induced by a wide variety of experimental pain stimuli, including the cold pressor test (CPT).[36,37]

An additional measurement issue is the timing and instructions regarding catastrophizing assessment. Standard instruction sets for the CSQ-CAT and PCS have participants recall the frequency of such cognitions during previous occurrences of pain. An alternative approach – termed "in-vivo" – is to have participants complete the measure immediately following a pain task with instructions modified to assess their experience during that task. This distinction between standard and in-vivo assessment has been shown to be important in experimental pain paradigms. For example, Dixon et al[4] and Edwards et al[6] reported stronger correlations for in-vivo catastrophizing measures and pain ratings. Although these results argue for the use of in-vivo measures of catastrophizing in experimental pain paradigms, given the relative paucity of data on this topic, additional work seems warranted.

Consistent with the FAM, various clinical investigations have included measures of both pain-related fear and catastrophizing.[3,18,25] Conversely, relatively few studies have concurrently examined these constructs in the context of experimental pain. The purpose of the current study was to build upon previous work examining fear of pain and pain catastrophizing in the context of experimental pain. Although we previously found catastrophizing to be less relevant when examined concurrently with pain-related fear,[10] that study did not take into account the issues of assessment timing or measurement instrument noted above. In considering these issues in the current study, we sought to contribute additional data to this line of research. We hypothesized that in-vivo catastrophizing would have a stronger relationship to experimental pain responding than standard catastrophizing. Catastrophizing, as measured by the PCS total score, was expected to be more strongly related to pain than the CSQ-CAT measurement. Finally, we explored the relative size of the relationships to experimental pain indices, between fear of pain and pain catastrophizing.

Materials and Methods

Participants

Participants (N = 100) were recruited from undergraduate and graduate courses at the University of Florida and the surrounding community. Participants were given the option of receiving course credit or financial compensation for their time. Exclusion criteria were a history of any of the following: Raynaud's disease, diabetes, hypertension, vascular insufficiency, and chronic pain. Sixty-six percent of participants were female. The average age of participants was 21.2 years (SD = 1.7 years), and the average education level was 15.2 years

(1.6 years). Forty-six percent of participants were Caucasian, 20% Hispanic, 17% Asian/Pacific Islander, 10% African American, and 7% missing/other.

Measures

Fear of Pain Questionnaire (FPQ-III)—The FPQ-III is a 30-item, 5-point rating scale that measures fear about specific situations that would typically produce pain.[21] The FPQ-III is well-validated and appropriate for use in clinical and non-clinical populations.[1,21,23] The total score was used in the current study.

Pain Catastrophizing Scale (PCS)—The PCS consists of 14 items rated on a 5-point scale.[36] Participants are instructed to rate the degree to which they have specified thoughts and feelings when experiencing pain. Three dimensions of pain catastrophizing are assessed: rumination, magnification, and helplessness. Only the total score was used in the current study. The PCS is validated for clinical and non-clinical populations.[24,36]

Coping Strategies Questionnaire (CSQ-CAT)—The CSQ is a measure of individuals' use of pain coping strategies.[32] Ratings are made on a 7-point scale to indicate the frequency with which a particular strategy is used to cope with pain. Although consisting of seven subscales in total, only the catastrophizing subscale was used in the current study. The CSQ-CAT measures helpless and pessimistic cognitions related to the pain experience. The psychometric properties of this scale are sound,[17,31,32] and the scoring system suggested by Riley and Robinson[27] was used in the current study.

Visual Analogue Scale (VAS)—Pain intensity ratings were provided on VASs. Each VAS consisted of a 10cm line anchored on the left with "no pain sensation" and on the right with "the most intense pain imaginable." When prompted, participants indicated their rating by making a vertical mark along the line. The distance from the left anchor to the vertical mark served as the pain rating.

Procedure

The University of Florida Institutional Review Board approved this protocol. Participants provided informed consent at the onset of the study. Participants were then administered a demographics form, FPQ-III, PCS, and CSQ-CAT. The standard timing and instructions for the PCS and CSQ-CAT were used for this assessment. Next, they completed the cold pressor task (CPT), which involved submerging their non-dominant hand in a circulating water bath maintained at 2°C (+/− .5). Participants were asked to keep their hand immersed for as long as they could tolerate (3 minute maximum), but were instructed that they could withdraw at any time without penalty. Participants indicated the point at which the cold sensation first began to feel painful (pain threshold), and also provided VAS ratings of pain intensity at pain threshold and withdrawal, as well as every 15 seconds during the CPT. Immediately following withdrawal, participants were administered the PCS and CSQ-CAT again, with instructions to complete these measures based solely on their experience during the CPT. Finally, participants were debriefed about the purpose of the study.

Data Analysis

Descriptive statistics were computed for the pain and psychological measures. Independent samples t-tests were used to test for sex differences among the three pain indices. Correlation analyses characterized the bivariate relationships among the pain and psychological variables. Hierarchical multiple regression procedures were then employed, with pain threshold time, pain tolerance time, and pain intensity at tolerance serving as the dependent variables (DV) in their respective models. Regarding the independent variables (IV) in these regression

equations, participant sex was entered in the first block, followed by measures of pain catastrophizing and fear of pain in the second block. This analytic approach is consistent with that employed in our previous study.[10] To determine the influence of various pain catastrophizing measures and assessment time points, four regression equations were computed for each DV, with each model containing the FPQ and one measure of pain catastrophizing (CSQ-CAT or PCS, pre- or in-vivo assessment) as IVs in the second block. In addition to standard regression statistics, Variance Inflation Factor (VIF) coefficients are reported to assess for the extent of multicollinearity among the IVs. Although the construction of multiple regression equations for each DV does increase the risk for Type I error inflation, we believe that this is mitigated by the fact that the current study was a follow-up to a previous study with very specific hypotheses. As such, we did not make any alpha adjustments.

Results

Descriptive data for the pain and psychological variables are presented in Table 1. Sex differences emerged for one out of the three pain perception measures. Consistent with previous studies on this topic, male participants (M = 13.43, SD = 8.80) had higher pain tolerance times [$t(57.87) = -2.23$, $p < .05$, $d = .49$] than female participants (M = 10.77, SD = 7.96). There were no sex differences in pain threshold times [$t(78) = -1.37$, $p > .05$, $d = .32$] or ratings of pain intensity at tolerance [$t(96) = 1.36$, $p > .05$, $d = .29$]. The lack of sex difference in pain threshold is not surprising given the conflictual results that have been published to date.[22, 30,42] The lack of sex difference in pain ratings at threshold and tolerance was also expected and is consistent with the previous study by our group.[10] Table 2 contains the results of correlation analyses examining the bivariate relationships among the pain and psychological variables. Although the magnitude of the relationships between measures of fear of pain and pain catastrophizing was moderate to large (r range: .34 – .41, $p < .01$), 16% was the maximum variance shared between psychological variables. Furthermore, the VIFs for the regression models (Table 3–Table 5) were sufficiently low as to satisfy the multicollinearity assumption of multiple regression. Statistically significant associations among the pain perception variables were observed for pain threshold and tolerance times ($r = .31$, $p < .01$), and pain tolerance time and pain intensity at tolerance ($r = -.25$, $p < .01$). The bivariate relationship between pain threshold time and pain intensity at tolerance was not significant ($r = -.12$, $p > .05$). In addition to their conceptual distinctiveness, the above results indicating large amounts of unshared variance provided further support for the use of these pain perception measures as separate dependent variables in their respective regression models.

Results of regression analyses for pain threshold are presented in Table 3. Participant sex was not a significant contributor in the first block of the model. The second block, containing measures of fear of pain and pain catastrophizing, accounted for an additional 7% to 9% of the variance in pain threshold, depending on the model. FPQ scores consistently approached significance (βs range: −.22 – −.25) as a unique predictor of pain threshold in the second block. The nature of these relationships was negative, such that higher FPQ scores were associated with shorter threshold times. Pain catastrophizing did not emerge as a significant variable in any model (ps > .05); neither the measure used (CSQ-CAT, PCS) nor the timing of assessment (pre, "in-vivo") influenced the nature of these results. Overall, a moderate amount of variance in pain threshold time (R^2 range: .11 – .12) was accounted for across final regression models.

Table 4 contains the results of regression analyses for pain tolerance. Participant sex was a significant predictor in the first step of each model; as previously noted, males had greater tolerance times than females in each instance. Between 11% and 13% (ps < .05) of additional variance in pain tolerance was accounted for by measures of fear of pain (FPQ) and pain catastrophizing (CSQ-CAT, PCS) in the second step of the regression models. Examination of the standardized coefficients indicated that FPQ score (βs range: −.28 – −.36), but not pain

catastrophizing scores (βs range: .01 – −.17), was a significant constituent of the respective models. Similar to pain threshold results above, neither the measure nor timing of catastrophizing assessment appreciably influenced the results. The final models accounted for between 16% and 18% (ps < .01) of the variance in time to pain tolerance.

The regression models for pain intensity ratings at pain tolerance are summarized in Table 5. After controlling for participant sex – which was not a significant predictor in the first block – an additional 9% to 11% (ps < .05) of the variance in pain ratings at tolerance was accounted for by measures of fear of pain and pain catastrophizing. FPQ scores (βs range: .30 – .35) again emerged as the only significant, unique predictor across regression models, with higher scores associated with greater pain ratings. The pattern of these results was not affected by the timing or measurement of pain catastrophizing. Between 9% and 11% (ps < .05) of the variance in pain ratings at tolerance was accounted for in the final regression models.

Discussion

The current study examined several components of the fear-avoidance model (FAM) in an experimental pain context, while taking into consideration recent advances concerning the assessment of pain catastrophizing. Although the full model was not tested, to our knowledge this is the first investigation to consider these conceptual and measurement issues in the context of the FAM. Experimental paradigms permit greater control over pain stimuli and allow for measurement of multiple pain indices, which are important advantages in the study of relationships between pain and psychological variables. Results indicated pain-related fear was a consistently stronger predictor of experimental pain indices compared to catastrophizing. These findings largely replicate those from our previous study.[10] Neither the measurement instrument nor timing or instructions regarding assessment of catastrophizing significantly influenced these results.

That pain-related fear played such a prominent role in this context was not surprising. The theoretical and empirical literature is replete with articles highlighting the role of fear in the experience of pain (see recent review by Leeuw et al[19]). Indeed, fear is an important element of many biopsychosocial models of pain and disability, such as the FAM. We were surprised, however, that pain catastrophizing did not emerge as a significant factor in this study. Catastrophizing has been shown to be related to pain perception in experimental paradigms.[9,13,34,37] What appears to be an important difference between these studies and the current one – as well as our previous report[10] – is the inclusion of pain-related fear. Few studies have concurrently considered both constructs in experimental paradigms. This is now the second study, to our knowledge, indicating fear is a stronger predictor than catastrophizing in this context. It is also possible these constructs have more complex relationships than those examined herein. Future work including theory-driven mediational analyses may yield important results, although the magnitude and significance of the present bivariate coefficients suggests any mediational relationships between these variables would be rather modest. Regardless, at this point it seems prudent for future experimental pain studies to include fear among the other more frequently assessed psychological variables (eg, depression and catastrophizing).

Although caution is due when extrapolating from the experimental to the clinical setting, these data support the notion that fear is an important feature of the clinical pain experience. Although closely related and likely to be responsive to similar interventions, explicit targeting of pain-related fear should be considered in the treatment of pain. Catastrophizing has received increased focus of late (see the treatment protocol of Thorn and colleagues[38,39]), and we agree with the importance placed on this cognitive process. Additionally, our data, clinical experience, and a growing literature (see Leeuw et al[19] for review) suggest pain-related fear

should also be the recipient of targeted clinical efforts, likely in the form of graded activity, behavioral exposure, and/or cognitive restructuring.[11] While this is not a new idea for the management of musculoskeletal pain, it is our opinion that fear often receives less clinical attention than other psychological factors. The convergence of the current findings with many of these clinical studies provides additional support for the external validity of this study.

We found little difference between two common measures of pain catastrophizing – CSQ-CAT and PCS – and their association with several indices of experimental pain; neither was significantly related to pain after controlling for fear. This was counter to our hypothesis that the PCS would be more strongly related to pain due to its broader conceptualization of catastrophizing than the unidimensional CSQ-CAT. Although the PCS may be preferable on theoretical grounds (see Sullivan et al[35] and Turner and Leslie[40]), there is not extensive data on the practical implications of the differences between instruments. At this point, decisions regarding the choice of instrument should perhaps be guided more by the purpose of the assessment than concerns about relative measurement quality. For example, if one is interested solely in the construct of catastrophizing, the PCS may be preferred since it is briefer and multidimensional. If, however, one intends to measure various pain-coping strategies, the CSQ may be preferred since it includes other domains (eg, distraction, ignoring).

In addition to the instrument issue, we sought to contribute to the emerging literature concerning the timing and instructions regarding catastrophizing assessment. Previous studies found in-vivo measurement (ie, occurring immediately after a pain task with instructions to complete the instrument based on one's preceding experience) to be a better predictor of experimental pain responding than standard measurement.[4,6] The current results diverge with this literature; no appreciable differences emerged between standard and in-vivo catastrophizing measurements. Perhaps this is due to our inclusion of pain-related fear in the analyses. It is also possible measurement timing and instruction are less important than initial indications. Since few studies have addressed this issue, we caution against drawing strong conclusions at this point. Continued research is needed to further elucidate the role of timing and instruction in pain catastrophizing assessment.

An additional issue warranting further study is the role of sex in this context. An emerging literature indicates the relationships among pain and psychological variables differ for males and females.[5,7,8,14,27,28,29] For example, Robinson and colleagues[29] found the relationship between pain (clinical and induced low back pain) and pain-related anxiety was stronger in men than women. George and colleagues[11] found although men and women had similar physical therapy outcomes for disability, the factors predicting outcome differed between them. Most relevant to the current study, fear of pain and activity predicted change in disability for men but not women. Somewhat to the contrary, Hirsh and colleagues[16] found the pain-disability relationship to be more direct in males, whereas in females, psychological factors served a mediating role. As it was beyond the scope of the current study, we did not investigate sex differences in the relationships examined herein. We encourage future work to build upon this and other studies to consider how sex may influence the experience of pain and associated cognitive and affective processes.

Several limitations of the current study should be considered. The clinical relevance is limited by the experimental nature of the pain stimuli. The CPT is considered a good model of clinical pain, due to its sufficient duration and prior association with high unpleasantness ratings.[26] Of particular concern, however, is the issue of perceived threat. The CPT may not be sufficiently threatening to elicit psychological reactions, such as catastrophizing, consistent with those associated with clinical pain.[10,13] We did not measure perceived threat and, thus, cannot address this issue directly. Future work could measure threat and perhaps manipulate it outright. Such attempts raise ethical concerns; however, it seems possible threat could be

ethically altered via instructional set if followed by a debriefing addressing any associated deleterious effects. This would permit an empirical investigation of the interaction between perceived threat and pain-related fear and catastrophizing. A few studies[2,33] have attempted to manipulate threat associated with experimental pain; the results were mixed and suggest continued work in this area. Relatedly, it is possible catastrophizing failed to emerge as a prominent variable in the current study due to range restriction. Perhaps there is not sufficient variability in the magnitude of catastrophic cognitions of healthy individuals undergoing a relatively predictable and controllable pain experience. Another limitation concerns measurement. We modified the instructional sets of two psychometrically sound measures of catastrophizing. These modifications were made in accord with those of Dixon and colleagues[4] and Edwards and colleagues[6] to facilitate across-study comparisons. Nevertheless, the effects of such modifications on the psychometric properties of the instruments are not known. If these measurement issues continue to receive empirical attention, the effects of instruction modification will need to be fully characterized. Another potential limitation concerns Type I error. Since this was a follow-up study with very specific hypotheses, we do not think error inflation was of sufficient concern to warrant alpha adjustments. Nevertheless, a conservative approach is to adopt an alpha level based on the number of models per DV. Since there are four models per DV, one could divide .05 by four and use the resulting quotient (.0125) as the new alpha by which to judge the significance of individual regression coefficients. With the exception of sex, all previously significant coefficients would remain significant at an alpha of .0125. Taken together with the consistency of findings across different studies, DVs, and regression models, this suggests the current results are unlikely to be due to Type I error.

In summary, these data are consistent with the emphasis placed on pain-related fear by the FAM and other biopsychosocial models of pain. Results were not entirely in line with updated versions of these models, however, in that catastrophizing was not significantly related to experimental pain indices when simultaneously considered with fear of pain. No differences were found between two common measures of pain catastrophizing. In contrast to recent reports, we did not find the timing and instruction regarding catastrophizing assessment to be important in this context. Continued work is needed to replicate these findings and further elucidate the many issues raised in this study.

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Table 1

Summary of pain and psychological variables

Measure	Observed range	Mean (SD)
Pain threshold (sec)	1 – 51	11.70 (8.31)
Pain tolerance (sec)	7 – 180	79.93 (57.01)
Pain intensity at tolerance	9 – 101	75.98 (23.00)
FPQ	8 – 88	50.34 (17.28)
Pre-CSQ-CAT	0 – 22	6.80 (4.17)
In vivo-CSQ-CAT	0 – 23	7.59 (5.19)
Pre-PCS	0 – 38	18.57 (9.17)
In vivo-PCS	3 – 41	20.56 (9.85)

Table 2

Zero-order correlations for variables included in regression analyses

	2.	3.	4.	5.	6.	7.	8.
1. Pain threshold	.31**	−.12	−.31**	−.11	−.20	−.24*	−.17
2. Pain tolerance		−.25*	−.38**	−.15	−.26**	−.12	−.31**
3. Pain at tolerance			.31**	.03	.16	.06	.12
4. FPQ				.40**	.34**	.41**	.40**
5. Pre-CSQ-CAT					.62**	.80**	.61**
6. In vivo-CSQ-CAT						.52**	.86**
7. Pre-PCS							.61**
8. In vivo-PCS							

*$p < .05$

**$p < .01$

Table 3

Results of hierarchical regression analyses predicting pain threshold

Step	Independent variables	R^2	ΔR^2	ΔF	β	VIF
1	Sex	.04	.04	2.69	.19	1.17
2	FPQ	.11†	.07†	2.58†	−.25†	1.29
	Pre-CSQ-CAT				−.06	1.20
1	Sex	.04	.04	2.69	.19	1.17
2	FPQ	.12*	.08*	3.23*	−.23†	1.23
	In vivo-CSQ-CAT				−.15	1.14
1	Sex	.04	.04	2.69	.19	1.18
2	FPQ	.12*	.08*	3.16*	−.22†	1.32
	Pre-PCS				−.15	1.26
1	Sex	.04	.04	2.69	.19	1.17
2	FPQ	.12*	.09*	3.38*	−.22†	1.27
	In vivo-PCS				−.16	1.20

†$p < .10$

*$p < .05$

Table 4

Results of hierarchical regression analyses predicting pain tolerance

Step	Independent variables	R^2	ΔR^2	ΔF	β	VIF
1	Sex	.05*	.05*	4.98*	.23*	1.14
2	FPQ	.16**	.11**	5.41**	−.35**	1.28
	Pre-CSQ-CAT				.01	1.21
1	Sex	.05*	.05*	4.98*	.23*	1.14
2	FPQ	.18**	.12**	6.48**	−.30**	1.23
	In vivo-CSQ-CAT				−.15	1.15
1	Sex	.05*	.05*	4.98*	.23*	1.14
2	FPQ	.16**	.11**	5.49**	−.36**	1.29
	Pre-PCS				.04	1.22
1	Sex	.05*	.05*	4.98*	.23*	1.15
2	FPQ	.18**	.13**	6.86**	−.28*	1.28
	In vivo-PCS				−.17	1.22

†$p < .10$

*$p < .05$

**$p < .01$

Table 5

Results of hierarchical regression analyses predicting pain intensity at tolerance

Step	Independent variables	R^2	ΔR^2	ΔF	β	VIF
1	Sex	.01	.01	1.12	−.11	1.13
2	FPQ	.11*	.09*	4.45*	−35**	1.28
	Pre-CSQ-CAT				−.13	1.20
1	Sex	.01	.01	1.12	−.11	1.14
2	FPQ	.09*	.08*	3.78*	.30**	1.22
	In vivo-CSQ-CAT				.00	1.15
1	Sex	.01	.01	1.12	−.11	1.13
2	FPQ	.10*	.09*	4.18*	.34**	1.29
	Pre-PCS				−.10	1.21
1	Sex	.01	.01	1.12	−.11	1.14
2	FPQ	.10*	.09*	4.01*	.33**	1.28
	In vivo-PCS				−.07	1.21

† $p < .10$

* $p < .05$

** $p < .01$