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# Anxiety sensitivity, body vigilance and fear of pain

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## Abstract

The aim of the present study was to investigate the role of anxiety sensitivity (AS) as a factor relevant to pain and pain persistence. Two studies were conducted to examine the relationship between AS, body vigilance and the experience of pain in non-clinical samples. Study 1 investigated the relationship between AS and body vigilance that was operationalized by the detection latency for innocuous electrical stimuli; trait anxiety and neuroticism were also included as covariates. Results indicated that the high AS group ($N = 69$) presented shorter detection latency than the low AS group ($N = 70$); neuroticism and trait anxiety did not have significant effects on detection latency. Using another sample, Study 2 investigated the relationship between AS, body vigilance, pain tolerance, catastrophizing, and self-reported distress and pain during a cold pressor task. Neuroticism, trait anxiety and fear of pain were included as covariates. Results showed significant differences between high- ($N = 66$) and low- ($N = 69$) AS groups in body vigilance, catastrophizing and tolerance. The covariates neuroticism, trait anxiety and fear of pain did not have any significant effects. No significant differences were found in pain and distress ratings. Results from both studies support the importance of AS in body vigilance and the experience of pain. The theoretical, preventive and clinical implications of these findings are discussed.
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## Introduction

Current cognitive–behavioural models of chronic pain (Lethem, Slade, Troup, & Bentley, 1983; Vlaeyen & Linton, 2000) and recent studies (Asmundson, Norton, & Vlaeyen, 2004; Boersma & Linton, 2005; Sieben et al., 2005) show that fear of pain plays a crucial role in the transition from acute to chronic pain. Few studies have examined the factors involved in the propensity of individuals to respond to pain-associated experiences and activities with fear and avoidance. Anxiety sensitivity (AS) has been proposed to account for individual differences regarding pain-related fear. AS is defined as fear of anxiety-related sensations; specifically, AS is related to the fear of bodily sensations (Reiss & McNally, 1985). Early studies showed that AS exacerbates fear of pain and indirectly promotes pain-related escape and avoidance behaviour even after controlling for the effects of pain severity (Asmundson & Norton, 1995; Asmundson & Taylor, 1996; Plehn, Peterson, & Williams, 1998).

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The fear-avoidance model conceptualizes fear of pain as a specific phobia (Lethem et al., 1983; Vlaeyen & Linton, 2000). The model states that fear responses will be specifically linked to potentially painful stimuli. In contrast, the AS approach considers that fear of pain is a manifestation of a more fundamental fear: the fear of anxiety symptoms or AS (Asmundson & Norton, 1995; Norton & Asmundson, 2003). The latter approach predicts that chronic pain patients with high AS will present more fear responses to anxiety-provoking stimuli than to pain-induction alone. The results of recent studies lend support to the AS approach (i.e. Asmundson & Hadjistavropoulos, 2007; Greenberg & Burns, 2003).

It has been suggested that AS plays a role in the development and maintenance of various acute and chronic pain-related conditions, such as headache, gastrointestinal pain, menstrual pain, asthma, lower-back pain and musculoskeletal pain (Asmundson, Wright, & Hadjistavropoulos, 2005). Experimental studies also corroborate the relationship between AS and responses to pain. Schmidt and Cook (1999) found that panic disorder patients, who typically have high AS levels, exhibited greater negative responses to cold pressor pain than non-clinical controls. Furthermore, AS appeared to be indirectly associated with pain by contributing to anxiety. High levels of AS have been associated with more self-reported sensory pain (Keogh & Birkby, 1999) and more sensory and affective pain (Keogh & Mansoor, 2001) in non-clinical populations participating in cold pressor tasks. Besides differences in self-reported measures, only Keogh and Cochrane (2002) have found that high levels of AS were related to a lower pain threshold, although no differences in pain tolerance were found. These results suggest that AS may moderate how pain is reported, rather than moderating actual behavioural responses to pain.

Several studies have investigated the potential mechanisms that may mediate the relationship between AS and fear of pain, concluding that attentional processes could explain their association. Reiss, Peterson, Gursky, and McNally (1986) were the first to propose that high AS may be characterized by hypervigilant self-monitoring of internal physical sensations. Chapman (1978) was one of the first researchers to associate hypervigilance with pain, and considered that individuals who appraise bodily sensations as dangerous were more likely to scan the body for threatening sensations. Moreover, AS is related to cognitive biases for physically threatening and pain-related materials (Keogh, Dillon, Georgiou, & Hunt, 2001; Stewart, Conrod, Gignac, & Pihl, 1998). Recently, Asmundson and Hadjistavropoulos (2007) identified groups of patients differing in levels of fearfulness by using cluster analysis of their scores on the Anxiety Sensitivity Index (ASI) (Peterson & Reiss, 1992) and the Pain Anxiety and Symptoms Scale (McCracken, Zayfert, & Gross, 1992). They found that fearful participants exhibited hypervigilance for all word types on a dot-probe task compared with less fearful participants. The authors concluded that their results support the hypothesis that fear of pain—measured by the combined ASI and PASS scores—is a manifestation of a general predisposition to be fearful of anxiety symptoms, given that those with a high fear of pain initially attend to and process all stimuli to determine their threat value. Asmundson, Kuperos, and Norton (1997) found that individuals with chronic pain and low AS were able to shift their attention away from stimuli related to pain, in contrast to the subjects with high AS. Keogh and Cochrane (2002) found that the tendency to negatively interpret ambiguous bodily sensations related to panic mediated the association between AS and emotional responses to cold pressor pain. Interestingly, when controlling for fear of pain, AS was still related to affective pain scores.

Although the fear-avoidance model (Vlaeyen & Linton, 2000) suggests that pain hypervigilance is an effect of fear of pain, in contrast to the results of the aforementioned studies, which suggest that pain hypervigilance is determined by AS, several studies highlight the importance of catastrophizing as a determinant of hypervigilance (Crombez, Eccleston, Van den Broeck, & Goubert, 2002; Crombez, Eccleston, Van den Broeck, Goubert, & Van Houdenhove, 2004; Vancleef & Peters, 2006). In line with these studies, self-reported vigilance to pain has been found to be strongly related to pain catastrophizing and pain-related fear (Roelofs, Peters, McCracken, & Vlaeyen, 2003). Goubert, Crombez, and Van Damme (2004) found that vigilance to pain was dependent upon catastrophic thinking and pain-related fear in a sample of patients with chronic pain. In addition, neuroticism appeared as a vulnerability factor that lowers the threshold at which pain is perceived as threatening, and at which catastrophic thoughts about pain emerge.

Currently, it is generally assumed that neuroticism, trait anxiety and AS are distinct but related personality traits (Lilienfeld, 1997). Nevertheless, it is important to examine the incremental validity of AS because if higher-order dimensions of personality are not taken into account, the observed relationship

between lower-order dimensions, such as AS, and an external criterion may be attributable to the influence of unmeasured higher-order dimensions, such as trait anxiety or neuroticism (Lilienfeld & Penna, 2001).

To recapitulate, in the light of previous research AS seems to be related to individual differences in the experience of pain. However, some controversy exists on the nature of the relationship between AS, body vigilance, fear of pain and catastrophizing. Two studies evaluated the role of AS in the pain experience and studied whether this connection is maintained when controlling for fear of pain, neuroticism and trait anxiety. The first study tested the relationship between AS and body vigilance that was operationalized by the detection latency for innocuous electrical stimuli (Peters, Vlaeyen, & Van Drunen, 2000). It was predicted that high AS participants would present higher body vigilance than low AS participants, and that AS would display a unique variance in relation to body vigilance above and beyond trait anxiety and neuroticism.

The second study, which used another sample was aimed at testing the relationship between AS, body vigilance, catastrophizing, self-reported pain and distress, and tolerance when pain was induced by a cold pressor task. Based on the AS approach (Asmundson & Hadjistavropoulos, 2007; Greenberg & Burns, 2003), it was postulated that high AS participants would display higher body vigilance, higher pain catastrophizing, higher self-reported pain and distress, and shorter tolerance time than low AS participants. It was also predicted that the effects of AS would remain when controlling for fear of pain, neuroticism and trait anxiety.

Following the proposals of several authors, a multi-method approach was followed to avoid inflated effects between variables due to shared method variance as the result of exclusively relying on self-report measures (Crombez et al., 2004; Greenberg & Burns, 2003). As suggested (Keogh & Mansoor, 2001), healthy participants took part in the study to elucidate the role of AS as a predisposing factor in increasing negative pain experiences. These studies were restricted to women since previous research has found that women are particularly sensitive to cold pressor pain and tend to have higher levels of AS (Keogh & Birkby, 1999; Keogh & Cochrane, 2002).

## Study 1

### Method

#### Participants

Two hundred and seventy-eight first-year undergraduate female psychology students volunteered to participate in exchange for course credits. The participants completed the Anxiety Sensitivity Index (ASI, Peterson & Reiss, 1992). High and low AS groups were determined by upper and lower tertiles in the sampled group. Participants who scored below 14 were classified as low AS, whereas those with scores above 35 were classified as high AS. The remaining subjects were not included for further participation in the study, and were not informed of this until the end of the experiment although they also received course credits. The final sample consisted of 139 participants; 69 were included in the high AS group and 70 in the low AS group. As indicated by Cohen (1988), the size of the experimental groups meant that the analysis had high power (.80) to detect medium-size effects (.25) at a .05 significance level with one degree of freedom. The mean age was 20 years (SD = 3.01). Contraindications for TENS were considered as exclusion criteria (Sales & Service, 2000): epilepsy, pregnancy and having an artificial cardiac pacemaker. Given the central role of anxiety in the present study, another exclusion criteria was being under psychiatric supervision or a physician's care. Nobody was excluded from participating on these grounds.

#### Apparatus and measures

#### Body vigilance

Body vigilance was operationalized as the detection latency for innocuous electrical stimuli (Peters et al., 2000). Electrical stimuli were delivered by a transcutaneous electrical nerve stimulator (TENS 3002-Multifunction Stimulator, Sales & Service, 2000). The TENS unit is an electronic device measuring $25 \times 64 \times 98 \, mm^3$. The unit is connected to the skin using two electrodes. The TENS unit has 11 levels of intensity (0–10) with stimulation amplitude ranging from 0 to 80 mA (max). The pulses were delivered at a constant internal frequency of 2 Hz through two electrodes attached to the non-dominant hand.

The electrodes are provided by the manufacturer and include a flexible tin backing coated with a hydrated gel matrix designed to contact and follow the shape of the skin. The inter-electrode distance was 1 cm. The stimulation started at the minimum intensity level and was increased every 30 s until the participant indicated that she had perceived the stimulus.

Subjects responded to stimulus detection by pressing the "space bar" on a computer keyboard. When the bar was pressed, electrical stimulation was immediately interrupted and the time from the start of the stimulus (detection latency) was automatically recorded by a computer program. When the experimenter pressed the "enter" key the program activated a stopwatch on the screen, which stopped when the participant pressed the space bar. A previous pilot study, with another sample, indicated that electrical stimulation was detected by the entire sample at TENS intensity level 3. Specifically, 27.50% detected the stimulation at level 1 (8 mA); 55.70% at level 2 (16 mA); and, 16.80% at level 3 (24 mA). Therefore, the maximum intensity applied was level 3, always starting at level 1.

### Anxiety sensitivity

The ASI (Peterson & Reiss, 1992) is a 16-item questionnaire where respondents indicate the degree to which they fear the negative consequences of anxiety symptoms on a 5-point Likert-type scale (0 = very little to 4 = very much). The ASI has high levels of internal consistency and good test–retest reliability (Peterson & Plehn, 1999; Peterson & Reiss, 1992). It has three lower-order factors that all load on a single higher-order factor (Cox, Parker, & Swinson, 1996; Stewart, Taylor, & Baker, 1997). We used the total ASI score, as it represents the global AS factor. The Spanish version of the ASI is fully equivalent to the original (Sandín, Chorot, & McNally, 1996). The results of validation studies provide cross-cultural evidence for construct validity and concurrent validity of the Spanish ASI.

### Trait anxiety

The Trait form of the State-Trait Anxiety Inventory (STAI-T; Spielberger, Gorsuch, & Lushene, 1994) is a measure of trait anxiety, consisting of 20 items assessing enduring symptoms of anxiety. The STAI-T correlates highly with other self-report measures of negative emotionality (Watson & Clark, 1984) and differentiates patients with anxiety disorders from healthy subjects (Taylor, Koch, & McNally, 1992). The test–retest reliability for the Spanish version is .80 and internal consistency ranges from .83 to .92. Several studies have also shown that the relationship of the Spanish version of the STAI with other measures of anxiety ranges from .58 to .79 (Spielberger et al., 1994).

### Neuroticism

The Spanish version of the Neuroticism scale of the Eysenck Personality Inventory form A (EPI-N, Eysenck & Eysenck, 1990) was used. The scale consists of 24 dichotomous items. The Spanish version has suitable psychometric properties, with an internal consistency of .84 for the neuroticism scale.

The internal consistency of the self-report measures for the current sample was calculated. Cronbach's $\alpha$ coefficients showed an acceptable reliability for all the instruments (ASI, $\alpha = .83$; EPI-N, $\alpha = .70$; STAI-T, $\alpha = .86$).

### Procedure

Participants were given a package of self-report measures (see Measures) during group sessions. These measures were administered in fixed order: the ASI, the STAI-R and the EPI-N. First, the general nature of the study was explained and those who consented to participate completed the questionnaire package. As previously described, high- and low-AS groups were determined and eligible participants were scheduled for the laboratory session by telephone. After all the subjects had participated in the experiment, the experimenter explained the purpose and design of the study in a group session. The subjects who had been excluded received an apology but also received course credits, despite not taking part in all the sessions.

When the participants first arrived at the laboratory they read and signed the consent form. The research project—of which this study is a part—was approved by the Carlos Haya Hospital Ethics Committee. The experimental sessions were run by the same research assistant who was blinded to AS status. The participants

were tested individually in a private laboratory room with only the research assistant present. They sat at a computer keyboard and were informed of the nature of the task. The participants were not familiarized with the electrical stimulus prior to the experimental procedure. Two electrodes were attached to their non-dominant hand and they were instructed to press the space bar on the keyboard with their other hand the moment they felt the electrical stimulation. It was emphasized that the electrical stimulation was innocuous. Following these instructions, the participants were told when they could expect the stimulus and were then exposed to a continuous low-intensity electrical stimulation. One trial was conducted and detection latency was automatically recorded by the software when the participants pressed the space bar. The participants could see the keyboard but not the screen. Electrical stimulation was immediately interrupted the moment the participants indicated that they had detected it. The experiment lasted for 15 min.

*Results*

Prior to analysis, the variables were examined for accuracy of data entry. The variables were normally distributed as assessed using the Kolmogorov–Smirnov test.

A *t*-test was performed on AS, trait anxiety and neuroticism scores with the AS group (high vs. low) as the independent factor. Significant differences were found between high- and low-AS groups ($t$ (118.64) = 18.13, $p = .000$) in AS. Those high in AS showed higher AS ($M = 41.14$, SD = 6.08) than those in the low AS group ($M = 11.95$, SD = 3.59). Significant differences were found between high- and low-AS groups ($t$ (137) = 6.07, $p = .000$) in trait anxiety. Those high in AS showed higher trait anxiety scores ($M = 31.93$, SD = 4.66) than those in the low AS group ($M = 27.03$, SD = 4.64). Significant differences were found in neuroticism between high- and low-AS groups ($t$ (137) = 5.99, $p = .000$). Those high in AS showed higher neuroticism ($M = 22.38$, SD = 2.79) than those in the low AS group ($M = 19.71$, SD = 2.45).

To assess the effect of AS, a one-way ANCOVA was conducted to determine whether the two groups differed in body vigilance, when the influence of neuroticism and trait anxiety was controlled. The results showed significant differences in body vigilance between high- and low-AS groups, $F$ (1) = 7.71, $p = .01$. As expected, when controlling for neuroticism and trait anxiety, those high in AS showed a shorter detection latency ($M = 20.78$, SD = 14.61) than those allocated to the low AS group ($M = 25.64$, SD = 11.18). The covariates, neuroticism, $F$ (1) = .22, $p = .64$, and trait anxiety $F$ (1) = .03, $p = .86$, did not have significant effects on detection latency.

## Study 2

Study 2 was an extended replication of Study 1. In order to examine the relationship between AS, body vigilance and the experience of pain, the following extensions were made: (a) besides neuroticism and trait anxiety, fear of pain was included as a covariate; (b) after the electrical stimulation task, a cold pressor task was included and the following dependent variables were considered: tolerance, catastrophizing, pain and distress ratings; and (c) the possible influence of individual differences in verbal aptitude was controlled since the procedure to assess catastrophizing could be sensitive to this.

*Method*

*Participants*

The 134 participants who made up the final sample were selected on the basis of their scores on the ASI. Following the same procedure as the first study and using the same cut-off points, those who scored below 14 were classified as low AS ($N = 68$), whereas those with scores above 35 were classified as high AS ($N = 66$). According to Cohen (1988), the size of the experimental groups gives a high power to the analysis (.80) to detect medium-size effects (.25) at a .05 significance level with one degree of freedom. The mean age was 20 years (SD = 2.99).

Besides the exclusion criteria related to the use of the TENS unit (see Study 1, participants), and given the nature of a cold pressor task, participants were also excluded if the following medical problems were present (Edens & Gil, 1995; Wilson, Chaplin, & Thorn, 1995): (a) an existing pain condition; (b) a history of heart

disease; (c) high blood pressure; (d) recent injuries; (e) circulatory disorders; and (f) they were under psychiatric care or a physician's care. Two people were excluded from the study for one of these reasons.

*Apparatus and measures*

Body vigilance, AS, trait anxiety and neuroticism were assessed with the same measures described in the first study (see Study 1, Apparatus and measures).

*Cold pressor task*

The cold pressor apparatus consisted of two metal containers that measured approximately $50 \times 30 \times 30\,cm^3$. One of the containers was filled with water at room temperature (approximately 21 °C). The other container was divided into two sections by a wire screen. It was filled with water and the ice was placed on one side of the wire screen, with the subjects' hand and forearm immersed in the ice-free side. The water was maintained at 2–4 °C and kept circulating by a pump during immersion. Water temperature was measured using a digital thermometer immersed in the water and fixed to the container. During testing, the participants were seated in a comfortable chair adjacent to the container and they rested their non-dominant arm in a cradle support. The range of 2–4 °C was considered appropriate for the purpose of this study. Lower temperatures of 0–2 °C are frequently used to provoke more intense pain, and numbing effects usually appear quickly; nevertheless, the temperature of 2–4 °C allows longer tolerance times.

*Fear of pain*

The Spanish version of the *Fear of Pain Questionnaire-III* (FPQ-III; Camacho & Esteve, 2005; McNeil & Rainwater, 1998) was used. The *FPQ*-III is composed of 30 items that are scored on a 5-point scale ranging from 1 (not at all) to 5 (extreme). The FPQ-III measures fear of pain responses in three painful stimulus situations that correspond to its three sub-scales: fear related to severe pain (e.g., breaking your arm); fear related to minor pain (e.g., having sand or dust blown into your eyes); and fear related to medical pain (e.g., receiving an injection in your mouth). It is possible to use the *FPQ-III* with both pain and non-pain populations. The English version showed suitable psychometric properties (Osman, Breitenstein, Barrios, Gutierrez, & Koper, 2002). The Spanish version showed adequate internal consistency (severe pain, $\alpha = .70$; minor pain, $\alpha = .80$; medical pain, $\alpha = .80$), similar to those reported by McNeil and Rainwater (1998) and Osman, Breitenstein, Barrios, Gutiérrez, and Koper (2002). Factor analysis yielded a correlated three-factor structure, which corresponds to the three sub-scales of the instrument previously proposed by McNeil and Rainwater (1998).

*Verbal aptitude*

The verbal factor of the Differential Aptitudes Test (DAT, Bennett, Seashore, & Wesman, 2003) was applied to assess verbal aptitudes. The instrument consists of 46 synonym items. The total of correct answers was computed for each subject.

*Catastrophizing*

The participants' thought records were coded following the system developed by Masedo (2003) based on previous studies (Sullivan, Rouse, Bishop, & Johnston, 1997). The inter-judge agreement Kappa index (Cohen, 1960) for the classification system is between .80 and .90. Sentence structure (i.e. phrases separated by periods, or phrases beginning on a new line) is the primary basis for categorizing the subject's responses. Three classes of catastrophic thoughts were distinguished in reference to the pain-induction experience: magnification thoughts (i.e. 'The pain that I feel is horrible'); helplessness (i.e. 'There is nothing I can do to reduce the intensity of the pain'); or rumination thoughts (i.e. 'I can't stop thinking about how much it hurts'). The score in catastrophizing corresponds with the total frequency of catastrophic thoughts.

*Tolerance*

Tolerance time is the length of time that the hand and forearm is under the cold water. The immersion time, measured in seconds, was recorded using a digital stopwatch.

*Pain ratings*

Subjective pain was assessed by a rating scale (displayed in front of the subject during the cold pressor task) with the endpoints (0) indicating 'no pain' and (10) indicating 'the worse pain'. Patients were asked 'How much pain do you feel at the moment?' All the ratings for each 30-s period were added together and this sum was divided by the number of the ratings collected for each subject. This ratio was calculated because the single sum of ratings could lead to errors given that the participants with longer tolerance times would have a higher sum of ratings of pain and distress. The contrary is also true: the subjects with shorter tolerance times would present the lowest pain and distress ratings simply because their hands stayed in the water for shorter periods during which they could report on their pain.

*Distress ratings*

Subjective distress was assessed by a rating scale (displayed in front of the subject during the cold pressor task) with the endpoints (0) indicating 'no distress' and (10) indicating 'the worse distress'. Patients were asked 'how distressed are you at the moment by the pain in your arm?' A distress index was also constructed by adding all the distress ratings for each 30-s period and dividing this sum by the number of ratings collected for each subject.

The internal consistency of the self-report measures for the current sample was calculated. Cronbach's $\alpha$ coefficients showed acceptable reliability for all the instruments (ASI, $\alpha = .83$; EPI-N, $\alpha = .70$; STAI- T, $\alpha = .86$; FPQ- III, $\alpha = .91$).

*Procedure*

As in the first study, participants were recruited in a group session and a package of self-report measures was administered (see Apparatus and measures). High- and low-AS groups were determined and eligible participants were scheduled for an individual session. Immediately following informed consent and prior to entering the laboratory, each participant was interviewed to exclude those who presented the aforementioned medical contraindications to TENS unit stimulation and the cold pressor task. They filled in the verbal factor of the DAT (Bennett et al., 2003) and subsequent analyses showed no significant differences between high- and low-AS groups in verbal aptitude ($t$ (132) = 1.240, $p = .217$).

Following the same procedure as in Study 1, the participants first took part in the innocuous electrical stimuli task. The participants then underwent a cold pressor task. As in previous studies (for example, Dar & Leventhal, 1993; Turk, Meichenbaum, & Genest, 1983), the cold pressor task proceeded as follows:

- Participants were shown the ice water immersion apparatus and were given instructions about the procedure.
- Each participant immersed their non-dominant arm in the container filled with room-temperature water for 5 min to regulate the hand and forearm temperature.
- They were then asked to introduce their non-dominant arm into the container of cold water and told they were free to terminate the exposure at any time they wished.

The experimenter used a stopwatch to measure tolerance time. According to Edens and Gil (1995), exposure time should never be longer than 300 s to avoid excessive exposure to the cold water, which could cause lesions on the arms. For this reason, immersion time was limited to 5 min. The participants were not informed of this ceiling in an attempt to reduce the risk of competitiveness and to avoid any misconception that their hand was expected to be submerged in the cold water for that specific length of time.

The participants were instructed to report on their perceptions of pain and distress at 30-s intervals, while their non-dominant arm was immersed the ice water until they took their arm out of the cold water. The subjects were asked to report their pain and distress ratings aloud, which were then recorded by the experimenter. The order of the pain and distress reports was counterbalanced. The participants were provided with a booklet of lined paper and were asked to write down all the thoughts that came into their mind during the procedure. This thought-recording procedure was similar to that described by Sullivan et al. (1997). When all the subjects had participated in the experiment, the experimenter explained the purpose and design

of the study to the entire group and apologized to the subjects who had been excluded but who also received course credits.

## Data analysis

Prior to analysis, the variables were examined for the accuracy of data entry. The variables were normally distributed as assessed using the Kolmogorov–Smirnov test. First, a *t*-test was performed on AS, trait anxiety, neuroticism and fear of pain scores with the AS group (high vs. low) as the independent factor. Correlational analyses were conducted between the self-report measures and pain detection latency, pain tolerance, catastrophizing, and pain and distress ratings. To assess the effect of AS, a one-way ANCOVA was conducted to determine whether the two groups differed in the dependent variables, when the influence of neuroticism, trait anxiety and fear of pain was controlled.

## Results

Significant differences were found between high- and low-AS groups ($t$ (83.84) = 17.41, $p$ = .000) in AS. Those high in AS showed higher AS ($M$ = 41.70, SD = 6.70) than those in the low AS group ($M$ = 11.85, SD = 2.72). Significant differences were found between high- and low-AS groups ($t$ (132) = 4.99, $p$ = .000) in trait anxiety. Those high in AS showed higher trait anxiety scores ($M$ = 47.80, SD = 8.02) than those in the low AS group ($M$ = 40.60, SD = 8.63). Significant differences were found in neuroticism between high- and low-AS groups ($t$ (132) = 5.13, $p$ = .000). Those high in AS showed higher neuroticism ($M$ = 13.09, SD = 2.99) than those in the low AS group ($M$ = 10.49, SD = 2.88). Significant differences were found in fear of pain between high- and low-AS groups ($t$ (132) = 4.44, $p$ = .000). Those high in AS showed higher fear of pain ($M$ = 84.62, SD = 12.10) than those in the low AS group ($M$ = 74.07, SD = 15.19).

As Table 1 shows, AS significantly correlated with fear of pain, detection latency, tolerance and catastrophizing; although significant, the relationship with pain ratings was weaker, and had a non-significant association with distress ratings. Fear of pain was significantly correlated with detection latency, tolerance and catastrophizing and pain and distress ratings, and catastrophizing significantly correlated with detection latency and pain and distress ratings.

The results indicated significant differences in body vigilance between high- and low-AS groups, $F$ (1) = 26.84, $p$ = .00. As expected, when controlling for neuroticism, trait anxiety and fear of pain, the high AS group showed a shorter detection latency ($M$ = 21.18, SD = 8.80) than the low AS group ($M$ = 32.53, SD = 10.50). The covariates neuroticism, $F$ (1) = .42, $p$ = .52, trait anxiety, $F$ (1) = .06, $p$ = .81, and fear of pain, $F$ (1) = .41, $p$ = .53, did not have significant effects on body vigilance.

Table 1
Correlations between anxiety sensitivity, neuroticism, trait-anxiety, fear of pain, detection latency, tolerance, catastrophizing, pain ratings and distress ratings

| Variables | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1. Anxiety sensitivity | – | .46*** | .50*** | .45*** | −.49*** | −.26** | .25** | .18 | .15 |
| 2. Neuroticism | – | – | .72*** | .26** | −.29** | .01 | .20* | −.00 | −.05 |
| 3. Trait-anxiety | – | – | – | .36*** | −.28** | −.01 | .24** | .06 | .02 |
| 4. Fear of pain | – | – | – | – | −.24** | −.22* | .23** | .19 | .19 |
| 5. Detection latency | – | – | – | – | – | .19 | −.27** | −.15 | −.01 |
| 6. Tolerance | – | – | – | – | – | – | −.15 | −.37*** | −.43*** |
| 7. Catastrophizing | – | – | – | – | – | – | – | .24** | .23** |
| 8. Pain ratings | – | – | – | – | – | – | – | – | .79*** |
| 9. Distress ratings | – | – | – | – | – | – | – | – | – |

*$p$ < .05.
**$p$ < .01.
***$p$ < .001.

There were significant differences in catastrophizing between high- and low-AS groups, $F(1) = 5.64$, $p = .02$. As expected, when controlling for neuroticism, trait anxiety and fear of pain, the high AS group showed a higher frequency of catastrophic thoughts ($M = 1.06$, SD $= 1.26$) than the low AS group ($M = .38$, SD $= .81$). The covariates neuroticism, $F(1) = .00$, $p = .96$, trait anxiety, $F(1) = .87$, $p = .35$, and fear of pain, $F(1) = 1.38$, $p = .24$, did not have significant effects on catastrophizing.

There were also significant differences in tolerance between high- and low-AS groups, $F(1) = 9.32$, $p = .00$. As expected, when controlling for neuroticism, trait anxiety and fear of pain, the high AS group presented lower tolerance ($M = 124.94$, SD $= 84.77$) than the low AS group ($M = 178.76$, SD $= 104.57$). The covariates neuroticism, $F(1) = .71$, $p = .40$, trait anxiety, $F(1) = .59$, $p = .44$, and fear of pain, $F(1) = 3.61$, $p = .06$, did not have significant effects on tolerance.

No significant differences were found in pain ratings between high- and low-AS groups, $F(1) = 1.89$, $p = .17$. The high AS group ($M = 5.78$, SD $= 2.43$) and the low AS group ($M = 5.07$, SD $= 2.08$) did not differ regarding their pain ratings. The covariates neuroticism, $F(1) = .95$, $p = .33$, trait anxiety, $F(1) = .08$, $p = .78$, and fear of pain, $F(1) = 2.67$, $p = .11$, did not have significant effects on pain ratings.

There were no significant differences in distress ratings between high- and low-AS groups, $F(1) = .76$, $p = .39$. The high AS group ($M = 5.89$, SD $= 2.49$) and the low AS group ($M = 5.40$, SD $= 2.42$) did not differ regarding their pain ratings. The covariates neuroticism, $F(1) = 1.33$, $p = .25$, trait anxiety, $F(1) = .05$, $p = .83$, and fear of pain, $F(1) = 3.43$, $p = .07$, did not have significant effects on pain ratings.

## Discussion

Two studies were conducted to test the influence of AS on the experience of pain. The aim of Study 1 was to determine whether AS was associated with body vigilance. As predicted, the high AS group showed shorter detection latency regarding a low-intensity electrical stimulation than the low AS group. These results are replicated in Study 2 and lend support to the notion that high AS would be characterized by ''interoceptive sensitivity'', such that individuals high in AS would show hypervigilant self-monitoring of internal physical cues or sensations, as first suggested by Reiss et al. (1986). According to the fear-avoidance model of chronic pain (Vlaeyen & Linton, 2000), pain hypervigilance is the result of fear of pain; however, the findings of Studies 1 and 2 showed that AS was also characterized by attention focused on physiological sensations. Furthermore, correlation analyses in Study 2 showed that body vigilance was weakly related to tolerance, pain and distress ratings, whereas it was significantly related to the self-report measures (AS, neuroticism, trait anxiety and fear of pain). This finding is meaningful given that body vigilance was not measured by self-reporting but by an experimental detection task. The non-painful nature of the electrical stimulation could explain the absence of relationship with pain and distress ratings. In addition, the hypothesis that body vigilance is a stable characteristic mainly related to dispositional constructs should be investigated.

These findings in a non-clinical sample are of particular importance given that vigilance to physiological sensations as measured by interoceptive acuity has been demonstrated among clinical populations (Ehlers & Breuer, 1992; Tyrer, Lee, & Alexander, 1980), although the findings are ambiguous for non-clinical individuals with high and low AS (Asmundson, Sandler, Wilson, & Norton, 1993; Butler & Rapee, 1991; Sturges & Goetsch, 1996; Sturges, Goetsch, Ridley, & Whittal, 1998). It is worth recalling that Sturges, Goetsch, Ridley, and Whittal (1998) considered that these inconsistent findings could be explained by the use of an interoceptive detection methodology too complicated for research participants to perform. In this study, a procedure was chosen, which was initially proposed by Peters et al. (2000) to assess hypervigilance in a study with fibromyalgia patients. This is an easy measurement procedure and none of the participants in this study had any difficulty in performing the task.

Study 2 was aimed at examining the relationship between AS and the experience of pain. The results showed significant differences between high- and low-AS groups in body vigilance, catastrophizing and tolerance; however, the covariates neuroticism, trait anxiety and fear of pain did not show significant effects. The results showed that AS did not have significant effects on the subjective pain and distress ratings, but did show significant effects on pain tolerance. These results contrast with previous studies, which only found differences between AS groups regarding sensory pain (Keogh & Birkby, 1999; Schmidt & Cook, 1999) or sensory and affective pain (Keogh & Mansoor, 2001). Only Keogh and Cochrane (2002) found significant effects of AS on

pain thresholds besides effects on subjective measures (Keogh & Cochrane, 2002), although none found significant effects on pain tolerance. It has been suggested that the reason why previous studies have not found significant differences for behavioural measures has to do with the lower cut-off points used to classify participant as high in AS. This study—which is the first to find differences in tolerance—used a higher cut-off point, even higher than the one used by Keogh and Cochrane (2002), indicating that AS may indeed be associated with behavioural indicators of pain experiences, but only among those with extremely high ASI scores. This result can also be considered in the light of recent studies on AS. These suggest that the construct is taxonic rather than dimensional and that it may be more accurate to conceptualize two discrete forms of AS—a taxon (pathological) form and a non-taxon (normative) form (Bernstein et al., 2006; Bernstein, Zvolensky, Weems, Stickle, & Leen-Feldner, 2005). Thus, future research should replicate the present study in the light of the taxometric approach. The reason why no significant effects on subjective pain and distress ratings were found remains an issue; procedural differences could explain such results given that previous studies used a global measure of pain based on the short-form of the McGill Pain Questionnaire, whereas this study used numerical scales applied every 30 s. Roelofs, Peters, Van Der Zijden, and Vlaeyen (2004) found that AS, pain catastrophizing, and self-reported pain vigilance were positively associated with pain intensity, but not with pain tolerance. The authors explain these findings by the fact that most self-report measures directly refer to pain experiences themselves, but do not refer to behavioural responses to pain, which is reflected by tolerance time. In the present study, catastrophizing was the measure with the strongest relationship to pain and distress ratings, which is in line with the fact that the association of catastrophizing with heightened pain experience is one of the most consistent findings in the literature (Sullivan et al., 2001).

The finding that high- and low-AS groups significantly differed regarding pain catastrophizing during the cold pressor is consistent with previous research showing that although AS and catastrophizing are separate constructs, they share a common cognitive dimension—namely, a general tendency to catastrophize the meaning of unpleasant physical sensations (Drahovzal, Stewart, & Sullivan, 2006). This is an interesting finding, especially if it is taken into account that, in this study, catastrophizing was not assessed by a self-report questionnaire thus avoiding shared method variance. Future research should also take into account the recent results, which found that injury/illness sensitivity (IS) is a stronger predictor of pain catastrophizing and fear of pain than AS (Keogh & Asmundson, 2004; Vancleef, Peters, Roelofs, & Asmundson, 2006).

The correlation analysis in Study 2 showed that catastrophizing was significantly related to body vigilance. It must be borne in mind that in the present study we did not assess pain vigilance but body vigilance to innocuous electrical stimuli; nevertheless, a study with a similar design (Peters et al., 2000) found that the detection of innocuous electrical stimuli was predicted by pain vigilance when measured by the Pain Vigilance and Awareness Questionnaire (McCracken, 1997). These results could be related to several studies, which have shown that catastrophic thinking is strongly related to pain vigilance (Goubert et al., 2004; Roelofs et al., 2003). Crombez et al. (2004) supported the idea of comprehensive theories addressing the relationship between catastrophizing and vigilance to pain given that both concepts share attentional subcomponents.

The correlation analyses in Study 2 showed that there is a significant positive relationship between AS and fear of pain. AS had significant effects on body vigilance, catastrophizing and tolerance. The covariate fear of pain did not have any significant effect, although it had an almost significant effect on tolerance. These results agree with several studies in which AS influenced the pain experience in response to a pain-induction task, and appeared to be a stronger predictor than fear of pain for pain responses following a cold pressor task (Greenberg & Burns, 2003; Keogh & Birkby, 1999; Keogh & Mansoor, 2001). In line with the "AS approach" (Asmundson & Hadjistavropoulos, 2007; Asmundson, Norton, & Norton, 1999; Norton & Asmundson, 2003), our results show that the experience of pain is mainly influenced by a general tendency to fear symptoms of anxiety rather than by pain-specific threats.

The analysis of covariance also showed that trait anxiety and neuroticism did not account for significant variance in body vigilance or in tolerance, catastrophizing, pain and distress ratings, whereas AS did. Thus, the results of a longitudinal study with musculoskeletal pain patients (Hadjistavropoulos, Asmundson, & Kowalyk, 2004) found that trait anxiety had a limited ability to predict adjustment to pain over time and AS contributed to the prediction of negative affect. Pennebaker and Watson (1991) showed that individuals with high levels of neuroticism appear to be hypervigilant about their bodies and have a lower threshold for noticing and reporting subtle bodily sensations. Nevertheless, our results indicated that when the influence of

AS and neuroticism on body vigilance was taken into account, only AS had a significant effect on body vigilance. Goubert et al. (2004) did not find a direct effect of neuroticism on vigilance to pain either; their findings show that the effect of neuroticism upon pain vigilance was largely mediated by pain catastrophizing and pain-related fear.

As suggested, an experimental pain-induction technique in healthy participants was used (Keogh & Mansoor, 2001) to study AS as a predisposing factor to increased negative pain experiences. Nevertheless, caution should be exercised in generalizing these results to clinical populations until these effects have been examined more extensively. Like previous studies (e.g. Keogh & Mansoor, 2001; Roelofs, Peters, Van der Zijden, & Vlaeyen, 2004), this study was limited to women given that previous research has found that they are particularly sensitive to cold pressor pain and tend to have higher levels of AS. Although it has been frequently found that women score higher on the ASI than males (Peterson, & Reiss, 1992; Stewart et al., 1997), it should be pointed out that sex differences in AS have not always been found (e.g. Asmundson & Norton, 1995). Interestingly, several studies have found sex differences in the relationship between AS and pain (Keogh, Barlow, Mounce, & Bond, 2006; Keogh & Birkby, 1999). Future research may be designed to further explore the relationship between AS and gender regarding the pain experience.

Recent work suggests that the AS Physical Concern sub-dimension, rather than the other dimensions, plays a specific role in fear associated with bodily sensations (Zinbarg, Brown, Barlow, & Rapee, 2001; Zvolensky, Kotov, Antipova, & Schmidt, 2005) and specifically, fear of pain (Zvolensky, Goodie, McNeil, Sperry, & Sorrell, 2001). Thus, future research should replicate the present study with the ASI-3 (Taylor et al., 2007), which reliably assesses the basic dimensions of AS (physical, cognitive and social concerns).

The current findings indicate that AS may play an important role in the treatment of pain patients. Thus, cognitive–behavioural therapy similar to that used to treat panic disorder has been suggested; this involves deliberate exposure to symptoms of anxiety and the restructuring of their catastrophic appraisals of these sensations (Asmundson et al., 1999). Recently, Watt, Stewart, Lefaivre, and Uman (2006) showed that cognitive–behavioural therapy was useful for treating AS and also lead to changes in fear of pain in a non-clinical sample. AS may serve as a useful factor in the early identification of those at increased risk of becoming disabled by pain and who could be targeted for early preventive intervention.

## Acknowledgements

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