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Exposure to Physical Movements in Low Back Pain Patients: Restricted Effects of Generalization

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Whether the effects of exposure to 1 movement generalize to another dissimilar movement was investigated in 37 patients with low back pain (15 men, 22 women). Two movements were executed twice: bending forward while standing and lifting 1 leg while lying down. During each trial, baseline pain, expected pain, and experienced pain were recorded. Similar ratings for perceived harm were obtained. Analyses revealed an initial overprediction of pain, but after exposure the overprediction was readily corrected. This exposure effect did not generalize toward another dissimilar movement. These results were only characteristic for patients with catastrophic thinking about pain. Low pain catastrophizers did not overpredict pain. There were no effects of exposure on perceived harm. Exposure may profitably be conceived of as the learning of exceptions to a general rule.

Key words: pain, fear, exposure, chronic pain, disability, coping, extinction, avoidance

Low back pain (LBP) is among the most frequent health problems in the general population, affecting 58%–84% of all adults at some point in their lives (Dionne, 1999). Fortunately, when LBP problems are graded on pain severity and the lowered ability to accomplish tasks of daily living (disability), most episodes do not appear to be disabling (Von Korff, Ormel, Keefe, & Dworkin, 1992). Furthermore, natural history studies have revealed an excellent prognosis for LBP disability. Working disability lasts longer than 3 months and becomes a major clinical and chronic problem for only about 10% of those with LBP (Nachemson, 1985). However, the prognosis for the experience of LBP is less favorable. Von Korff, Deyo, Cherkin, and Barlow (1993) followed a cohort of 177 patients with recent onset of back pain over a period of 1 year. They found that about 80% still experienced back pain after 1 year, but only 14% showed substantial disability. Therefore, the problem of chronic LBP seems to be more related to disability than to pain (Aldrich, Eccleston, & Crombez, 2000; Eccleston & Crombez, 1999; Fordyce, 1995).

Pain severity is often a poor predictor of the inability to accomplish tasks of daily living in patients with chronic pain (Crombez, Vlaeyen, Heuts, & Lysens, 1999; Sullivan, Stanish, Waite, Sullivan, & Tripp, 1998; Waddell, Newton, Henderson, Sommerville, & Main, 1993). Several interrelated forms of pain-related fear have been identified and have been found to be important in explaining disability (Vlaeyen & Linton, 2000). Waddell et al. (1993) found that fear-avoidance beliefs about pain caused at the workplace and by physical activities were better predictors of self-reported disability in daily living and the number of lost work days in the past year than pain characteristics such as anatomical pattern of pain, time pattern, and pain severity. Vlaeyen, Kole-Snijders, Boeren, and van Eek (1995) observed that another form of pain-related fear, the fear of movement–(re)injury, was a better predictor of self-reported dysfunction than pain severity. Crombez et al. (1999) reported two studies in which the same type of pain-related fear was superior in predicting dysfunction and behavioral performance than pain intensity, pain duration, or the general disposition to experience negative affect. Patients who have an exaggerated negative orientation toward actual pain and anticipated pain experiences are at an especially high risk for developing pain-related fear, avoidance, and long-term disability (Linton, 2000; Vlaeyen et al., 1995). This type of appraisal has been labeled *catastrophic thinking about pain*. It has been found to be strongly related to fearful reactions toward pain in studies using both clinical patients and pain-free volunteers (Crombez et al., 1999; McCracken & Gross, 1993) and to be an important predictor of disability in a variety of chronic pain syndromes (Sullivan et al., 1998; Vlaeyen et al., 1995).

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One mechanism by which pain-related fear may explain disability is the instigation of avoidance of daily activities that are expected to hurt and harm (Asmundson, Norton, & Norton, 1998; Philips, 1987; Vlaeyen et al., 1995). Such avoidance behavior may easily persist because few opportunities exist to correct mistaken expectations and beliefs about pain. An important question is how LBP patients may recover from avoidance behavior. Philips (1987) has suggested that “exposure should be undertaken in order to produce disconfirmations between expectations of pain and actual pain experiences” (p. 279). For patients suffering from phobias and anxiety disorders, exposure to the feared stimulus has already proven to be the most effective treatment ingredient (Davey, 1997). However, exposure in pain patients has not been systematically implemented and studied in treatment settings (Morley, Eccleston, & Williams, 1999). To date, there are only experimental studies demonstrating that exposing LBP patients to physical activities leads to a swift correction of overpredictions of pain and fear of (re)injury (Crombez, Vervaet, Lysens, Baeyens, & Eelen, 1998; Crombez, Vervaet, Lysens, Eelen, & Baeyens, 1996; McCracken, Gross, Sorg, & Edmands, 1993). For example, in the study by McCracken et al. (1993), LBP patients raised one leg while lying down on several trials. McCracken et al. found that patients with high pain-related fear tended to overpredict pain and anxiety during early trials of straight leg raising but that predictions became more accurate with experience.

Although exposure has potential clinical utility for LBP patients, it is not yet known whether the effects of exposure generalize to other dissimilar physical movements. This issue is also theoretically important because it reveals exposure to be a dynamic phenomenon that cannot simply be equated with unlearning. This view is in line with the current ideas on extinction in a classical conditioning paradigm, which is often considered an experimental analogue of exposure (Bouton, 1988, 2000). In an impressive series of classical conditioning studies using animals, Bouton (1988, 2000) repeatedly demonstrated that extinction effects do not easily generalize across different contexts. More specifically, extinction in a context that was dissimilar from the original acquisition context resulted in extinction that was restricted to that particular context. Bouton suggested that during extinction, exceptions to the acquisition rule are learned rather than a fundamental change of that rule. Assuming that simple phobias result from classical conditioning processes, Rowe and Craske (1998) tested a similar idea in a student population with fear of spiders. They found that exposure toward the same spider resulted in a clear return of fear in response to another novel spider at follow-up. Applying and extending this idea to discrete stimuli and physical movements, it is reasonable to hypothesize that LBP patients will not change their general belief that certain movements hurt and harm, even after disconfirmations of that belief.

The primary objective of this study was to investigate generalization of exposure to physical activities. We wanted to investigate whether (a) patients experience an increase in pain and perceived harm during movements; (b) patients make overpredictions of pain and perceived harm; (c) patients correct these overpredictions when the same movement is repeated; and (d) the correction of overprediction generalizes to another, dissimilar movement. A further objective was to explore the relationship between individual differences of pain-related fear and overpredictions. Building on the above ideas, it is expected that overpredictions of pain and perceived harm will be present in patients with high pain-related fear and with a high catastrophic thinking about pain. No study to date has provided firm evidence for such a relationship. A final hypothesis, then, was that overpredictions of pain and perceived harm would be positively related to the Tampa Scale for Kinesiophobia and the Pain Catastrophizing Scale (see *Questionnaires*, below).

Method

Participants

Thirty-seven patients with a chronic or recurrent back pain problem (mean age 43.24 years, $SD = 12.57$) were recruited from the Centrum voor Evaluatie en Revalidatie van Motorische Functies (Center for Evaluation and Revalidation of Motor Functions) at a Belgian university hospital. All were Caucasian. Most patients were employed (15 part time, 5 full time); 3 patients were unemployed, 2 of whom attributed unemployment to their pain problem. Twenty-seven patients reported pain radiating to the leg. There were no indications of spinal disease or other organic pathology requiring further surgical intervention (some patients had previously had surgery).

Behavioral Test

The performance tests consisted of two variants of movements selected from the Movement and Pain Prediction Scale (MAPPS; Council, Ahern, Follick, & Kline, 1988): toe touch in standing position and straight leg raise in supine position. Patients were requested to execute both movements twice. To standardize the performance of both movements, two devices were constructed. *Bending forward* (Movement A) consisted of bending forward with straight legs until the fingers touched a horizontal metal bar that was positioned at two thirds of the distance between ground level and the knees. The other movement consisted of *raising the leg* (Movement B) until the leg reached a wooden plank that was positioned at an angle of 60°.

Questionnaires

Patients received a number of questionnaires designed to assess the following constructs. *Fear of movement–(re)injury*: the Dutch version of the Tampa Scale for Kinesiophobia (TSK; Vlaeyen et al., 1995) is a 17-item questionnaire that measures the fear of (re)injury due to movement (e.g., “I wouldn’t have this much pain if there weren’t something potentially dangerous going on in my body”). It has been shown to have good reliability and validity (Crombez et al., 1999; Vlaeyen et al., 1995). *Pain catastrophizing*: the Dutch version of the Pain Catastrophizing Scale (PCS; Crombez, Eccleston, Baeyens, & Eelen, 1998) was included in this study. This is a 13-item scale developed for both nonclinical and clinical populations. Participants reflect on past painful experiences and indicate the degree to which they experienced thoughts or feelings during pain on a 5-point scale (e.g., “I can’t seem to keep it out of my mind, I feel I can’t stand it any more”). The Dutch version has been shown to have good reliability and validity in a student population (Crombez, Eccleston, et al., 1998) and in a clinical population (Crombez et al., 1999; Van Damme, Crombez, Bijttebier, Goubert, & Van Houdenhove, 2002). *Negative affect*: The Negative Affect (NA) subscale of the Positive Affect–Negative Affect Scale (PANAS; Watson, Clark, & Tellegen, 1988) was used to measure negative affect. The PANAS is a 20-item scale that consists of emotional adjectives. Respondents are asked to rate the degree to which each of the adjectives generally describes them (e.g., *tense*, *alert*, *anxious*). The Dutch version of the PANAS has proven reliable and valid (Stegen, 1998).

Procedure

The patient was requested to perform both movements twice, resulting in four performances. The same movement was repeated consecutively. Duration of the exposure phase was approximately 15 min. Eighteen patients began with the bending-forward test (order of movements: AABB). The other patients began with the straight-leg raising test (order of movements: BBAA). Before each performance, the patient rated the current back pain intensity using an 11-point numerical rating scale (*baseline pain*). The patient then rated the pain that he or she expected to experience during the performance of the movement (*expected pain*), using the same scale. Immediately after the performance of the movement, the patient rated the back pain that was experienced (*experienced pain*). This sequence was repeated for each of the four performances. Self-reports about perceived harm (*baseline harm*, *expected harm*, and *experienced harm*) were obtained in parallel with the pain reports using an 11-point numerical rating scale. The time lags between the four performances were solely dependent on time necessary to instruct and to obtain pain and harm reports. At the end of the experiment, the patient received the questionnaires. Patients were requested to complete these questionnaires at home and to mail them back.

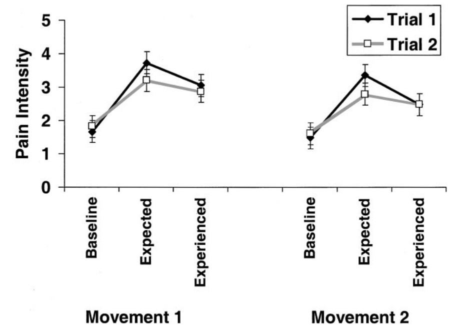

Figure 1. The self-reported pain ratings (baseline pain, expected pain during physical activity, experienced pain during physical activity) during exposure to two physical movements. Each movement was performed twice.

Results

Behavioral Test

Only 4 patients were unable to perform one or both movements. Because the objective was to investigate correction of expectancies after successful performance, data of these 4 subjects were excluded from further statistical analyses.[1] A 2 (movement: first movement vs. second movement) × 2 (trial: first trial vs. second trial) × 3 (type of report: baseline pain, expected pain, or experienced pain) analysis of variance (ANOVA) was performed on the pain reports. There was no significant main effect of movement, $F(1, 32) = 2.33$, *ns*, $MSE = 5.56$. There were significant main effects of trial, $F(1, 32) = 4.89$, $p < .05$, $MSE = 0.56$, and of type of report, $F(2, 64) = 31.72$, $p < .01$, $MSE = 2.86$. Of particular importance to this study are the significant Trial × Type of Report interaction, $F(2, 64) = 10.81$, $p < .01$, $MSE = 0.37$, and the nonsignificant Movement × Trial × Type of Report interaction, $F(2, 64) = 0.43$, *ns*, $MSE = 0.33$, indicating possible effects of exposure with the same movement but no effects of generalization of exposure to the dissimilar movement.

A series of one-tailed *t* tests was performed to further corroborate these observations. These tests revealed the following. (a) Patients experienced an increase in pain during the performance of the exercises. Experienced pain during each of the four executions was significantly higher than baseline pain, $t(32) = 4.78$, $p < .01$. (b) Patients overpredicted the amount of pain during the first trial of each of the two movements. The expected pain was larger than experienced pain during the first trial of the first movement, $t(32) = 2.64$, $p < .01$, and during the first trial of the second movement, $t(32) = 3.13$, $p < .01$. (c) The overprediction of pain was readily corrected after the first trial for each of the two movements. For the first movement, the overprediction of pain during the first trial was almost significantly higher than during the second trial of that movement, $t(32) = 1.65$, $p < .06$. For the second movement, this effect was significant, $t(32) = 2.04$, $p < .05$. (d) The correction of overprediction obtained during the first movement did not generalize to the second movement. The overprediction of pain in the first trial of the first movement was not significantly different from the overprediction of pain in the first trial of the second movement, $t(32) = 0.56$, *ns*.

The means of the pain reports during the four physical performances are displayed in Figure 1. This figure also illustrates that the means are in line with our hypotheses: (a) Patients experienced an increase in pain during both trials of each movement, (b) patients overpredicted pain during the first trial of each of the two movements, (c) patients corrected this overprediction during the second trial of each of the two movements, and (d) this correction did not generalize from the first movement to the second movement.

A 2 (movement: first movement vs. second movement) × 2 (trial: first trial vs. second trial) × 3 (type of report: baseline harm, expected harm, or experienced harm) ANOVA was performed on perceived harm reports. Only a main effect of type of report was significant, $F(2, 64) = 21.49$, $p < .01$, $MSE = 3.54$. Further exploration of this significant effect revealed that patients experienced an increase in perceived harm during the performance: Experienced harm ($M = 1.64$, $SD = 1.68$) during the movements was significantly higher than baseline harm ($M = 0.60$, $SD = 0.95$), $t(32) = 4.28$, $p < .01$. Also, patients overpredicted perceived harm: Expected harm ($M = 2.08$, $SD = 1.97$) was significantly higher than experienced harm ($M = 1.64$, $SD = 1.68$), $t(32) = 2.80$, $p < .01$. All other ANOVA effects were not significant, including the Trial × Type of Report interaction, $F(2, 64) = 2.22$, *ns*, $MSE = 0.58$, and Movement × Trial × Type of Report interaction, $F(2, 64) = 0.45$, *ns*, $MSE = 0.45$. There were no indications that exposure had a statistically reliable effect on perceived harm, and, therefore, no further detailed analyses were performed. However, it is noteworthy that the averaged scores of perceived harm are in the lower range of the 11-point scale, possibly indicating that an expectancy of bodily harm was not an issue during the exposure phase for these patients.

The Role of Pain Catastrophizing and Fear of Movement–(Re)injury

In a further exploration of the data, the overprediction of pain and perceived harm were related to pain catastrophizing (PCS: $M = 20.64$, $SD = 8.92$), fear of movement–(re)injury (TSK: $M = 38.04$, $SD = 7.81$), and NA ($M = 9.11$, $SD = 7.80$). Questionnaire data were available for 28 patients. A measure of average overprediction was calculated by subtracting experienced pain (perceived harm) from expected pain (perceived harm) in

[1] Analysis with these 4 subjects included in the statistical analyses did not reveal any different results.

both movements. Only the self-reports of the first trial of each movement were taken into account. As expected, a significant positive correlation existed between the PCS and the TSK ($r = .58$, $p < .01$). Of particular interest was the finding that the correlation between the overprediction of pain and the PCS was significantly positive ($r = .39$, $p < .05$). This was not the case for the TSK ($r = .24$) nor for the NA ($r = .14$). Surprisingly, none of the individual difference variables were significantly related to the overpredictions of perceived harm (PCS: $r = -.09$; TSK: $r = .24$; NA: $r = .18$).

In a final analysis, the effect of pain catastrophizing on the generalization of the correction was investigated. Patients were split in two groups according to the median of the PCS (*Mdn* = 20.5). This resulted in a group of 14 patients (7 women and 7 men) with a high frequency of pain catastrophizing *(high pain catastrophizers)* and a group of 14 patients (10 women and 4 men) with a low frequency of pain catastrophizing *(low pain catastrophizers)*. A 2 (group: high pain catastrophizers vs. low pain catastrophizers) × 2 (movement: first movement vs. second movement) × 2 (trial: first trial vs. second trial) × 3 (type of report: baseline pain, expected pain, or experienced pain) ANOVA was performed on the verbal pain reports.[2] The first variable was between subjects. All other variables were within subjects. The main effects of trial, $F(1, 26) = 5.23$, $p < .05$, $MSE = 0.62$, and of type of report, $F(2, 52) = 35.19$, $p < .01$, $MSE = 2.92$, were statistically significant. The Trial × Type of Report interaction was also significant, $F(2, 52) = 10.44$, $p < .01$, $MSE = 0.36$. Of particular interest are the interactions with group. Only the Group × Trial × Type of Report interaction was significant, $F(2, 52) = 3.725$, $p < .05$, $MSE = 0.365$. All other effects were not significant. The means of the significant Group × Trial × Type of Report interaction are displayed in Figure 2. This figure clearly suggests that our ideas regarding the correction of overprediction are only valid for the high pain catastrophizers. Low pain catastrophizers did not seem to overpredict pain.

A series of one-tailed *t* tests was performed to further explore our hypotheses. (a) Both high pain catastrophizers and low pain catastrophizers experienced an increase in pain during the performance of the exercises, and there was no significant difference between these two groups, $t(26) = 1.00$, *ns*. (b) High pain catastrophizers, but not low pain catastrophizers, overpredicted pain. For high pain catastrophizers, the expected pain was larger than the experienced pain during the first trial of the first movement, $t(26) = 3.30$, $p < .01$. This was also true for the second movement, $t(26) = 2.64$, $p < .01$. For the low pain catastrophizers, no significant overpredictions were present during the first movement, $t(26) = 0.55$, *ns*, and the second movement, $t(26) = 1.55$, *ns*. Because low pain catastrophizers did not overpredict pain, the subsequent tests regarding the correction of overprediction and the generalization of the correction toward a dissimilar movement are meaningless. (c) High pain catastrophizers easily corrected the overprediction of pain. For high pain catastrophizers, the overprediction of pain during the first trial of the first movement was significantly higher than during the second trial, $t(26) = 2.35$, $p < .05$. This correction was also significant during the second trial for the high pain catastrophizers, $t(26) = 1.98$, $p < .05$. (d) The correction of the overprediction did not generalize across the two movements for the high pain catastrophizers, $t(26) = 0.36$, *ns*.

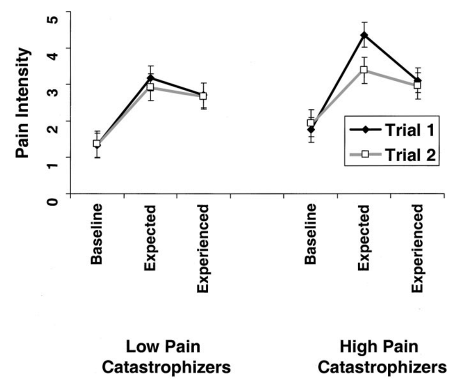

Figure 2. The self-reported pain (baseline pain, expected pain during physical activity, experienced pain during physical activity) during exposure to the two physical movements as a function of pain catastrophizing. Reported means are averaged across the two different movements.

Discussion

This study was designed to investigate whether the effects of exposure to a movement generalize toward another dissimilar movement. LBP patients were requested to perform two movements twice. During each of the four exercises, baseline pain, expected pain, and experienced pain were recorded. Similar ratings for perceived harm were obtained.

Overall, initial overpredictions of pain were readily corrected when the same movement was repeated. This pattern has been frequently observed with experimental and clinical pain (Crombez et al., 1996; Crombez, Vervaet et al., 1998; Rachman & Arntz, 1991). It is promising for the applicability of graded exposure to back-stressing movements because it has been suggested that overpredictions and avoidance behavior may be eliminated with a gradual exposure to back-stressing movements (Crombez et al., 1999; Eccleston & Crombez, 1999). A necessary condition for its success, however, is that patients experience disconfirmation of their predictions. This study offers further support for this prerequisite.

Of particular interest to this study was whether the effects of exposure with one particular movement generalize to another dissimilar movement. In line with current views of extinction (Bouton, 1988, 2000), it was predicted that despite successful exposure during the first movement, overpredictions would return during the second movement. The hypothesis was confirmed for the overpredictions of pain. Although patients readily corrected overpredictions of pain, this correction of overprediction of pain did not extend across different movements. The results regarding perceived harm are less clear. The ANOVA results seem to indicate that overpredictions of harm were not corrected by exposure. However, it is possible that our procedure was not valid or sensitive enough to detect effects of exposure on perceived harm. First, the average scores on perceived harm during the exposure phase are very low, possibly indicating that expectancy of harm was not a real issue during exposure for these patients. Second, there was

[2] A similar ANOVA on the reports of perceived harm did not reveal any significant effects, except a main effect of type of report, $F(2, 52) = 25.73$, $MSE = 3.45$, $p < .01$.

no relationship between the scores on a questionnaire measuring fear of (re)injury during physical movements (the TSK) and the expectancy of harm during the exposure phase. The latter finding suggests that perceived harm as measured during the exposure phase is distinct from the more validated construct of fear of (re)injury as measured by the TSK.

Another objective was the exploration of the role of individual-difference variables in explaining overpredictions during the behavioral test. As in the study of Crombez et al. (1999), we did not obtain any evidence that fear of (re)injury (as measured by the TSK) or general negative affect (as measured by the PANAS) was related to overpredictions of pain. However, pain catastrophizing (as measured by the PCS) was related to overpredictions of pain. More specifically, patients with a low frequency of catastrophic thinking about pain differed from the overall pattern of results: They were accurate in their predictions of pain. Only patients with a high frequency of catastrophic thinking about pain overpredicted pain and did not show a generalization effect. To our knowledge, this is the first study that has observed such a relationship. It is clear from our data that this relationship is not simply the consequence of pain severity: In fact, there was no effect of pain catastrophizing on experienced pain. A premature but intriguing hypothesis may be derived from the results of the pain catastrophizers. Although a cognitive style of pain catastrophizing is known to be related to a cognitive style of overgeneralization (Lefebvre, 1981), our data can only be fully explained if an asymmetry in overgeneralization is assumed: Pain catastrophizers are liberal in assuming that a painful experience during one movement applies to even slightly similar movements, but they are conservative in assuming that the experience that a movement is less painful than expected applies to slightly dissimilar movements.

Catastrophizing about pain has often been considered an instantiation of the high threat value of pain (Aldrich et al., 2000; Eccleston & Crombez, 1999; Sullivan et al., 2001) and therefore a precursor for the development of pain-related fear (Crombez et al., 1996, 1999; Sullivan et al., 2001; Vlaeyen et al., 1995) and avoidance behavior (Vlaeyen et al., 1995). Furthermore, pain-related fear has been found to mediate the relationship between pain catastrophizing and avoidance behavior (Crombez et al., 1999). At first sight, our data are not consistent with this view because we found no relationships between pain-related fear on the one hand and the pain expectancy and harm measures on the other hand. However, pain-related fear is not a unitary construct and probably encompasses several partly unrelated forms of pain-related fear (e.g., fear of pain, fear of blood, fear of [re]injury, fear of flare-ups, and fear of long-term consequences of pain). It is highly plausible that in our study, the fear of pain was more prevalent than the fear of (re)injury. It will be critically important for further research to identify the varied and specific contents of the threat value of pain and their interrelationships. There is to date no systematic research on this important theoretical and clinical issue (Aldrich et al., 2000; Crombez, Hermans, & Adriaensen, 2000). The finding that the correction of overprediction of pain did not extend across different movements offers a possible explanation for the treatment resistance that is often observed in patients with persistent pain (Turk & Rudy, 1990). If exposure is to develop into a clinical tool, either as a therapy in itself or as part of physical therapy, research must be conducted to ascertain the optimal conditions for generalization across movements, situations, and time. In particular, identification is needed of the essential cues for threat to which patients can be exposed. It is plausible that generalization of exposure effects is facilitated once patients have been successfully exposed to the essential stimuli (see Vlaeyen, de Jong, Geilen, Heuts, & van Breukelen, 2001). We also suggest that exposure to varying physical movements will facilitate generalization to new physical movements. Furthermore, it is plausible that, in combination with exposure, cognitive techniques such as the eliciting of negative thoughts and the explicit testing of predictions concerning pain and injury will be necessary to directly challenge the validity of catastrophic assumptions and misinterpretations (Vlaeyen, de Jong, Sieben, & Crombez, 2002; Warwick, Clark, Cobb, & Salkovskis, 1996).

A number of limitations to the current research must be considered. First, movements were not individually selected and may have reduced the possibility of finding generalization effects. Second, the role of pain catastrophizing is promising but needs replication, because this study consisted of a relatively small sample. Therefore, one should be cautious in generalizing to other populations until these effects are examined more extensively and their clinical implications more fully considered. Although we were able to demonstrate that the pattern of results observed here for the pain catastrophizers was robust (Goubert, Francken, Crombez, Vansteenwegen, & Lysens, 2002), it remains possible that the statistical power in our study was low, resulting in the detection of large effects but leaving undetected differences with small effect size. Third, exposure has limitations for LBP patients because it only corrects overpredictions. It is clear from our data that movements hurt. It is therefore unlikely that a permanent extinction of anticipatory responses and avoidance can be accomplished.

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