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Anxiety Sensitivity and Pain-related Anxiety in the Prediction of Fear Responding to Bodily Sensations: A Laboratory Test

Adam Gonzalez, B.A.^a, Michael J. Zvolensky, Ph.D.^a, Julianna Hogan, M.Ed.^a, Alison C. McLeish, Ph.D.^b, and Kristin S. Weibust, Ph.D.^a

^a University of Vermont, Department of Psychology

^b University of Cincinnati, Department of Psychology

Abstract

Objective—The present investigation sought to examine the simultaneous effects of anxiety sensitivity and pain-related anxiety on fear and anxious responding to a 10% carbon dioxide enriched air challenge.

Methods—Participants included 247 adults (53% women; age $M = 21.91$ years, $SD = 8.41$) recruited from the community. At the laboratory, participants were administered a structured clinical interview, completed a battery of self-report measures, and underwent a 10% carbon dioxide enriched air challenge.

Results—Both anxiety sensitivity and pain-related anxiety were significantly and uniquely predictive of post-challenge panic attacks, total post-challenge panic attack symptoms, and intensity of cognitive panic attack symptoms. Anxiety sensitivity, but not pain-related anxiety, also was predictive of post-challenge physical panic symptoms. The observed significant effects for both anxiety sensitivity and pain-related anxiety were evident above and beyond the variance accounted for by gender, age, current level of non-specific bodily pain, and negative affectivity. Neither anxiety sensitivity nor pain-related anxiety was significantly predictive of change in anxiety focused on bodily sensations or heart rate.

Conclusion—Results suggest that anxiety sensitivity and pain-related anxiety, although related to one another, may be independently important variables underlying fear reactivity to bodily sensations.

Keywords

Panic; Anxiety; Anxiety Sensitivity; Pain-anxiety; Pain

There is a large body of empirical research examining risk processes underlying fear responding to bodily sensations [1–3]. Perhaps the most well-known construct in this domain is anxiety sensitivity (AS) [4]. AS is defined as the extent to which individuals believe that anxiety and anxiety-related sensations have harmful consequences [2,5]. Empirical study of this construct indicates that AS is composed of a global, higher-order

Corresponding Author: Michael J. Zvolensky, Ph.D., University of Vermont, John Dewey Hall, 2 Colchester Avenue, Burlington, VT 05405-0134, 802-656-8994 (phone), 802-656-5567 (facsimile), Michael.Zvolensky@uvm.edu.

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factor and three lower-order factors, namely concerns about mental incapacitation (AS-mental concerns), concerns about physical symptoms of anxiety (AS-physical concerns), and concerns about the social consequences of experiencing anxious arousal (AS-social concerns) [6]. Prospective [7–11] and laboratory [12–16] studies suggest that AS increases the risk for more intense anxiety symptoms and anxiety psychopathology.

AS and anxious and fearful responding to bodily sensations may be one of a variety of cognitive-based factors that may underlie vulnerability to fearful responding to bodily sensations. Indeed, researchers increasingly are exploring the possibility that there may be cognitive factors beyond AS that are relevant to anxiety and fear processes focused on somatic symptoms [17,18]. For example, significant relations have been observed between fear responding to a biological challenge and discomfort intolerance (defined as the capacity to withstand uncomfortable physical sensations) [19]. Other work has examined a comprehensive affect sensitivity and tolerance model including AS, discomfort intolerance, and distress tolerance (defined as the ability to withstand negative emotional states [20]) in relation to fear and anxious responding to a biological challenge. Here, Kutz and colleagues [21] found that within this model, only AS was significantly related to fearful responding. Collectively, this line of work suggests that there may be specific cognitive vulnerabilities beyond AS that could amplify fear responding to bodily sensations.

Previous work suggests that the development and maintenance of anxiety disorders and chronic pain may follow similar patterns consistent with fear-anxiety-avoidance models [1,22,23] and consequently, may share similar underlying processes and mechanisms [24]. Pain-related anxiety is one specific cognitive factor of interest that has received growing theoretical and clinical attention, and is related to acute and chronic pain [17,25,26] and anxiety problems [27]. Pain-related anxiety is related to, but theoretically and empirically distinct from, AS; it refers to anxiety and worry about pain or pain-related events [17]. Individuals high compared to low in pain-related anxiety may be more apt to experience elevated levels of anxiety in response to pain or events perceived as potentially pain inducing. Consistent with fear-anxiety-avoidance models, pain-related anxiety might be one relevant factor implicated in the development and maintenance of anxiety psychopathology. McCracken and colleagues developed the Pain Anxiety Symptoms Scale (PASS) to assess pain-related anxiety [28], and later, a shorter version of the PASS, the PASS-20 [29], to more quickly assess this construct. The validity of the PASS and PASS-20 is supported by significant positive correlations with measures of general anxiety, pain, disability, and depression [28,29]. The only apparent utility in using the PASS-20 over the original PASS is to lessen completion time and burden [29]. Research utilizing the PASS or the PASS-20 indicates that patients with chronic pain disorders report greater pain-related anxiety relative to a variety of comparison groups (e.g., nonclinical populations, persons with non-pain health disorders), over-predict the intensity of pain, cope maladaptively with pain sensations, and demonstrate elevated somatic reactivity (e.g., heart rate change) in anticipation of pain-eliciting physical activity [27,30]. Thus, pain-related anxiety may contribute to poorer emotional adjustment via a number of anxiety-related cognitive, behavioral, or physiologic processes.

Initial work suggests that pain-related anxiety and AS, although related are theoretically and empirically unique vulnerability factors for psychopathology [31,32]. Carleton and colleagues [27], for instance, found that pain-related anxiety does not differ across the spectrum of anxiety and depressive disorders, but is higher among persons with such conditions compared to individuals without psychopathology. AS, on the other hand, is differentially elevated across these same clinical samples [27,33]. Specifically, individuals with panic disorder score significantly higher on the Anxiety Sensitivity Index (ASI) [34] than persons with depressive disorders, social anxiety disorder, or obsessive-compulsive

disorder [27]. Moreover, individuals with chronic pain report similar levels of pain-related anxiety compared to those with anxiety and depressive disorders, with the exception of scores on the escape/avoidance sub-factor of the PASS, on which individuals with chronic pain tend to score higher [27]. Yet, this same chronic pain sample reports greater overall pain-related anxiety than non-clinical/non-chronic pain controls [27]. These data suggest that AS and pain-related anxiety may not be perfectly coupled across clinical populations. Although pain-related anxiety is elevated across the spectrum of anxiety disorders similarly to those with chronic pain, it remains unclear, however, whether AS and pain-related anxiety serve to increase risk for anxious and fearful responding to somatic perturbation independently of one another.

The purpose of the present study was to examine whether AS and pain-related anxiety represent distinct mechanisms for fear responding to bodily sensations by amplifying reactivity to these sensations during a laboratory-based biological challenge procedure. Given that most individuals can relate to the experience of pain and that many anxiety-related symptoms and disorders commonly co-occur with pain (e.g., tingling, muscle tension, Post-traumatic Stress Disorder, Panic Disorder [35], those reporting greater pain-related anxiety may have amplified fear reactivity to induced bodily sensations. Based on extant research [11,27,28], we hypothesized that AS and pain-related anxiety, although related to one another, would each independently predict self-reported anxious and fearful responding to a 10% carbon-dioxide enriched air challenge. For heart rate, only pain-related anxiety was hypothesized to have a significant incremental effect based upon past work indicating its association to enhanced physiological arousal [30]; no such effect was posited for AS as past work has not found an association between this cognitive factor and heart rate [36]. Additionally, we hypothesized that these effects would be evident above and beyond the variance accounted for by other factors found to influence anxious and fearful responding to bodily sensations in past work, including gender, age, non-specific bodily pain, and negative affectivity [36].

Method

Participants

Participants included 247 adults (53% women; *Mean* age = 21.91 years, *SD* = 8.41) who were recruited via advertisements for a laboratory study on 'emotion' that were placed throughout various community settings and university-based bulletin boards and classrooms. The racial distribution of the sample reflected that of the Vermont population [37]: 91.5% Caucasian, 1.6% Hispanic, 1.6% African American, 0.9% Asian, 1.2% Bi-racial, 1.2% responded as "other", and 2% did not complete this question. The majority of the sample had a high school degree or equivalent (76.5%), 1.6% only completed up to grade 7, 13.8% completed part of college, 3.2% completed a 2-year college, 2.8% completed a 4-year college, 0.5% completed part of graduate school, 1% completed graduate school, and 1% did not provide a response.

Participants were eligible for this study if they were adults between 18 and 65 years of age. Exclusionary criteria for the study included: (1) current Axis I disorder, (2) current suicidal or homicidal ideation; (3) current or past chronic cardiopulmonary illness (e.g., chronic obstructive pulmonary disease, severe asthma); (4) seizure disorder, cardiac dysfunction, or other serious medical illness (e.g., history of seizures, emphysema); (5) pregnant or trying to become pregnant (women); and (6) inability to give informed, written consent. These screening criteria were employed for two reasons: first, to protect participants by decreasing the probability of unanticipated medical complications resulting from the biological challenge [36]; and second, to help ensure any observed effects between the studied variables and challenge response were not due to pre-existing factors (e.g., psychiatric

problems [38]). This study was approved by the Institutional Review Board at the University of Vermont.

Measures

Pre-challenge assessment—The *Structured Clinical Interview for DSM-IV Axis I Disorders- Non-Patient Edition (SCID-NP; [39])* is a well-established diagnostic interview for psychiatric problems. The interview was administered by trained clinical psychology graduate students to rule out current Axis I psychopathology and related exclusionary criteria, including suicidal ideation or intent. In the present study, the principal investigator reviewed each SCID-NP to ensure inter-rater agreement; no disagreements were noted.

The *Pain Anxiety Symptoms Scale (PASS; [28])* is a 40-item self-report measure in which respondents indicate anxiety related to pain on a six-point Likert-type scale (0 = *never* to 5 = *always*). The PASS assesses (a) cognitive anxiety symptoms related to the experience of pain (e.g., “My thoughts are agitated and keyed up as pain approaches.”), (b) escape and avoidance responses related to reducing pain (e.g., “I go immediately to bed when I feel severe pain.”), (c) fearful appraisals of pain (e.g., “I think that if my pain gets too severe, it will never decrease.”), and (d) physiological anxiety symptoms related to pain (e.g., “I become sweaty when in pain.”). The validity of the total and four subscale scores is supported by significant positive correlations with measures of general anxiety, pain, and disability [28]. The PASS-total score for the current study evidenced excellent internal consistency (Cronbach’s $\alpha = .93$) and, in line with past work [28], was used to index pain-related anxiety in the present study. As recommended by previous work [29], the PASS was used as opposed to the PASS-20 to allow for a more comprehensive assessment of pain-related anxiety.

The *Anxiety Sensitivity Index (ASI; [34])* is a 16-item measure on which respondents indicate on a five-point Likert-type scale (0 = *very little* to 4 = *very much*) the degree to which they are concerned about possible negative consequences of anxiety symptoms. The ASI has high internal consistency ranging from .84 for a sample of college students to .88 – .90 for a clinical sample of anxiety-disordered patients [34], and .86 among the current sample. The ASI has demonstrated excellent convergent validity ($r > .70$) with other established anxiety-relevant measures [40]. The ASI is unique from, and demonstrates incremental predictive validity relative to, trait anxiety [14] and negative affectivity [41].

The *Positive Affect Negative Affect Schedule (PANAS; [42])* assesses two global dimensions of affect: negative and positive. For each of 20 adjectives (e.g., “irritable”), participants indicate on a 5-point Likert-type scale (1 = *very slightly* to 5 = *extremely*) the degree to which the descriptor typifies how they generally feel. Only the negative affectivity scale (PANAS-NA) was used in this study as a global index of the trait-level propensity to experience negative affect. The PANAS-NA has demonstrated sound internal consistency in clinical and non-clinical populations (range of alpha coefficients: .85 to .93), test-retest reliability (e.g., $r = .71$ for two months to $r = .43$ for seventy-two months), as well as convergent and discriminant validity in relation to multiple measures of state-level affect, trait-level mood, and personality [43]. The PANAS-NA demonstrated good internal consistency in the current study (Cronbach’s $\alpha = .85$).

The *Short-Form General Health Survey (GHS; [44])* was used to assess current levels of bodily pain. The GHS is a questionnaire consisting of 20-items and asks respondents to indicate perceptions of their health status on a Likert-type scale. The current investigation utilized question 2 on the GHS only -- “How much bodily pain have you had during the past four weeks (a. *none*, b. *very mild*, c. *mild*, d. *moderate*, e. *severe*)” -- to assess participants’ current degree of bodily pain. This item indexed non-specific pain; that is, it was not

oriented on a particular pain-related medical condition. The GHS has demonstrated adequate reliability and validity in previous work [44].

Challenge assessment—During the experimental procedure (described below), the *Subjective Units of Distress Scale* (SUDS; [45]) was used to index self-reported anxiety. The SUDS is a Likert-type scale ranging from 0 (*no anxiety focused on bodily sensations*) to 100 (*extreme anxiety focused on bodily sensations*). Participants completed this scale before and after the challenge procedure.

The *Diagnostic Sensations Questionnaire* (DSQ; [46]) was used to assess DSM-IV panic attack symptoms immediately post-challenge. This measure is frequently employed in challenge work [47]. Ratings for the DSQ are made on a 9-point Likert type scale (0 = *not at all* to 8 = *very strongly felt*). The DSQ lists DSM-IV panic attack symptoms, which can be used to determine the presence of a panic attack as well as composite scores for a mean intensity level for cognitive (e.g., fear of going crazy) and physical (e.g., breathlessness or smothering sensations) symptoms. The symptom-specific factors of the DSQ have high levels of internal consistency (α 's > .80) and excellent convergent validity with other measures of anxiety [47–49]. In the current study, post-challenge panic attacks (dichotomous categorization) and continuous indices of post-challenge symptom intensity were employed. In line with past work [50,51] and following DSM-IV-TR standards [52], individuals met criteria for a panic attack if they reported four or more symptoms (one of which had to be cognitive) and a “sensation of panic” at a moderate intensity rating or greater.

Physiological Assessment—A J&J Engineering I-330-C2 system was used to digitally record physiological data on-line at a sample rate of 1024 samples per second across channels using J&J Engineering Physiolab Software. Heart rate (a measure of beats per minute) was the only physiological variable examined for the current study. Raw electrocardiogram data were collected with disposable Ag/AgCl electrodes placed in a standard bilateral configuration on the palmar side of each wrist. Data were processed through a 1–100 Hz bandpass filter designed to maximize R-wave frequency.

Materials and apparatus

Laboratory sessions were conducted in a 3-m $\times$ 3-m experimental room in the Department of Psychology at the University of Vermont. After completing physiological hookup and providing experimental instructions (see Procedure for details), the experimenter ran and observed study participants from an adjacent control room containing an apparatus designed to provide participants with either room air or a mixture of 10% carbon dioxide enriched air. Carbon dioxide was stored in a 24-in. diameter hospital grade latex bag and delivered via 5-cm tubing to a positive-pressure C-pap mask worn by the participant. In addition to a one-way mirror, a video and audio monitoring system allowed the experimenter to observe all session events.

Procedure

Interested persons responding to local advertisements who contacted the research team were given a detailed description of the study over the phone. After providing verbal consent, an appointment was setup for the participant to come into the laboratory to complete the study protocol. Upon arrival, the participant was greeted by a research assistant and filled out a consent form agreeing to participate in the study. Participants were administered the SCID-NP [39] by trained interviewers, to assess for study exclusionary criteria (e.g., current Axis I psychopathology, suicidal/homicidal ideation). Participants then completed a battery of self-report measures, followed by the biological challenge procedure. The challenge procedure

consisted of electrode placement for physiological measurement, a 10-min adaptation period (breathing room air through the C-PAP mask), 4-min 10% carbon dioxide enriched air challenge, and 5-min recovery period (breathing room air through the mask again). Participants completed the DSQ immediately following the 4-min challenge period. Physiological data were gathered continuously throughout the experimental portion of the study. After the study, participants were debriefed and compensated \$20. The current study data were collected as part of a larger investigation [53]; the current analyses and results are novel.

Data Analytic Strategy

Descriptive statistics and zero-order correlations were first examined for all study variables. A binary logistic regression analysis was conducted with post-challenge panic attack status (yes/no) as the criterion variable. The main effects of gender, age, current levels of bodily pain, and negative affectivity were entered at step 1 and the ASI-total score and the PASS-total score were entered at step 2. A set of hierarchical regression analyses were subsequently conducted with the following post-challenge criterion variables: (1) DSQ-derived total panic symptoms, (2) DSQ-derived mean intensity level of cognitive and physical panic symptoms, (3) SUDS, and (4) heart rate. The main effects of gender, age, current levels of bodily pain, and negative affectivity were entered at step 1. For the post-challenge SUDS rating and heart rate variables, baseline (i.e., last minute of baseline) SUDS rating and heart rate were also respectively entered at step 1. At step 2, the main effects of the ASI-total score and the PASS-total score were simultaneously entered.

Results

Descriptive Data and Zero-order Relations

Descriptive statistics and correlations are reported in Table 1. The PASS-total score was positively and significantly associated with all of the outcome variables except for post challenge heart rate ($r = .13$, $p = .08$). The range of observed statistically significant relations with the PASS-total score and the criterion variables was $r = .17$ (post-challenge SUDS) to $.34$ (post-challenge DSQ-Cognitive symptoms). The PASS-total score also was positively and significantly related to the ASI-total score ($r = .48$, $p < .001$, 23% shared variance). The ASI-total score was positively and significantly associated with all of the outcome variables (range of observed r s = $.23$ to $.32$, see Table 1) except post-challenge heart rate ($r = .07$, $p = .33$).

Regression Analyses

Please see Tables 2 and 3 for a summary of the regression analyses. Regarding endorsing criteria for having a panic attack immediately post challenge, the overall model accounted for 15% of variance. Predictor variables in step 1 did not account for a significant portion of the variance, however, PANAS-NA was a significant independent predictor at this level ($OR = 1.07$, 95% $CI = 1.01$ – 1.13 , $p = .01$). At step 2, the simultaneous addition of the PASS-total and ASI-total scores accounted for 10% of additional variance ($p < .001$), with both the PASS-total and ASI-total scores making significant contributions ($OR = 1.02$, 95% $CI = 1.00$ – 1.03 , $p = .01$ and $OR = 1.05$, 95% $CI = 1.01$ – 1.09 , $p = .03$, respectively).

For total panic symptoms endorsed immediately post challenge, predictor variables in step 1 accounted for a significant portion of variance ($R^2 = .08$, $p < .001$). Gender and PANAS-NA were the only significant predictors at this level ($\beta = .19$, $p < .01$ and $\beta = .15$, $p = .02$, respectively). At step 2, the simultaneous addition of the PASS-total and ASI-total scores accounted for 7% of additional variance ($p < .001$), with both the PASS-total and ASI-total scores making significant contributions ($\beta = .15$, $p = .03$ and $\beta = .19$, $p = .01$, respectively).

Regarding the mean intensity level of post-challenge DSQ-cognitive symptoms, predictor variables in step 1 accounted for a significant portion of variance ($R^2 = .05, p = .01$). Gender and PANAS-NA were the only significant predictors at this level ($\beta = .16, p = .02$ and $\beta = .15, p = .02$, respectively). At step 2, the simultaneous addition of the PASS-total and ASI-total scores accounted for 12% of additional variance ($p < .001$), with the PASS-total and ASI-total scores making significant contributions ($\beta = .25, p < .001$ and $\beta = .20, p < .01$, respectively).

Regarding the mean intensity level of post-challenge DSQ-physical symptoms, predictor variables in step 1 accounted for a significant portion of variance ($R^2 = .08, p < .001$). Gender and PANAS-NA were the only significant predictors at this level ($\beta = .19, p < .01$ and $\beta = .13, p = .04$, respectively). At step 2, the simultaneous addition of the PASS-total and ASI-total scores accounted for 4% of additional variance ($p < .01$), with only the ASI-total score making a significant univariate contribution ($\beta = .17, p = .02$).

In terms of post-challenge SUDS rating, predictor variables in step 1 accounted for 25% of variance ($p < .001$) with gender and baseline SUDS rating as significant predictors ($\beta = .25, p < .001$ and $\beta = .43, p < .001$, respectively). At step 2, the simultaneous addition of the PASS-total and ASI-total scores did not account for a significant portion of variance. Regarding post-challenge heart rate, predictor variables in step 1 accounted for 22% of variance ($p < .001$) with gender and baseline heart rate as the only significant predictors ($\beta = .22, p = .001$ and $\beta = .40, p < .001$, respectively). At step 2, the simultaneous addition of the PASS-total and ASI-total scores did not account for a significant portion of additional variance.

Discussion

There is a growing recognition that multiple types of cognitive-based risk factors may influence anxious and fearful responding to bodily sensations [27]. However, empirical data pertaining to the unique explanatory roles of AS and pain-related anxiety is lacking. To help fill this gap in the existing literature, the present investigation sought to examine the independent effects of AS and pain-related anxiety in regard to anxious and fearful responding during a biological challenge procedure.

The observed results offer novel empirical insight into the role of cognitive-based risk for anxious and fearful responding to bodily sensations. Consistent with prediction, AS and pain-related anxiety were each significantly, incrementally related to increased likelihood of having a panic attack as well as total panic attack symptoms and intensity of cognitive panic attack symptoms post-challenge. In each of these instances, the observed effects were of a similar magnitude in terms of effect size [54] and evident above and beyond the variance accounted for by gender, age, non-specific bodily pain, and negative affectivity. Thus, there was consistent evidence of explanatory specificity for these two cognitive factors that was not attributable to other factors known to influence panicogenic responding (e.g., negative affectivity).

The current results uniquely extend past research in at least two ways by (1) documenting that AS effects for fear and panic responding to biological challenge are not alternatively accounted for by shared variance with pain-related anxiety; and (2) illustrating that pain-related anxiety appears to be a potentially relevant cognitive factor to consider in models of fear responding to somatic perturbation. Overall, the findings collectively suggest that there may be distinct cognitive-based mechanisms for anxious and fearful responding to bodily sensations, including pain-oriented fear processes. Future work is needed to replicate and extend such findings using other methodologies (e.g., prospective designs) as well as to

evaluate the consistency of the observed findings in relation to specific clinical populations (e.g., chronic pain with and without co-occurring panic disorder).

Inconsistent with prediction, only AS was significantly incrementally related to intensity of post-challenge physical panic attack symptoms. Thus, AS, but not pain-related anxiety, is incrementally (uniquely) related to post-challenge intensity of physical panic attack symptoms. This finding, consistent with past work on AS [12,50], suggests that AS and pain-related anxiety may not relate in the same manner to all aspects of fear responding. Interestingly, neither AS nor pain-related anxiety was significantly related to *change* in anxiety focused on bodily sensations nor heart rate reactivity during the challenge. The lack of an association between AS and heart rate is not necessarily uncommon to extant work [36]. However, many studies have found AS to be related to anxiety change (e.g., SUDS ratings) during a panic provocation paradigm [12]. The relatively large number of covariates included in the analyses, in conjunction with the shared variance with pain-related anxiety, may have attenuated the putative AS-anxiety reactivity (e.g., SUDS ratings) effect.

Although these data provide evidence that AS and pain-related anxiety are relevant to better understanding fear responsivity to bodily sensations, the mechanisms linking these factors to such emotional responding is presently unclear. One possibility is that these variables may be promoting more adverse emotional events (e.g., more intense symptoms), which lead to greater levels of negative emotional learning and subsequent life impairment. Another non-mutually exclusive possibility is that these factors may be parts of a larger fear-sensitivity construct promoting maladaptive affect regulation (e.g., avoidance, rumination) that, in combination with high levels of emotional distress, produce an increased risk of negative emotional outcomes. Ultimately, elucidating the mechanisms linking these putative risk factors to clinical conditions will facilitate theoretical refinement of models of disorder development and aid in tailoring intervention work on clinical conditions.

Although not the primary aim of the investigation, a number of other observations warrant brief comment. First, the association between AS and pain-related anxiety is noteworthy. The ASI-total score and PASS-total score were significantly correlated and shared 23% variance with one another. This finding indicates that these two cognitive factors reflect different, albeit related, forms of cognitive vulnerability processes. Second, women were more likely to report higher ratings of panic attack symptoms relative to men. These findings replicate and extend past work suggesting women are more responsive to panic provocation than men [55]. Such work also is broadly consistent with research that suggests gender differences are associated with differential emotional reactivity to stress [56]. Interestingly, AS, but not pain-related anxiety, was related to gender, such that women reported higher levels of AS than men. This association is consistent with previous work that has documented gender differences in regard to AS [57]. Third, AS and pain-related anxiety both were positively and significantly associated with negative affectivity and current non-specific bodily pain (see Table 1). These associations also are in line with past work implicating these cognitive factors in regard to the expression of pain and negative emotional experience more generally [31,58].

The present study has several limitations. First, the present sample was limited in that it was comprised of a relatively homogenous group of young adults. To increase the generalizability of these findings, it will be important for researchers to draw from populations other than those used in the present study. Second, although the present investigation examined the two well-established cognitive vulnerability factors, there are other cognitive risk factors that may warrant examination (e.g., intolerance of uncertainty [59], emotional dysregulation [60]). By continuing to study cognitive factors in multi-risk factor models, clinically-relevant information concerning the interplay between such factors

can be better understood and applied to understanding the enigmas of anxiety and pain-based psychopathology. Third, at the present stage of research development, we focused on global measurements of AS and pain-related anxiety. Some work suggests focusing on lower-order factors of the constructs may offer further explanatory specificity. We did not employ that type of approach here because there is (a) inconsistency as to whether AS physical or cognitive (mental incapacitation) concerns best predict panic responsivity [7,10]; and (b) there was no direct evidence that a particular facet of pain-related anxiety should demonstrate explanatory specificity to fear reactivity. Future work could build upon the present findings and explore whether certain lower-order factors of AS and pain-related anxiety offer enhanced explanatory power relative to the global constructs. For example, research could address whether AS and pain-related anxiety, among other cognitive factors, compose a larger fear-sensitivity construct relevant to anxious responding to bodily sensations. Fourth, level of pain was not assessed post challenge. Future work might consider examining concurrent changes in pain in response to anxiety-related provocation tasks. Such studies might benefit from utilizing a Visual Analogue Scale to measure pain, as a means to more fully capture variability within an individual's experience of pain [61]. Finally, the present study was focused on a laboratory model of fear responding. Thus, there is naturally some level of disconnect between a laboratory model and naturally occurring fear behavior [62]. Future work is therefore needed to replicate and extend the current model of cognitive vulnerability using larger-scale prospective designs or time sampling procedures (e.g., ecological momentary assessment).

Overall, the present investigation adds uniquely to the extant empirical literature on AS and pain-related anxiety in terms of fear responding to bodily sensations. Results suggest that AS and pain-related anxiety, although related to one another, may each be independently important variables to consider in better understanding fear reactivity to bodily sensations. Future investigations are warranted to better understand the interplay of these constructs in regard to fear-responding, especially among clinical populations.

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Table 1
Descriptive Data and Zero-order (or, Bi-variate, as applicable) Relations Between Variables

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	<i>M (SD) or %</i>	Observed Range
1 Gender (% women) ¹	---	-.20**	-.13*	.12	.01	.09	.14*	.12	.09	.23***	.17**	.23***	.26***	.25***	53%	
2 Age		---	.10	.06	.05	-.10	.11	.14*	-.04	-.11	-.03	-.13*	-.03	-.16*	21.91 (8.41)	18-62
3 Bodily Pain ²			---	.16*	.08	-.13*	.13*	.14*	-.04	-.01	.00	-.02	.02	-.00	2.35 (1.00)	1-5
4 PANAS-NA ³				---	.44***	-.03	.40***	.33***	.16*	.16*	.17**	.15*	.23***	.03	17.68 (5.51)	10-44
5 Baseline SUDS ⁴					---	.05	.30***	.22***	.22**	.30***	.23***	.30***	.44***	-.02	18.75 (18.00)	0-100
6 Baseline HR ⁵						---	.00	.02	.07	.01	-.02	.02	.03	.41***	81.05 (10.37)	55.89-113.55
7 ASI-Total Score ⁶							---	.48***	.26***	.27***	.32***	.23***	.25***	.07	16.39 (8.31)	1-45
8 PASS-Total Score ⁷								---	.25***	.24***	.34***	.18**	.17**	.13	58.18 (28.21)	6-132
9 Post-Challenge PA (% yes) ⁸									---	.65***	.81***	.54***	.42***	.24**	25%	
10 DSQ-Total Panic Symptoms ⁹										---	.82***	.98***	.66***	.39***	3.03 (1.55)	0-7.25
11 DSQ-Cognitive ⁹											---	.69***	.57***	.25**	7.66 (6.84)	0-30
12 DSQ-Physical ⁹												---	.63***	.41***	40.79 (19.58)	0-88
13 Post-Challenge SUDS ¹⁰													---	.28***	53.98 (28.37)	0-100
14 Post-Challenge HR ¹¹														---	91.27 (14.30)	58.83-139.46

Note:

* $p < .05$,

**

$p < .01$,

*** $p < .001$;

¹ Gender coded as 1 = man, 2 = woman,

² average bodily pain reported (Short-Form General Health Survey; Stewart et al., 1988),

³ Positive and Negative Affect Schedule-Negative Affect subscale (Watson et al., 1988),

⁴ Last minute of baseline Subjective Units of Distress Scale (Wolpe, 1958),

⁵ Last minute of baseline heart rate,

- ⁶ Anxiety Sensitivity Index (Reiss et al., 1986),
- ⁷ Pain Anxiety Symptoms Scale (McCracken et al., 1992),
- ⁸ Panic attack coded as 0 = no, 1 = yes,
- ⁹ Diagnostic Sensations Questionnaire (Sanderson et al., 1989),
- ¹⁰ Last minute of challenge Subjective Units of Distress Scale (Wolpe, 1958),
- ¹¹ Last minute of challenge heart rate.

Table II

Predictors of Post Challenge Panic Attack

Dependent variable:	ΔR^2	OR	95% CI (lower)	95% CI (upper)	p
Post-Challenge PA ¹					
Step 1	.05				.08
Gender ²		.78	.42	1.43	.42
Age		.99	.95	1.03	.54
Bodily Pain ³		.87	.63	1.20	.38
PANAS-NA ⁴		1.07	1.01	1.13	.01
Step 2	.10				< .001
ASI-Total Score ⁵		1.05	1.01	1.09	.03
PASS-Total Score ⁶		1.02	1.00	1.03	.01

Note:

¹ Panic attack coded as 0 = no, 1 = yes,

² Gender coded as 1 = man, 2 = woman,

³ average bodily pain reported (Short-Form General Health Survey; Stewart et al., 1988),

⁴ Positive and Negative Affect Schedule-Negative Affect subscale (Watson et al., 1988),

⁵ Anxiety Sensitivity Index (Reiss et al., 1986),

⁶ Pain Anxiety Symptoms Scale (McCracken et al., 1992)

Table III

Predictors of Post-Challenge Panic Symptoms, Heart Rate, and SUDS Rating

	ΔR^2	t	β	sr^2	p
<i>Dependent variable: Post-Challenge</i>					
<i>DSQ-Total Panic Symptoms¹</i>					
Step 1	.08				.001
Gender ²		2.99	.19	.04	<.01
Age		-1.36	-.09	.01	.17
Bodily Pain ³		.10	.01	.00	.92
PANAS-NA ⁴		2.30	.15	.02	.02
Step 2	.07				<.001
ASI-Total Score ⁵		2.59	.19	.03	.01
PASS-Total Score ⁶		2.13	.15	.02	.03
<i>Dependent variable: Post-Challenge</i>					
<i>DSQ-Cognitive¹</i>					
Step 1	.05				.01
Gender		2.37	.16	.02	.02
Age		-.18	-.01	.00	.86
Bodily Pain		.08	.01	.00	.94
PANAS-NA		2.32	.15	.02	.02
Step 2	.12				<.001
ASI-Total Score		2.82	.20	.03	<.01
PASS-Total Score		3.66	.25	.05	<.001
<i>Dependent variable: Post-Challenge</i>					
<i>DSQ-Physical¹</i>					
Step 1	.08				.001
Gender		2.95	.19	.04	<.01
Age		-1.66	-.11	.01	.10
Bodily Pain		.10	.01	.00	.92
PANAS-NA		2.09	.13	.02	.04

	ΔR^2	t	β	sr^2	p
Step 2	.04				<.01
ASI-Total Score		2.29	.17	.02	.02
PASS-Total Score		1.42	.10	.01	.16
<i>Dependent variable: Post-Challenge</i>					
<i>SUDS Rating⁷</i>					
Step 1	.25				<.001
Gender		4.28	.25	.07	<.001
Age		-.15	-.01	.00	.88
Bodily Pain		.45	.03	.00	.66
PANAS-NA		.17	.01	.00	.86
Baseline SUDS Rating ⁸		6.82	.43	.16	<.001
Step 2	.01				.27
ASI-Total Score		1.42	.10	.01	.16
PASS-Total Score		.24	.02	.00	.81
<i>Dependent variable: Post-Challenge</i>					
<i>HR⁹</i>					
Step 1	.22				<.001
Gender		3.29	.22	.05	.001
Age		-1.09	-.07	.01	.28
Bodily Pain		1.22	.08	.01	.22
PANAS-NA		.13	.01	.00	.90
Baseline HR ¹⁰		6.22	.40	.17	<.001
Step 2	.01				.38
ASI-Total Score		.11	.01	.00	.91
PASS-Total Score		1.23	.09	.01	.21

Note: β = standardized beta weights; sr^2 = squared semi-partial correlation coefficient;

⁷ DSQ: Diagnostic Sensations Questionnaire (Sanderson et al., 1989),

² Gender coded as 1 = man, 2 = woman,

³ average bodily pain reported (Short-Form General Health Survey; Stewart et al., 1988),

- ⁴ PANAS-NA: Positive and Negative Affect Schedule-Negative Affect subscale (Watson et al., 1988),
- ⁵ Anxiety Sensitivity Index (Reiss et al., 1986),
- ⁶ Pain Anxiety Symptoms Scale (McCracken et al., 1992),
- ⁷ Last minute of challenge Subjective Units of Distress Scale (Wolpe, 1958),
- ⁸ Last minute of baseline Subjective Units of Distress Scale (Wolpe, 1958),
- ⁹ Last minute of challenge heart rate,
- ¹⁰ Last minute of baseline heart rate