

ORIGINAL ARTICLE

An examination of the structural link between post-traumatic stress symptoms and chronic pain in the framework of fear-avoidance models

A.E. López-Martínez, C. Ramírez-Maestre, R. Esteve

Faculty of Psychology, Department of Personality, Assessment and Psychological Treatment, University of Málaga, Spain

Correspondence

Alicia E. López-Martínez
E-mail: aelm@uma.es

Funding sources

This study was supported by grants from the Spanish Ministry of Science and Innovation (PSI2008-01803/PSIC) and the Regional Government of Andalusia (HUM-566; P07-SEJ-3067).

Conflicts of interest

None declared.

Accepted for publication

14 January 2014

doi:10.1002/j.1532-2149.2014.00459.x

Abstract

Background: The tendency to respond with fear and avoidance can be seen as a shared vulnerability contributing to the development of post-traumatic stress disorder (PTSD) and chronic pain. Although several studies have examined which specific symptoms of PTSD (re-experiencing, avoidance, emotional numbing and hyperarousal) are associated with chronic pain, none has considered this association within the framework of fear-avoidance models.

Methods: Seven hundred fourteen patients with chronic musculoskeletal pain were assessed. Of these, 149 patients were selected for the study based upon the following inclusion criteria: exposure to a traumatic event before the onset of pain (with scores equal to or higher than 8 points on the fear and hopelessness scales of the Stressful Life Event Screening Questionnaire Revised) and scores equal to or higher than 30 on the Davidson Trauma Scale.

Results: Structural equation modelling was used to test the association between PTSD symptoms and pain outcomes (pain intensity and disability) using the mediating variables considered in the fear-avoidance models. The results show that emotional numbing and hyperarousal symptoms, but neither re-experiencing nor avoidance, affected pain outcome via anxiety sensitivity (AS), catastrophizing and fear of pain. PTSD symptoms increased the levels of AS, which predisposes to catastrophizing and, in turn, had an effect on the tendency of pain patients to respond with more fear and avoidance.

Conclusions: This study provides empirical support for the potential role of PTSD symptoms in fear-avoidance models of chronic pain and suggests that AS is a relevant variable in the relationship between both disorders.

1. Introduction

The relationship of post-traumatic stress disorder (PTSD) and chronic pain to increased disability and distress is well documented in the literature (Moeller-Bertram et al., 2012). PTSD is a syndrome characterized by three symptom clusters: intrusive re-experiencing (persistent re-experience of the event in a distressing way), avoidance/numbness (persistent avoidance of stimuli that remind one of the event, an

absence of emotional attachments and emotional numbing) and hyperarousal (increased arousal that implies hypervigilance and exaggerated startle response) [Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV); American Psychiatric Association, 1994]. Nevertheless, there is empirical evidence suggesting that avoidance and numbing symptom clusters should be considered independently (Asmundson et al., 2002) as it has been shown that they have differential impacts not only on

What's already known about this topic?

- The tendency to respond with fear and avoidance is considered to be a shared vulnerability of post-traumatic stress disorder (PTSD) symptoms and chronic pain. However, studies examining this relationship are few and it remains unclear which variables mediate the link between both disorders.

What does this study add?

- The current study represents an empirical evaluation of the potential role of PTSD symptoms to pain adjustment within the theoretical framework of fear-avoidance models of chronic pain.

responses to intervention but also on pain disability (Katz et al., 2009). In fact, the new edition of the DSM-5 (American Psychiatric Association, 2013) includes four symptom clusters because the avoidance/numbing cluster is divided into two distinct categories: avoidance and persistent negative alterations in cognitions and mood. The latter retains most of the numbing symptoms included in DSM-IV, although it also includes new symptoms, such as persistent negative emotional states.

Some possible explanations for the increased prevalence of PTSD in patients with chronic pain have been proposed; e.g., that both disorders mutually reinforce or maintain one another (Sharp and Harvey, 2001). In addition, it has been argued that a shared vulnerability may exist such that not only genetic factors predispose to the development of either disorder but also psychological factors such as anxiety sensitivity (AS) (Asmundson et al., 2002). In this regard, it has been suggested that patients with PTSD and pain respond with more fear and avoidance, which may increase pain catastrophizing due to the presence of high levels of AS (Norton and Asmundson, 2004). This tendency to respond with fear can be seen as a specific predisposing factor contributing to the development of either disorder (Otis et al., 2009; Alschuler and Otis, 2012). Despite the fact that AS has been conceptualized as a diathesis for PTSD, longitudinal investigations have found that more severe PTSD symptoms predicted higher levels of AS (Simpson et al., 2006; Marshall et al., 2010). Furthermore, the results of recent studies do not support the hypothesis that AS would significantly predict PTSD (Kraemer et al., 2013).

Few studies have investigated whether specific PTSD symptoms are associated with chronic pain, and

if so, which one. Tsui et al. (2011) found that hyperarousal alone was predictive of pain intensity, disability and pain acceptance. The results obtained by Cho et al. (2011) also indicated that hyperarousal symptoms, but not re-experiencing or avoidance, had significant direct effects on daily functioning. These findings suggest that hyperarousal may have a major impact on the daily functioning of chronic pain patients with a history of a traumatic experience.

Clapp et al. (2008) found that symptoms of emotional numbing were negatively associated with role functioning. Their results suggest that both pain severity and numbing interact to contribute to impairment in pain patients with PTSD. In line with this, the results of the study of Katz et al. (2009) showed that concurrent emotional numbing symptoms, but not avoidance, predicted significantly the level of pain disability. Cyders et al. (2011) found evidence that supported the differential predictive utility of various PTSD symptom clusters on pain outcomes. That is, hyperarousal symptoms had direct effects on pain severity, whereas avoidance symptoms predicted pain-related disability and re-experiencing had direct effects on pain distress alone. Nevertheless, none of these studies took into account those factors that have been suggested to explain the co-occurrence of PTSD and chronic pain and that represent a tendency to respond to physical sensations with fear, such as AS, catastrophizing and pain-related fear.

Understanding the psychological variables that explain the link between chronic pain and PTSD may be of further use in refining the shared characteristics of these conditions. Moreover, studies are required on how the relationship between these psychological variables and the specific PTSD symptom clusters affects pain adjustment in order to design more effective treatment for patients suffering both disorders.

Therefore, the purpose of the present study was to address, via structural equation modelling, how PTSD symptom clusters related to pain outcome. We hypothesized that the PTSD symptom clusters would significantly predict increased pain severity and pain disability. In addition, we proposed that the above relationships would be mediated by those variables included in the fear-avoidance models (Asmundson and Taylor, 1996; Vlaeyen and Linton, 2000): AS, pain catastrophizing and fear of pain. The hypothesized model predicts a direct effect of the four PTSD symptom clusters on AS, AS on catastrophizing and fear of pain, catastrophizing on fear of pain, fear of pain on pain intensity and disability, and pain intensity on disability (see Supporting Information Fig. S1).

2. Method

2.1 Participants

A total of 714 patients with chronic musculoskeletal back pain who attended four primary health centres in Málaga (Spain) were assessed. The inclusion criteria for the study were as follows: continuous or intermittent back pain of benign origin of at least 3 months duration, with an intensity of 3 or above on the Composed Pain Intensity Index of 10 points (Jensen et al., 1999), and which appears 5 or more days per week. Additionally, various criteria were applied to select patients with PTSD symptoms: exposure to a traumatic event before the onset of pain, as measured with the Stressful Life Event Screening Questionnaire Revised (SLESQ-R; Green et al., 2006), and scores equal to or higher than 30 on the Davidson Trauma Scale (DTS; Davidson, 1996). As the SLESQ-R does not address the subjective reaction to the event and given that the DTS is not a clinical diagnostic tool, more restrictive criteria were applied. Thus, to ensure that the event could be considered truly traumatic for the respondent, only those participants with scores equal to or higher than 8 points on the fear and hopelessness scales of the SLESQ-R were considered eligible for the study. The final sample of the study was composed of the 149 patients who met these criteria. Supporting Information Table S1 shows the demographic and clinical characteristics of this sample, as well as the kind of trauma they experienced. It must be noted that the traumatic events reported in Supporting Information Table S1 refer to each patient's lifetime exposure to a variety of traumatic events.

2.2 Measures and procedure

Prior to data collection, the researchers held a meeting with the participating doctors in which the eligibility criteria were explained and they decided on the procedures to follow. At the end of their medical visit, each patient who fulfilled the eligibility criteria was informed by their doctor of the study aims and their participation was requested. They were then contacted by telephone to make an appointment. The participants who accepted the request to participate completed a battery of questionnaires in the same order in an oral semi-structured interview format with a psychologist. All patients were interviewed at their clinic while waiting to be seen by their physicians. Informed consent was obtained prior to data collection. Patients were aware that the information collected was confidential. The research project, of which this study is a part, was approved by the Ethics Committees of the Málaga and Costa del Sol Health Districts (Spain).

2.2.1 The SLESQ-R (Green et al., 2006)

The SLESQ-R was developed as a screening instrument to identify criterion A events usually associated with PTSD and to minimize the reporting of subthreshold events. Consistent

with criterion A1, a traumatic event is defined as one that involves actual or threatened death or serious injury, or a threat to the physical integrity of self or others (DSM-IV; American Psychiatric Association, 1994). It has very good test-retest reliability, with a median κ of 0.73. It also has good convergent validity, with a median κ of 0.64, as well as good discrimination between criterion A and non-criterion A events (Goodman et al., 1998). The original questionnaire has been slightly modified (Green et al., 2006) by including miscarriage and by changing the way some items were phrased. As far as we know, no validated instruments are available in Spanish for assessing lifetime exposure to a variety of traumatic events. Thus, the SLESQ-R (Green et al., 2006) was translated into Spanish. Since the SLESQ-R does not assess criterion A2 (subjective reaction to the event) of the PTSD diagnosis, two questions focusing upon fear experienced during the event and feelings of hopelessness were added at the end of every item to evaluate this criterion. Criterion A2 was considered fulfilled when a patient responded with a score of 8 or more on the fear or hopelessness scales (Vázquez et al., 2006). Cronbach's α for this questionnaire was 0.70.

2.2.2 The DTS (Davidson, 1996)

The DTS measures the 17 PTSD symptoms described in DSM-IV. Each DTS item is measured on a 0–4 scale of severity and frequency, such that the maximum possible score is 136. Scores on the DTS can differentiate patients with PTSD and partial PTSD from patients without PTSD in the general population (Davidson et al., 2002). The DTS comprises items regarding these symptom clusters (Davidson et al., 1997): re-experiencing, avoidance, amnesia and numbing, and hyperarousal. Each subscale was calculated by summing their items. It has good test-retest reliability ($r = 0.86$), internal consistency ($r = 0.99$), and convergent and divergent validity, as well as current validity. It also predicts validity in relation to response to treatment, as well as sensitivity treatment effects (Davidson et al., 1997). Subjects with a DTS score of 40 or more are considered to have a probable diagnosis of PTSD, whereas scores between 30 and 40 are considered as probable subsyndromal PTSD (Davidson et al., 2002). The Spanish version was used in this study (Bobes et al., 2000). In this study, the sample mean of the DTS total score was 53.78 [standard deviation (SD) = 16.34]. Cronbach's alpha for this questionnaire were 0.84, 0.65, 0.79 and 0.83 for re-experiencing, avoidance, numbing and hyperarousal subscales, respectively. The internal consistency of the DTS total score was 0.92.

2.2.3 Anxiety Sensitivity Index (ASI; Reiss et al., 1986)

The ASI comprises 16 items using a 5-point Likert-type format ranging from 0 (*very little*) to 4 (*very much*) to assess AS. The Spanish version of the ASI is fully equivalent to the original (Sandín et al., 1996). The results of validation

studies provide cross-cultural evidence for construct validity and concurrent validity of the Spanish ASI. Cronbach's alpha for this questionnaire was 0.95.

2.2.4 Pain Catastrophizing Scale (PCS; Sullivan et al., 1995)

The PCS is composed of 13 items on a 5-point scale. The items describe different thoughts and feelings that individuals may experience when they are in pain. The PCS was developed to assess three components of catastrophizing: rumination, magnification and helplessness. It has excellent psychometric properties and has been widely used in research (Sullivan et al., 2001). The total score alone of the Spanish version (Muñoz and Esteve, 2005) was used in this study. Cronbach's alpha for this questionnaire was 0.97.

2.2.5 Pain Anxiety Symptoms Scale-20 (PASS-20; McCracken and Dhingra, 2002)

Fear of pain was assessed using the PASS-20, a self-report measure designed to assess anxiety and fear responses associated with the experience of chronic or recurrent pain. Prior research has supported the psychometric properties of this questionnaire (Coons et al., 2004). The Spanish version (López-Martínez et al., 2011) has reliable internal consistency ($\alpha = 0.86$) and validity (correlations ranging from $r = 0.51$ to $r = 0.17$ on several pain-related measures such as AS, fear-avoidance beliefs, pain hypervigilance, pain catastrophizing, pain-related disability and pain intensity). Cronbach's alpha for this questionnaire was 0.95.

2.2.6 Composed Pain Intensity Index (Jensen et al., 1999)

According to the recommendations of Jensen et al. (1999), patients were asked to rate their lowest, medium and strongest pain during the previous week, as well as their current pain, on a scale ranging from 0 (*not at all*) to 10 (*extremely painful*). The mean of these four scores was calculated to obtain the average pain intensity. Cronbach's alpha for this questionnaire was 0.83.

2.2.7 Roland Morris Disability Questionnaire (RMDQ; Roland and Morris, 1983)

The RMDQ consists of 24 items in which the responders are asked to rate the degree to which pain interferes with functioning in different areas of life. The RMDQ yields scores that are reliable for inferring the level of disability and is sensitive to change over time for groups of patients with low back pain. The Spanish version of this scale (Kovacs et al., 2002) has suitable reliability ($\alpha = 0.84$) and validity. Cronbach's alpha for this questionnaire was 0.85.

3. Results

3.1 Data analysis

Data were analysed using SPSS (Windows version 19.0, SPSS Inc., Chicago, IL, USA) and AMOS Graphics (version 19.0, Small Waters Corp., Chicago, IL, USA) software.

Univariate and multivariate distributions were examined. Inspection of Mahalanobis d^2 values did not indicate any multivariate outliers in the sample. The multivariate distribution was found to be normal, with a Mardia's coefficient of multivariate kurtosis of 0.33. There was no evidence of significant univariate skewness or kurtosis across any of the variables. Because the measured variables were normally distributed, the estimation maximum likelihood method was used. As a first step in the data analysis, we examined the associations between the PTSD symptom clusters (re-experiencing, avoidance, emotional numbing and hyperarousal), the variables considered as key domains of fear-avoidance models (AS, pain catastrophizing and fear of pain) and pain-related variables (pain intensity and disability). Table 1 shows correlations, means and SDs.

Model fit was evaluated using several fit indices, and convergence between findings was assessed (Ullman, 2001; Byrne, 2010). The Satorra-Bentler chi-square is a chi-square fit index that corrects the statistic under distributional violations by determining whether the value of this statistic is less than twice the model's degrees of freedom (Ullman, 2001). The root mean square error approximation (RMSEA) with 90% confidence intervals was assessed. Values less than 0.08 indicate an adequate fit (Hu and Bentler, 1999). Finally, additional fit indices were evaluated according to the published guidelines (Bentler, 1990; Byrne, 2010). These included the goodness-of-fit index (GFI) and the adjusted goodness-of-fit index (AGFI); both of which ranged between 0 and 1, where the closer to 1, the better the fit. The closer the values of these indices are to 1, the better the fit. We also calculated the comparative fit index (CFI; Bentler, 1990), which measures the proportional improvement in fit by comparing a hypothesized model with a more restricted baseline model. The CFI indices also ranged from 0 (*absolute lack of fit*) to 1 (*perfect fit*). As our sample size was over the 10 participants per observed variable but smaller than the minimum suggested (Ullman, 2001; Byrne, 2010), more emphasis was placed on RMSEA and CFI to aid in the interpretation of model fit, as these indices reduce the overestimation of goodness-of-fit in samples smaller than 200 (Fan et al., 2000).

Table 1 Descriptive information and correlations between the variables included in the model.

Measures	Mean (SD)	1	2	3	4	5	6	7	8	9
1. Re-experiencing	15.83 (6.21)	–	0.64*	0.74*	0.55*	0.32*	0.30*	0.28*	0.21*	0.24*
2. Avoidance	5.26 (2.90)		–	0.62*	0.35*	0.26*	0.25*	0.23*	0.22*	0.15 ^a
3. Emotional numbing	19.70 (5.78)			–	0.49*	0.30*	0.17**	0.31*	0.35*	0.23*
4. Hyperarousal	19.06 (6.37)				–	0.30*	0.28*	0.35*	0.03 ^a	0.11 ^a
5. Anxiety sensitivity	41.50 (13.43)					–	0.40*	0.55*	0.16 ^a	0.13 ^a
6. Catastrophizing	30.29 (10.73)						–	0.39*	0.28*	0.26*
7. Fear of pain	47.64 (17.39)							–	0.27*	0.32*
8. Pain intensity	6.04 (1.59)								–	0.42*
9. Pain disability	10.85 (4.99)									–

The numbers in the top row refer to the variables listed in rows 1–8. SD, standard deviation.

* $p < 0.01$.

** $p < 0.05$.

^aNonsignificant.

Any changes suggested by the modification indices were made if the modification improved the model fit, had a sound theoretical basis and did not result in significant changes to the model's parameters (Byrne et al., 1989).

Nine latent variables, such as re-experiencing, avoidance, emotional numbing and hyperarousal symptoms, AS, pain catastrophizing, fear of pain, pain intensity and disability, were associated in a hypothesized structural equation model. Nine observable variables of the latent variables were used. Because all the latent variables were measured by one variable, the error variance was fixed to 0 and the loading value to 1. The error terms of re-experiencing, avoidance, emotional numbing and hyperarousal were modelled as being correlated.

3.2 Evaluation of the measurement and structural models

The evaluation of the initial model indicated that several of the goodness-of-fit statistics did not satisfy the a priori criteria for a good model fit (see Table 2). Within the evaluation of the measurement model, the direct paths between re-experiencing and AS, and between avoidance and AS, were non-significant ($\beta = -0.12$; $p = 0.34$ and $\beta = 0.13$; $p = 0.23$, respectively). The model was therefore altered and the fit

was evaluated again. The statistical package suggested some possible modifications that would substantially improve model fit by specifying a covariance between four sets of error terms. The first covariance was between the error terms of catastrophizing and pain intensity. Given the literature on fear-avoidance models, we considered that the inclusion of this covariance was theoretically justifiable. The other covariances were between the error terms of hyperarousal and pain intensity, and between the error terms of emotional numbing and both catastrophizing and pain intensity. We considered that these covariances were also theoretically justifiable. The results of the evaluation of the final model are shown in Table 2. Fit indices indicated an adequate fit to the data.

With the aim of better appreciating the effects of all the variables in the model, the standardized direct, indirect and total effects are presented in Supporting Information Table S2. The most striking results are that both emotional numbing and hyperarousal have a small indirect effect on fear of pain, whereas AS has a small indirect effect on pain intensity and pain disability.

The final model, standardized coefficients and R^2 values are shown in Fig. 1, with R^2 values shown above each endogenous variable. Covariances between the pairs of error are not displayed in order to aid clarity. The covariance between the error terms

Table 2 Fit indices from the structural equation modelling analyses.

Model	χ^2 (df)	$\chi^2 \div df$	RMSEA (90% CI)	GFI	AGFI	CFI
Initial model	67.37 (20)	3.36	0.127 (0.094–0.160)	0.901	0.822	0.905
Modified model	68.94 (22)	3.13	0.120 (0.089–0.153)	0.919	0.834	0.909
Final model	31.09 (18)	1.73	0.070 (0.023–0.111)	0.958	0.894	0.974

AGFI, adjusted goodness-of-fit index; CFI, comparative fit index; CI, confidence interval; df, degrees of freedom; GFI, goodness-of-fit index; RMSEA, root mean square error approximation.

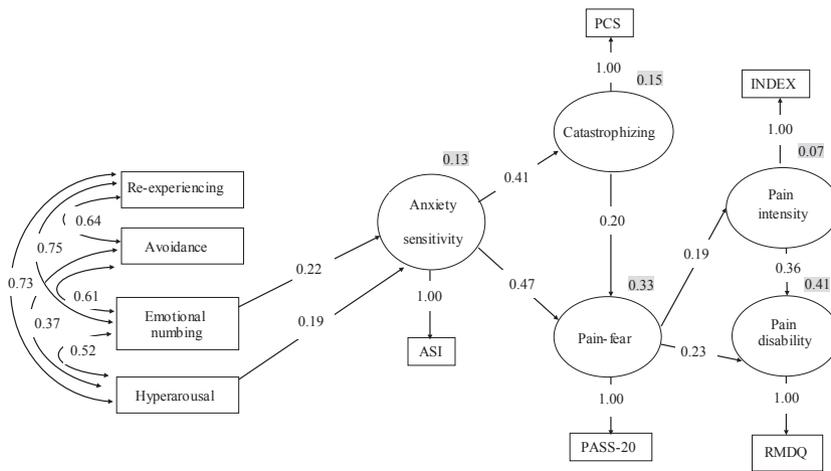


Figure 1 Standardized coefficients and R^2 values for the final model. Note that the paths between the pairs of the error terms are not displayed within the figure and are instead reported within the text. ASI, Anxiety Sensitivity Index; INDEX, Composed Pain Intensity Index; PASS-20, Pain Anxiety Symptom Scale-20; PCS, Pain Catastrophizing Scale; RMDQ, Roland Morris Disability Questionnaire.

was 0.22, $p < 0.01$ for catastrophizing and pain intensity; -0.16 , $p < 0.01$ for hyperarousal and pain intensity, 0.18, $p < 0.001$ for numbing and pain intensity; and -0.13 , $p < 0.01$ for numbing and catastrophizing.

4. Discussion and conclusions

The association between PTSD and chronic pain syndromes is well supported. Although recent publications have investigated the interactions between specific PTSD symptom clusters and pain outcome (Clapp et al., 2008; Cho et al., 2011; Cyders et al., 2011; Tsui et al., 2011), the present study represents the first empirical evaluation of the relative contribution of PTSD dimensions (re-experiencing, avoidance, emotional numbing and hyperarousal) to the chronic pain experience within the theoretical framework of the fear-avoidance models (Asmundson and Taylor, 1996; Vlaeyen and Linton, 2000; Norton and Asmundson, 2004). In this regard, the main purpose of the study was to investigate, via structural equation modelling, how PTSD symptom clusters and the psychological variables considered in these models affected pain outcome (namely, pain intensity and disability). We hypothesized that PTSD symptoms would significantly increase in pain severity and pain disability. In addition, we proposed that the above relationships would be mediated by the variables included in the fear-avoidance models: AS, pain catastrophizing and fear of pain.

Our model presented a good fit to the data. As hypothesized, hyperarousal and emotional numbing significantly predicted AS (namely, 13% of its variance). However, contrary to our hypothesis, neither avoidance nor re-experience significantly predicted AS. Further, in line with our hypothesis, AS signifi-

cantly predicted 15% of the variance of catastrophizing and 33% of the variance of fear of pain. Fear of pain had a direct effect on pain (explaining 7% of the variance), and pain intensity and fear of pain had a direct effect on pain disability (explaining 41% of the variance). Consequently, it seems that chronic pain patients with significant PTSD symptoms are likely to respond with more fear to physiological sensations, have more catastrophic beliefs about pain, engage in more avoidance behaviours and experience higher levels of pain as well as increased disability. It must be noted that the results indicated a lack of significance of the indirect effects. A possible explanation might be that all these variables together had a mediational effect, although none of them uniquely mediated the relationship examined.

In line with the results presented by Cho et al. (2011) and Tsui et al. (2011), hyperarousal symptoms have been shown to be associated with pain adjustment, although in the current study, this interaction was mediated by the variables included in the fear-avoidance models (Asmundson and Taylor, 1996; Vlaeyen and Linton, 2000). Hyperarousal symptoms of PTSD involve increased physiological arousal representing high levels of anxiety; anxiety is not only an important feature of PTSD but is also known to influence the perception and experience of pain (Cho et al., 2011). The results of studies based upon experimental designs have shown that AS indirectly influences pain perception through anticipatory pain anxiety (Conrod, 2006; Tsao et al., 2006) or by the fear of pain experienced during the experimental task (Uman et al., 2006). AS specifically involves fear of arousal-related body sensations due to beliefs that these sensations will have negative consequences (Reiss et al., 1986), and the heightened arousal of PTSD patients

has been suggested as an important mechanism of pain amplification in these subjects (Sharp and Harvey, 2001; Asmundson et al., 2002; Liedl and Knaevelsrud, 2008).

Regarding the symptoms of numbness, it is noteworthy that the results empirically support findings that avoidance and emotional numbing are separate symptom clusters, which is in line with previous factor analytic and conceptual studies (Asmundson et al., 2002, 2004) and with the diagnostic criteria for PTSD recently published in DSM-5 (American Psychiatric Association, 2013). They are also in line with the findings reported by Clapp et al. (2008) and Katz et al. (2009), showing that emotional numbing, but not avoidance, is related to role functioning and pain disability. It has been postulated that numbing may be secondary to a conditioned analgesic effect that is caused by the release of endogenous opioids during conditions of fear responses that serve to suppress pain and tranquilize the organism (Litz et al., 1997). Experimental studies suggest that emotional numbing primarily reflects diminished positive affect and a reduced tendency to express emotion (Litz et al., 2000; Orsillo et al., 2004). In this regard, emotional numbness has been considered as a dissociative symptom functionally similar to avoidance and escape behaviours, since it provides an escape from distress (Foa et al., 1989). Avoidance is considered a key factor in the perpetuation of pain and PTSD (Otis et al., 2009) that could lead patients with pain and PTSD towards a greater tendency to avoid activities that could elevate pain, due to pain being viewed as threatening. The results of the current study give indirect support to this possibility, taking into account the positive covariance between the error terms of numbing and pain intensity, indicating that both variables shared some common variance.

The findings of the present study showed that emotional numbing symptoms and catastrophizing also shared some common variance. As mentioned, emotional numbness could be considered to be a dissociative symptom. Dissociation, defined as a disruption in the integrated functions of consciousness, memory, identity or perception of the environment (American Psychiatric Association, 2000), is employed when active avoidance fails to reduce distress (Foa and Riggs, 1993) and has been viewed as a protective mechanism against physical pain during traumatic stress (Spiegel, 1991). One of the factors that has been argued to predict dissociation in response to stress is AS (Reiss and McNally, 1985). It has also been argued that AS and dissociation could be related because individuals may make attributions about their somatic experi-

ences that lead to altered perceptions of awareness (Nixon and Bryant, 2006). In addition, AS has been posited as a predisposing factor for catastrophizing, which, in turn, has been hypothesized to contribute to dissociation (Ehlers and Steil, 1995). In this regard, it has been empirically shown that AS and catastrophizing seem to facilitate the use of dissociative strategies by healthy individuals in response to non-traumatic but discomforting stress (i.e., a cold pressor task) (Gómez-Pérez et al., 2013). Therefore, it may be speculated that in the current study, emotional numbness (as reflecting dissociation) and catastrophizing shared some common variance because a dissociative response depends upon the way in which stressful situations are appraised. This, in turn, depends upon catastrophizing, with high levels of catastrophizing predicting high levels of dissociation, as has been recently demonstrated (Gómez-Pérez et al., 2013). In any case, this is an issue that warrants future studies.

Consistent with previous findings (Leeuw et al., 2007), the current study shows that catastrophizing affects fear of pain, which is a variable demonstrated to influence pain and pain disability (Picavet et al., 2002; Sieben et al., 2002; Swinkels-Meewisse et al., 2006; Leeuw et al., 2007; Esteve et al., 2012). Moreover, recent results have shown that chronic pain patients with PTSD symptoms reported significantly greater use of catastrophizing (Alschuler and Otis, 2012). Catastrophizing, defined by Sullivan et al. (1995) as an exaggerated negative orientation to noxious stimuli, has been proposed as a mechanism of vulnerability for the development of co-morbidity among PTSD and chronic pain patients. According to the mutual maintenance theory (Sharp and Harvey, 2001), pain catastrophizing may serve as a reminder of the trauma, triggering other trauma-related memories and associated arousal responses and exacerbating avoidance; in turn, PTSD symptoms intensify catastrophizing, causing subsequent increased pain fear-avoidance. A negative appraisal of trauma and its consequences is one of the key aspects that seems to promote the maintenance of PTSD over time (Ehlers and Clark, 2000). On the contrary, pain appraisal is also central to theories that have attempted to explain pain chronicity (Vlaeyen and Linton, 2000; Sharp and Harvey, 2001). Therefore, it may be possible that PTSD patients not only assess their PTSD symptoms more negatively but they also evaluate their pain symptoms more negatively.

Although the current study is of interest, it has some limitations that must be taken into account. First, the group of patients assumed to have PTSD was selected according to their scores on a self-report question-

naire, but they had not been clinically diagnosed with PTSD. Thus, they could not fulfil all the criteria needed for a full diagnosis of PTSD according to DSM-IV. Nonetheless, the high scores on the DTS (>30) are indicative of the presence of PTSD symptoms; previous studies have found that self-report measures and clinical interviews possess comparable validity to discriminate between individuals with and without PTSD diagnosis (Coffey et al., 1998). Second, the analyses were conducted on cross-sectional, self-report data collected at the time of enrolment. It is therefore impossible to determine the exact nature of the associations between the variables studied or to form conclusions on cause-and-effect relationships. Although the inclusion criteria required participants to have PTSD symptoms prior to the onset of pain symptoms, and that it was specified in the measurement model that PTSD symptoms predicted pain outcomes, it is possible that the causal pathway could be in the opposite direction. In addition, shared method variance may have contributed to the magnitude of some correlations. Third, although the fit indices showed, in general, an adequate fit to the data, the sample size was relatively small, possibly increasing the risk of overfitting. Fourth, the ratio of participants to observed variables should also be noted, as covariances become less stable when estimated using small samples (Tabachnick and Fidell, 1996). Fifth, the study patients were receiving treatment for pain in primary care centres, and thus the results may not be generalizable to patients not receiving treatment. Finally, the DTS was developed as a self-rating scale measuring DSM-IV symptoms of PTSD. Nevertheless, the recently published DSM-5 has made some changes to the criteria for the diagnosis of PTSD (American Psychiatric Association, 2013) that have not been considered in this study. Taking these limitations into account, future studies on the pattern of associations between PTSD and pain outcomes should be longitudinal and use large samples.

Despite these limitations, this study has some strengths that should be highlighted. As far as we know, this study represents the first empirical evaluation of the relative contribution of PTSD dimensions (re-experiencing, avoidance, emotional numbing and hyperarousal) to the chronic pain experience within the theoretical framework of the fear-avoidance models. In addition, the finding of an association between AS and PTSD symptoms adds to the existing literature regarding the relevance of AS as an important factor in the treatment of chronic pain patients with PTSD symptoms. Moreover, the study considered the full spectrum of potential traumatic exposure over

the lifespan of the participants, as traumatic exposure may have a cumulative impact on health (Sledjeski et al., 2008). Finally, these findings are important because they show that the use of a multi-factorial perspective of PTSD to make predictions contributes to understanding the varying effects of the different facets of the disorder on pain adjustment. Moreover, understanding the specific interactions between PTSD symptoms and the psychological variables that explain the link between both disorders may be of assistance in further refining models of co-morbid pain and PTSD and could be of help in addressing the need for well-designed treatment programmes for the simultaneous treatment of these conditions.

Author contributions

The project was designed by all the contributing authors. A.E.L.-M. performed the statistical analysis and drafted the first version of the article. All the authors interpreted the results and contributed to the Discussion section.

Acknowledgements

We thank the physicians of Cruz de Humilladero, Carranque, Puerta Blanca, Teatinos and the Carihuela Primary Health Care Centres, both in Málaga, Spain, for their help in data collection. The authors wish to thank anonymous reviewers whose comments and suggestions aided in the preparation of this article.

References

- Alschuler, K.N., Otis, J.D. (2012). Coping strategies and beliefs about pain in veterans with comorbid chronic pain and significant levels of post-traumatic stress disorder symptoms. *Eur J Pain* 16, 312–319.
- American Psychiatric Association (1994). *Diagnostic and Statistical Manual of Mental Disorders* (Washington, DC: American Psychiatric Association).
- American Psychiatric Association (2000). *Diagnostic and Statistical Manual of Mental Disorders*, 4th edn (Text Revised) (Washington, DC: American Psychiatric Association).
- American Psychiatric Association (2013). *Diagnostic and Statistical Manual of Mental Disorders*, 5th edn (Washington, DC: American Psychiatric Association).
- Asmundson, G.J.G., Coons, M.J., Taylor, S., Katz, J. (2002). PTSD and the experience of pain: Research and clinical implications of shared vulnerability and mutual maintenance models. *Can J Psychiatry* 47, 930–937.
- Asmundson, G.J.G., Stapleton, J.A., Taylor, S. (2004). Are avoidance and numbing distinct PTSD symptom clusters? *J Trauma Stress* 17, 467–475.
- Asmundson, G.J.G., Taylor, S. (1996). Role of anxiety sensitivity in pain related fear and avoidance. *J Behav Med* 19, 577–586.
- Bentler, P.M. (1990). Comparative fit indexes in structural models. *Psychol Bull* 107, 238–246.
- Bobes, J., Calcedo-Barba, A., García, M., François, M., Rico-Villademoros, F., González, M.P., Bascarán, M.T., Bousoño, M., y Grupo Español de Trabajo Para el Trastorno de Estrés Postraumático (2000). Evaluación de las propiedades psicométricas de la versión española de cinco cuestionarios para la evaluación del trastorno de estrés postraumático. *Actas Esp Psiquiatr* 28, 207–218.

- Byrne, B.M. (2010). *Structured Equation Modeling with AMOS. Basic Concepts, Applications, and Programming*, 2nd edn (New York, NY: Taylor & Francis).
- Byrne, B.M., Shavelson, R.J., Muthén, B. (1989). Testing for the equivalence of factor covariance and mean structures: The issue or partial measurement invariance. *Psychol Bull* 105, 456–466.
- Cho, S.K., Heiby, E.M., McCracken, L.M., Moon, D.E., Lee, J.H. (2011). Daily functioning in chronic pain: Study of structural relations with posttraumatic stress disorder symptoms, pain intensity, and pain avoidance. *Korean J Pain* 24, 3–21.
- Clapp, J.D., Beck, J.G., Palyo, S.A., Grant, D.M. (2008). An examination of the synergy of pain and PTSD on quality of life: Additive or multiplicative effects? *Pain* 138, 301–309.
- Coffey, S.F., Dansky, B.S., Falsetti, S.A., Saladin, M.E., Brady, K.T. (1998). Screening for PTSD in a substance abuse sample: psychometric properties of a modified version of the PTSD Symptom Scale Self-Report. Posttraumatic stress disorder. *J Trauma Stress* 11, 393–399.
- Conrod, P.J. (2006). The role of anxiety sensitivity in subjective and physiological responses to social and physical stressors. *Cogn Behav Ther* 35, 216–225.
- Coons, M.J., Hadjstavropoulos, H.D., Asmundson, G.J. (2004). Factor structure and psychometric properties of the Pain Anxiety Symptoms Scale-20 in chronic pain patients. *Eur J Pain* 8, 511–516.
- Cyders, M.A., Burris, J.L., Carlson, C.R. (2011). Disaggregating the relationship between posttraumatic stress disorder symptom clusters and chronic orofacial: Implications for the prediction of health outcomes with PTSD symptom clusters. *Ann Behav Med* 41, 1–12.
- Davidson, J.R.T. (1996). *Davidson Trauma Scale* (New York, NY: Multi-Health Systems, Inc).
- Davidson, J.R.T., Book, S.W., Colket, J.T., Tupler, L.A., Roth, S., David, D., Hertzberg, M., Mellman, T., Beckham, J.C., Smith, R.D. (1997). Assessment of a new self-rating scale for posttraumatic stress disorder. *Psychol Med* 27, 153–160.
- Davidson, J.R.T., Tharwani, H.M., Connor, K.M. (2002). Davidson Trauma Scale (DTS): Normative scores in the general population and effect sizes in placebo-controlled SSRI trials. *Depress Anxiety* 15, 75–78.
- Ehlers, A., Clark, D.M. (2000). A cognitive model of posttraumatic stress disorder. *Behav Res Ther* 38, 319–345.
- Ehlers, A., Steil, R. (1995). Maintenance of intrusive memories in posttraumatic stress disorder: A cognitive approach. *Behav Cogn Psychol* 23, 217–249.
- Esteve, R., Ramírez-Maestre, C., López-Martínez, A.E. (2012). Experiential avoidance and anxiety sensitivity as dispositional variables and their relationship to the adjustment to chronic pain. *Eur J Pain* 16, 718–726.
- Fan, X., Thompson, B., Want, L. (2000). Effects of sample size, estimation method, and model specification on structural equation modeling fit indexes. *Struct Equ Modeling* 6, 56–83.
- Foa, E.B., Riggs, D. (1993). Posttraumatic stress disorder and rape. In *American Psychiatric Press Review of Psychiatry*, Vol. 12, J.M. Oldham, M.B. Riba, A. Tasman, eds. (Washington, DC: American Psychiatry Press) pp. 273–303.
- Foa, E.B., Steketee, G., Rothbaum, B.O. (1989). Behavioral/cognitive conceptualizations of post-traumatic stress disorder. *Behav Ther* 20, 155–176.
- Gómez-Pérez, L., López-Martínez, A.E., Asmundson, G.J.G. (2013). Predictors of trait dissociation and peritraumatic dissociation induced via cold pressor. *Psychiatry Res* 210, 274–280.
- Goodman, L., Corcoran, C., Turner, K., Yuan, N., Green, B.L. (1998). Assessing traumatic event exposure: General issues and preliminary findings for the Stressful Life Events Screening Questionnaire. *J Trauma Stress* 11, 521–542.
- Green, B.L., Chung, J.Y., Daroowalla, A., Kaltman, S., DeBenedictis, C. (2006). Evaluating the cultural validity of the Stressful Life Events Screening Questionnaire. *Violence Against Women* 12, 1191–1213.
- Hu, L., Bentler, P.M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Struct Equ Modeling* 6, 1–55.
- Jensen, M.P., Turner, P., Romano, J.R., Fisher, L.D. (1999). Comparative reliability and validity of chronic pain intensity measures. *Pain* 83, 157–162.
- Katz, J., Asmundson, G.J.G., McRae, K., Halket, E. (2009). Emotional numbing and pain intensity predict the development of pain disability up to one year after lateral thoracotomy. *Eur J Pain* 13, 870–878.
- Kovacs, F.M., Llobera, J., Gil del Real, M.T., Abreira, V., Gestoso, M., Fernández, C. (2002). Validation of the Spanish version of the Roland Morris Questionnaire. *Spine* 2, 149–151.
- Kraemer, K.M., Luberto, C.M., McLeish, A.C. (2013). The moderating role of distress tolerance in the association between anxiety sensitivity physical concerns and panic and PTSD-related re-experiencing symptoms. *Anxiety Stress Coping* 26, 330–342.
- Leeuw, M., Houben, R.M., Severeijns, R., Picavet, H.S., Schouten, E.G., Vlaeyen, J.W. (2007). Pain-related fear in low back pain: A prospective study in the general population. *Eur J Pain* 11, 256–266.
- Liedl, A., Knaevelsrud, C. (2008). Chronic pain and PTSD: The perpetual avoidance model and its treatment implications. *Torture* 18, 69–79.
- Litz, B.T., Schlenger, W.E., Weathers, F.W., Caddell, J.M., Fairbank, J.A., La Vange, L.M. (1997). Predictors of emotional numbing in posttraumatic stress disorder. *J Trauma Stress* 10, 607–618.
- Litz, B.T., Orsillo, S.M., Kaloupek, D., Weathers, F. (2000). Emotional processing in posttraumatic stress disorder. *J Abnorm Psychol* 109, 26–39.
- López-Martínez, A.E., Esteve-Zarazaga, R., Ramírez-Maestre, C. (2011). The Spanish version of the Pain Anxiety Symptoms Scale (PASS-20): Preliminary data on its reliability, validity and factorial structure. *Eur J Pain* 5 (Suppl.), 517.
- McCracken, L.M., Dhingra, L. (2002). A short version of the Pain Anxiety Symptoms Scale (PASS-20): Preliminary development and validity. *Pain Res Manag* 7, 45–50.
- Marshall, G.N., Miles, J.V., Stewart, S.H. (2010). Anxiety sensitivity and PTSD symptom severity are reciprocally related: Evidence from longitudinal study of physical trauma survivors. *J Abnorm Psychol* 119, 143–150.
- Moeller-Bertram, T., Keltner, J., Strigo, I.A. (2012). Pain and post traumatic stress disorder: Review of clinical and experimental evidence. *Neuropharmacology* 62, 586–597.
- Muñoz, M., Esteve, R. (2005). Reports of memory functioning by patients with chronic pain. *Clin J Pain* 21, 287–291.
- Nixon, R.D.V., Bryant, R.A. (2006). Dissociation in acute stress disorder after a hyperventilation provocation test. *Behav Cogn Psychol* 34, 343–349.
- Norton, P.J., Asmundson, G.J. (2004). Anxiety sensitivity, fear, and avoidance behaviour in headache pain. *Pain* 111, 218–223.
- Orsillo, S.M., Batten, S.V., Plumb, J.C., Luterek, J.A., Roessner, B.M. (2004). An experimental study of emotional responding in women with posttraumatic stress disorder related to interpersonal violence. *J Trauma Stress* 17, 241–248.
- Otis, J.D., Keane, T.M., Kerns, R.D., Monson, C., Scioli, E. (2009). The development of an integrated treatment for veterans with comorbid chronic pain and posttraumatic stress disorder. *Pain Med* 10, 1300–1311.
- Picavet, H.S.J., Vlaeyen, J.W.S., Schouten, J.S.A.G. (2002). Pain catastrophizing and kinesiophobia: Predictors of chronic low back pain. *Am J Epidemiol* 156, 1028–1034.
- Reiss, S., McNally, R.J. (1985). The expectancy model of fear. In *Theoretical Issues in Behavior Therapy*, S. Reiss, R.R. Bootzin, eds. (New York, NY: Academic Press) pp. 107–121.
- Reiss, S., Peterson, R.A., Gursky, M., McNally, R.J. (1986). Anxiety sensitivity, anxiety frequency, and the prediction of fearfulness. *Behav Res Ther* 24, 1–8.
- Roland, M.O., Morris, R.W. (1983). A study of the natural history of back pain. Part 1: Development of a reliable and sensitive measure of disability in low back pain. *Spine* 8, 141–144.
- Sandín, B., Chorot, P., McNally, R.J. (1996). Validation of the Spanish version of the Anxiety Sensitivity Index in a clinical sample. *Behav Res Ther* 34, 283–290.
- Sharp, T.J., Harvey, A.G. (2001). Chronic pain and posttraumatic stress disorder: Mutual maintenance? *Clin Psychol Rev* 21, 857–877.
- Sieben, J.M., Vlaeyen, J.W.S., Tuerlinckx, S., Portegijs, P.J. (2002). Pain-related fear in acute low back pain: The first two weeks of a new episode. *Eur J Pain* 6, 229–237.
- Simpson, T., Jakupcak, M., Luterek, J.A. (2006). Fear and avoidance of internal experiences among patients with substance use disorders and PTSD: The centrality of anxiety sensitivity. *J Trauma Stress* 19, 481–491.

- Sledjeski, E.M., Speisman, B., Dierker, L.C. (2008). Does number of lifetime traumas explain the relationship between PTSD and chronic medical conditions? Answers from the National Comorbidity Survey-Replication (NCS-R). *J Behav Med* 31, 341–349.
- Spiegel, D. (1991). Dissociation and trauma. In *American Psychiatric Press Review of Psychiatry*, A. Tasman, S.M. Goldfinger, eds. (Washington, DC: American Psychiatric Press) pp. 261–275.
- Sullivan, M.J.L., Bishop, S.R., Pivik, J. (1995). The Pain Catastrophizing Scale: Development and validation. *Psychol Assess* 7, 524–532.
- Sullivan, M.J.L., Thorn, B., Haythornthwaite, J.A., Keefe, F., Martin, M., Bradley, L.A. (2001). Theoretical perspectives on the relation between catastrophizing and pain. *Clin J Pain* 17, 52–64.
- Swinkels-Meewisse, I.E.J., Roelofs, J., Schouten, E.G.W., Verbeek, A.L.M., Oostendorp, R.A.B., Vlaeyen, J.W.S. (2006). Fear of movement/(re)injury predicting chronic disabling low back pain: A prospective inception cohort study. *Spine* 31, 658–664.
- Tabachnick, B.J., Fidell, L.S. (1996). *Using Multivariate Statistics*, 3rd edn (New York, NY: Harpercollins).
- Tsao, J.C.I., Lu, Q., Kim, S.C., Zeltzer, L.K. (2006). Relationships among anxious symptomatology, anxiety sensitivity and laboratory pain responsivity in children. *Cogn Behav Ther* 35, 207–215.
- Tsui, P., Stein, T., Sonty, N. (2011). The relationship among PTSD symptoms, chronic pain acceptance and disability. *J Pain* 11 (Suppl.), 558.
- Ullman, J.B. (2001). Structural equation modelling. In *Using multivariate statistics*, B.G. Tabachnick, L.S. Fidell, eds. (Needham Heights, MA: Allyn & Bacon) pp. 653–711.
- Uman, L.S., Stewart, S.H., Watt, M.C., Johnston, A. (2006). Differences in high and low anxiety sensitive women's responses to a laboratory-based cold pressor task. *Cogn Behav Ther* 35, 189–197.
- Vázquez, C., Pérez-Sales, P., Matt, G. (2006). Post-traumatic stress reactions following the March 11, 2004 terrorist attacks in a Madrid community sample: A cautionary note about the measurement of psychological trauma. *Span J Psychol* 9, 61–74.
- Vlaeyen, J.W., Linton, S.J. (2000). Fear-avoidance and its consequences in chronic musculoskeletal pain: A state of the art. *Pain* 85, 317–332.

Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Figure S1. Hypothesized model describing relations among PTSD symptom clusters and the variables included in the fear-avoidance models.

Table S1. Means, standard deviations and frequency data for the demographic, clinical and traumatic events variables.

Table S2. Standardized total, direct and indirect effects for all variables in the model.