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Examination of the stability of the anxiety sensitivity index across the menstrual cycle in trauma-exposed women with and without PTSD

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Abstract

Background and Objectives: Anxiety sensitivity (AS), as measured by the Anxiety Sensitivity Index (ASI), has consistently been studied as a trait-level predictor of a variety of emotional and physical health conditions, including premenstrual symptoms. The menstrual cycle influences symptom expression and stress reactivity among anxiety and stress-related disorders. However, research has yet to directly evaluate the stability of AS across the various phases of the menstrual cycle, particularly in clinical populations with high levels of AS and with documented menstrual cycle differences in symptoms such as women with posttraumatic stress disorder (PTSD).

Design and Methods: The current study examined whether AS fluctuates as a function of menstrual cycle phase among a community sample of trauma-exposed women ($N = 48$) with and without PTSD. Participants completed the ASI, including subscales assessing sensitivity to physical, cognitive, and social symptoms of anxiety, during early follicular and midluteal menstrual cycle phases.

Results: Results revealed that ASI scores remained relatively stable across the different phases of the menstrual cycle assessed; evidence for stability was particularly strong for the subscale assessing sensitivity to physical symptoms of anxiety.

Conclusion: This study provides additional support for the conceptualization of AS as a stable, trait-like, cognitive risk factor.

Keywords

Anxiety sensitivity; anxiety sensitivity index; menstrual cycle; posttraumatic stress disorder

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Anxiety sensitivity (AS), the fear of anxiety-related symptoms and the consequences of these symptoms (Reiss, Peterson, Gursky, & McNally, 1986), has been conceptualized as a stable, trait-like, cognitive risk factor associated with a range of psychological and medical disorders, including posttraumatic stress disorder (PTSD; Elwood, Mott, Williams, Lohr, & Schroeder, 2009; Olatunji & Wolitzky-Taylor, 2009). Although AS has been conceptualized as a stable predictor of mental and physical health outcomes, research suggests that AS is malleable in response to cognitive-behavioral therapy (Gutner, Nillni, Suvak, Wiltsey-Stirman, & Resick, 2013).

Given that AS can change in response to treatment, it is possible that there may also be transient variations in AS. For example, cyclical changes in physiological sensations, such as those changes associated with the menstrual cycle, may influence the report of AS. Such knowledge is critical to contextualizing past findings of AS, particularly as it relates to the notion that AS functions as a stable trait-level predictor. A small, albeit growing, body of literature has begun to examine the role of AS in relation to the experience of premenstrual symptoms. Specifically, women who score high on AS report more premenstrual symptoms as compared to women who score low or medium on AS (e.g., Sigmon, Dorhofer, Rohan, & Boulard, 2000). However, prospective studies examining the impact of AS on menstrual-related symptoms across different menstrual cycle phases have yet to demonstrate a significant interaction between AS and menstrual cycle phase (Nillni, Rohan, Mahon, Pineles, & Zvolensky, 2013), suggesting that high AS impacts increased reporting of menstrual-related symptoms, regardless of current menstrual cycle phase. Notably, this work was developed under the assumption that AS is *not* influenced by the menstrual cycle, and is guided by the theory that high AS individuals may be more likely to notice naturally occurring menstrual cycle-related bodily changes and catastrophize about their meaning, thereby increasing the intensity of these symptoms.

A competing hypothesis is that AS is state-dependent (Schmidt, Lerew, & Joiner, 2000), with levels of AS fluctuating due to contextual factors such as physiological and psychological changes that occur in the context of the menstrual cycle. Menstrual cycle-related changes in affect, including anxiety, are well documented. Specifically, for some women, exacerbation of symptoms is reported in the late luteal (i.e., premenstrual) and early follicular cycle phases, when estradiol and progesterone are declining or low, as compared to other menstrual cycle phases, such as the late follicular phase, when estradiol is rising and progesterone is low and stable (Halbreich, Borenstein, Pearlstein, & Kahn, 2003; Hendrick, Altshuler, & Burt, 1996). Women with PTSD are more likely to experience elevated levels of AS (Elwood et al., 2009), and premenstrual dysphoric disorder (Wittchen, Perkonig, & Pfister, 2003), a disorder characterized by significant menstrual cycle related fluctuations in psychological symptoms. They are also more likely to experience menstrual cycle phase differences in extinction learning and PTSD symptoms (Garcia, Walker, & Zoellner, 2018). For example, women with PTSD report increased phobic anxiety during the early follicular phase as compared to their mid-luteal phase (Nillni et al., 2015). Consistent with this perspective, it may be that experiencing heightened physical and emotional symptoms throughout the menstrual cycle uniquely contribute to increased levels of AS. Therefore, in order to strengthen our confidence in the conceptualization of AS as a stable risk factor

involved with the experience of menstrual cycle related increases in symptoms, further scientific study is needed to examine the stability of AS in the context of the menstrual cycle.

The aim of this investigation was to examine whether AS, as measured by the Anxiety Sensitivity Index (ASI), fluctuates as a function of menstrual cycle phase among women with PTSD and trauma-exposed women without psychopathology. The ASI has demonstrated acceptable test-retest reliability, validity, and good internal reliability in psychometric studies (Peterson & Heilbrunner, 1987; Reiss et al., 1986). Examining change in AS across the menstrual cycle among both healthy women without psychopathology (but controlling for trauma exposure) and women with PTSD allows us to examine how the menstrual cycle may impact report of AS among women with varying levels of AS. Additionally, the current study compared AS within two relevant menstrual cycle phases that have been shown to be associated with differences in symptom expression among women with PTSD (Nillni et al., 2015); the early follicular phase – a time when estradiol and progesterone levels are relatively low and the mid-luteal phase – a time when estradiol and progesterone levels are relatively high. AS is composed of a single, higher-order general factor and three lower-order factors (i.e., fear of physical symptoms, cognitive dyscontrol, and socially observable symptoms; Zinbarg, Barlow, & Brown, 1997). Because these dimensions may be differentially influenced by menstrual cycle phase, we examined the total score as well as the three sub-scale scores in order to comprehensively evaluate AS across cycle phases. As this is the first examination of the stability of AS across the menstrual cycle, it was difficult to make specific hypotheses. Because anxiety symptoms are influenced by menstrual cycle phase, particularly among individuals with PTSD and other anxiety disorders, it is possible that fear of these sensations may also fluctuate (Schmidt et al., 2000). Alternatively, in line with past psychometric studies documenting the stable, trait-like nature of AS, menstrual cycle phase may not influence an individual's ability to report on how they generally respond to anxiety-related sensations (Reiss & Haverkamp, 1996).

Method

Participants

This study included 48 trauma-exposed women with and without PTSD ($M_{\text{age}} = 32.27$ years, $SD = 9.41$, range = 19–49) who were recruited from the community for a larger investigation examining neurobiological and psychophysiological factors across the menstrual cycle. Women with PTSD reported at least one re-experiencing symptom, three avoidance symptoms, two hyperarousal symptoms, and had a total score (frequency plus intensity) 40 on the Clinician Administered PTSD Scale for DSM-IV (CAPS; Blake et al., 1995). Participants in the trauma control group experienced a lifetime Criterion A traumatic event, but did not meet criteria for lifetime or current (past month) PTSD based on above criteria. Current Axis I disorders (with the exception of specific and public speaking phobia) and history of lifetime recurrent major depression were additional exclusion criteria for participants in the trauma control group. Exclusion criteria for the larger study also included: infectious illness, organic brain disorder, major neurological problems, endocrine disorders, psychotic disorders, bipolar I disorder, current substance abuse or dependence, irregular

menstrual cycle, participation in active-trauma focused psychotherapy, and use of psychotropic medications or hormonal contraceptives.

The majority of the sample identified as Caucasian (29.2%) or African American (43.8%). Participants were relatively well-educated (83.3% had completed at least some college) and most were single (79.2%). Within the PTSD group, 63% ($n = 15$) and 42% ($n = 10$) met criteria for at least one comorbid anxiety or depressive disorder, respectively. Within the trauma control group, 4% ($n = 1$) met criteria for specific or public speaking phobia.

Measures and procedure

This study was approved by the VA Boston Healthcare System IRB. Individuals, who responded to study advertisements and passed a telephone pre-screen, were scheduled for an in-person study session. Study inclusion and exclusion criteria were assessed during two initial screening sessions, and informed consent was obtained in person at the beginning of the first screening session. A total of 168 women attended the screening sessions. Of these, 106 were determined ineligible or were lost to follow-up prior to completing either of the menstrual cycle phase visits. Of the 62 women enrolled in the larger study, 48 were included in the current analysis because they had completed AS measures at both menstrual cycle phases. PTSD was assessed with the CAPS and other Axis I diagnoses were assessed with the Structured Clinical Interview for DSM-IV Axis I Disorders (First, Spitzer, Gibbon, & Williams, 2007). Participants who qualified for the study later completed the ASI (Reiss et al., 1986) during two study visits. The ASI is a 16-item self-report measure that assesses fear of symptoms related to anxious arousal and provides a total score as well as subscale scores for: physical concerns (e.g., rapid heartbeat), cognitive concerns (e.g., inability to concentrate), and social concerns (e.g., fearing publicly observable anxiety symptoms; Reiss et al., 1986; Zinbarg, Mohlman, & Hong, 1999). Prior research has demonstrated acceptable test-retest reliability (ranging from .71 to .75) and validity (Reiss et al., 1986), and good internal reliability ($\alpha = .88$; Peterson & Heilbronner, 1987). Reliability of the total symptom scale from the ASI in the current sample was excellent in both the early follicular ($\alpha = .93$) and mid luteal cycle phases ($\alpha = .94$). Reliability of the three subscales ranged from fair to excellent (physical concerns: follicular $\alpha = .88$ and luteal $\alpha = .90$; cognitive concerns: follicular $\alpha = .88$ and luteal $\alpha = .86$; social concerns: follicular $\alpha = .64$ and luteal $\alpha = .74$).

Women were randomly assigned to first complete the ASI during either their early follicular phase (1–5 days after start of menses) or mid-luteal phase (6–10 after detection of the lutenizing hormone [LH] surge). These menstrual cycle phases were chosen to maximize differences in progesterone and estradiol levels. To schedule sessions during the early follicular phase, participants notified study staff when they began menstruating and were subsequently scheduled 1–5 days after the start of their period. To schedule sessions during the mid-luteal phase, participants used a home testing kit each morning to test for their LH surge starting 5 days after menstruation. Sessions were scheduled 6–10 days after detection of their LH surge. Plasma was available to confirm menstrual cycle phases via estradiol and progesterone assays (procedures described fully in Nillni et al., 2015). Plasma levels of estradiol and progesterone were 26.62 pg/ml (SD = 13.64) and 0.59 ng/ml (SD = 0.78) in the early follicular phase respectively, and 76.86 pg/ml (SD = 26.80) and 12.47 ng/ml (SD =

6.19) in the midluteal phase respectively. As expected, estradiol ($t = -9.820$, $p < .001$) and progesterone ($t = -10.22$, $p < .001$) levels significantly differed between phases. However, women with and without PTSD did not significantly differ on hormone levels within each phase ($p > .05$).

Results

Initially, a series of 2×2 repeated measures ANOVAs were conducted using SPSS 25 to examine the impact of group assignment (PTSD group vs. trauma control group) and cycle phase (early follicular vs. mid-luteal cycle) on the endorsement of AS (see Table 1). Consistent with previous research, analyses revealed significant main effects for PTSD on ASI total scores, as well as on the physical, cognitive, and social concerns subscale scores (p 's $< .01$); women in the PTSD group consistently reported higher AS levels as compared to women in the trauma control group. There were no significant main effects for menstrual cycle phase or interaction effects between PTSD group and menstrual cycle phase.

To further examine the stability of AS across the menstrual cycle, 2×2 Bayesian repeated measures ANOVAs were conducted using JASP 0.9.1.0 (JASP Team, 2018). Examining Bayes factors is superior to traditional null hypothesis significance testing when researchers are interested in determining if evidence favors the null hypothesis (i.e., no difference between menstrual cycle phases) or the alternative hypothesis (i.e., differences between menstrual cycle phases; Jarosz & Wiley, 2014). Results of these additional analyses, as well as guidelines for their interpretation, are presented in Table 2. Consistent with the analyses above, strong to decisive support was found in favor of women with PTSD reporting higher scores for the ASI total score and each of the three subscale scores as compared to women without PTSD. Bayes factors associated with the main effects of phase indicated substantial (physical and social concerns subscales) or anecdotal support for the null (ASI total score and cognitive concerns subscale), indicating that ASI scores remained stable across menstrual cycle phases. Bayes factors associated with the Group $\times$ Phase interaction effects indicated substantial support for the null for the interaction effect involving the physical concerns subscale. Anecdotal support for the null was found for interaction effects involving the ASI total score and the cognitive and social concerns subscales, though it should be noted that the Bayes factor for the ASI total score (.36) was just shy of meeting the .33 guideline for strong support (Jarosz & Wiley, 2014). Again, these results indicate that for women with and without PTSD, ASI scores remained stable across their menstrual cycles.

A secondary analysis was conducted to examine the impact of estradiol and progesterone levels on ASI scores within each cycle phase, as well as the association between change in hormone levels and change in ASI between phases. There were no significant associations between hormone levels and ASI total and subscale scores within each menstrual cycle phase (r range: 0.030–0.222, $ps > .05$), and no significant association in hormone level change and ASI change between menstrual cycle phases (r range: 0.023 – 0.222, $ps > .05$).

Discussion

To our knowledge, this is the first study to examine the stability of AS across the menstrual cycle in trauma-exposed women with and without PTSD. Consistent with previous research (Elwood et al., 2009), results provided compelling support for greater AS among women with vs. without PTSD. Results from the present investigation also suggest that AS, as measured by the ASI, is not sensitive to fluctuations based on menstrual cycle phase or absolute hormone level. Evidence was particularly strong for stability of the physical concerns subscale of the ASI. While physical symptoms and reactivity to bodily sensations may change in the context of menstrual cycle phase (Nillni, Rohan, & Zvolensky, 2012), one's report on their overall interpretation of the meaning and consequences of these sensations, as measured by the ASI, are not impacted by menstrual cycle phase. Furthermore, absolute estradiol and progesterone levels, as well as amount of change in hormone levels between the early follicular and mid-luteal cycle phases were not associated with ASI scores. These findings are generally consistent with previous work suggesting that AS is a stable, trait-like, cognitive risk factor (Reiss & Havercamp, 1996).

Several study limitations warrant further consideration. First, women were only examined in the early follicular and mid-luteal cycle phases. Given the distinct hormonal variations across the menstrual cycle, future research would benefit from examination of AS across all menstrual cycle phases, particularly the late luteal phase when naturally occurring physiological symptoms occur for a majority of women (Halbreich et al., 2003). For example, previous work has found that women with panic disorder, which is a population with high levels of AS, prospectively reported more anxiety and panic symptoms in the premenstrual phase as compared to other menstrual cycle phases (Haigh, Craner, Sigmon, Yoon, & Thorpe, 2018). The current study, therefore, presents the first step in understanding how AS may fluctuate as a function of menstrual cycle phase. Specifically, the current study suggests that changes in AS are not sensitive to periods of times when hormones are low or high. Future research is needed to determine if ASI is also stable during times when hormones are changing (e.g., during the late luteal phase). Second, the original 16-item ASI was employed in the current investigation. Since the development of this study, newer versions of the ASI (ASI-3; Taylor et al., 2007) have been created to improve on the psychometric properties of the original ASI. The largest criticism of the original ASI has been related to its multidimensional factors because the majority of items in the original ASI load onto the physical concerns subscale, creating an imbalance with the number of items in the other two scales (cognitive and social concerns). Both the ASI and ASI-3 utilize the same response scale (i.e., 0 = "*very little*" to 4 = "*very much*"), many of the exactly worded items or similarly worded items, and assess the same three factors (i.e., physical, cognitive, and social concerns). However, the ASI-3 aimed to improve the multidimensional nature of the measure by equally including items tapping all three factors. Therefore, future research would benefit from replication of these findings using the ASI-3, particularly when examining the subscales. Third, this study excluded women with substance use disorder (SUD). Given the high comorbidity between PTSD and SUD (Pietrzak, Goldstein, Southwick, & Grant, 2011), excluding these individuals may impact the generalizability of our findings. Finally, although we used a repeated measures design, this study was

comprised of a small sample size ($N = 48$), which could have limited our power and increased our likelihood of type II error. It should be noted that supplemental Bayesian ANOVAs confirmed results obtained from traditional ANOVAs. However, in several instances evidence supporting AS stability could only be classified as anecdotal. For both reasons, replication of these findings in a larger sample is important.

Despite its limitations, there are several noteworthy implications for women with and without PTSD related to the current findings. First, research examining AS-menstrual cycle relations has operationalized AS as a stable predictor when interpreting the results. However, to date, no previous study within this domain of inquiry has directly tested the stability of AS across menstrual cycle phases. Thus, our findings provide initial empirical support for the continued use of the ASI as a trait-level predictor in terms of understanding variations of reactivity across the menstrual cycle as well as a predictor of menstrual-related distress. Second, given that our results support the relative stability of AS across distinct hormonal states that differ in regard to characteristic physical symptoms and emotions, it is possible that such findings may generalize to other state conditions that influence the degree of physiological sensations. For example, it is possible that report of anxiety-related fear may also be stable even as individuals experience fluctuations in stress and chronic pain (both common in PTSD sample, López-Martínez, Ramirez-Maestre, & Esteve, 2014). However, future research is needed to test this hypothesis.

In sum, the early follicular and mid-luteal menstrual cycle phases, when estradiol and progesterone are low or high, does not impact self-report of anxiety sensitivity, as measured by the ASI, in each cycle phase. Furthermore, this finding held true both for women with PTSD, a group with higher levels of AS, and for healthy women. This provides initial support for the use of the ASI as a trait-level predictor that may be less impacted by menstrual-cycle related changes among women with varying levels of AS.

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Table 1.

Main effects and interactions for PTSD group and menstrual cycle phase for predicting ASI scores.

	Early Follicular		Mid-luteal		Effect size ^a		
	PTSD <i>n</i> = 24	No PTSD <i>n</i> = 24	PTSD <i>n</i> = 24	No PTSD <i>n</i> = 24	Group	Phase	Group × Phase
ASI	M (SD)	M (SD)	M (SD)	M (SD)			
Total Score	23.33 (13.81)	9.34 (7.21)	21.27 (14.06)	8.86 (6.95)	0.29 ^{**}	0.04	0.02
Physical concerns	11.17 (7.16)	3.75 (3.93)	10.63 (7.43)	3.61 (3.91)	0.31 ^{**}	0.008	0.003
Cognitive concerns	4.63 (4.13)	0.83 (1.17)	3.79 (3.80)	0.67 (1.20)	0.29 ^{**}	0.06	0.03
Social concerns	5.96 (2.80)	3.42 (2.50)	5.25 (3.03)	3.54 (2.75)	0.15 ^{**}	0.02	0.04

Note: ASI = Anxiety Sensitivity Index.

^aPartial eta square.^{**}
p < .01.

Table 2.

Bayes factors (BF_{10}) obtained for PTSD group, menstrual cycle phase, and their interaction.

ASI	Group	Phase	Group $\times$ Phase
Total Score	198.32	.46	.36
Physical concerns	270.98	.25	.32
Cognitive concerns	236.65	.73	.48
Social concerns	6.76	.33	.66

Note: BF_{10} values from 1–3, 3–10, 10–30, 30–100, to >100 provide anecdotal, substantial, strong, very strong, and decisive support for the alternative hypothesis; BF_{10} values from 1–.33, .33–.10, .10–.03, .03–.01, to $< .01$ provide anecdotal, substantial, strong, very strong, and decisive support for the null hypothesis (Jarosz & Wiley, 2014).