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Executive attention moderates the effect of trait anxiety on hyperarousal symptoms

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ABSTRACT
The majority of individuals exposed to trauma do not go on to develop posttraumatic stress disorder (PTSD); thus, researchers have sought to identify individual difference variables that make one particularly susceptible to posttraumatic stress symptoms. Trait anxiety is one individual difference variable implicated in the pathogenesis of posttraumatic stress symptoms. Following from cognitive theories of anxiety and extant data, the purpose of the present study was to examine executive attention as a moderator of the relation between trait anxiety and posttraumatic stress symptoms, particularly hyperarousal symptoms, among undergraduate women reporting trauma exposure (N = 88). As predicted, executive attention moderated the association between trait anxiety and hyperarousal symptoms, such that there was a significantly weaker relation as executive attention increased. Study results further support the potential buffering effect of executive attention in relation to posttraumatic stress symptoms, as well as the possible importance of targeting executive attention following trauma exposure.

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Over the lifespan, the likelihood of being exposed to a traumatic event is highest in late adolescence and young adulthood (Breslau et al., 1998). Rates of trauma exposure and posttraumatic stress following trauma exposure are particularly high among women college students (Frazier et al., 2009; Kumpula, Orcutt, Bardeen, & Varkovitzky, 2011). In fact, women are approximately twice as likely as men to develop posttraumatic stress disorder (PTSD) following trauma exposure (see Tolin & Foa, 2006, for a review). As such, there is a need to examine factors that make undergraduate women vulnerable to posttraumatic stress following trauma exposure to inform potential prevention and treatment efforts (Frazier et al., 2009).

Trait anxiety—the general inclination to respond fearfully to stimuli perceived as aversive or threatening (Spielberger, 1985)—is one vulnerability for posttraumatic stress. Those with relatively higher trait anxiety are more likely to experience posttraumatic stress following trauma exposure (Hensley & Varela, 2008; Kok et al., 2016; Weems et al., 2007), with women reporting higher levels of trait anxiety than men.
As such, it may be especially important to consider the role of trait anxiety in the development of posttraumatic stress among undergraduate women. Extending existing findings linking trait anxiety to posttraumatic stress, the purpose of the present study was to examine whether the effect of trait anxiety on posttraumatic stress symptom severity occurs synergistically with a potentiating variable known as executive attention among undergraduate women reporting trauma exposure.

Cognitive theories of anxiety (e.g. Eysenck, Derakshan, Santos, & Calvo, 2007; Hirsch & Mathews, 2012) point to the potential buffering role of executive attention on the relation between trait anxiety and posttraumatic stress. Executive attention is used to allocate attention toward goal-directed behavior in the face of concurrent attentional demands related to relatively automatic response tendencies (Sarapas, Weinberg, Langenecker, & Shankman, 2017). In the context of posttraumatic stress, relatively stronger executive attention prior to trauma exposure predicts lower posttraumatic stress symptom severity following trauma exposure (Bardeen, Fergus, & Orcutt, 2015). An explanation for these findings provided by Bardeen et al. (2015) is that executive attention serves as a buffer for symptom severity by facilitating the down-regulation of negative affective states. The down-regulation of negative affect may bolster one’s ability to remain in trauma-relevant contexts, thereby promoting emotional processing and habituation, and reducing the likelihood of developing PTSD.

Extending those findings, Bardeen and Fergus (2016) found that greater executive attention could serve as a buffer against developing posttraumatic stress symptomatology even among those who are particularly vulnerable for developing such pathology. More precisely, they found that self-reported executive attention moderated the association between individual difference factors broadly relevant to difficulty relating to uncomfortable internal experiences (i.e. emotional distress intolerance, experiential avoidance, and anxiety sensitivity) and posttraumatic stress symptom severity. The pattern of associations indicated that as executive attention increased, the strength of the relationship between each individual difference variable and symptom severity weakened.

Among the four symptoms clusters (i.e. intrusions, hyperarousal, avoidance, and negative alterations in cognition and mood; American Psychiatric Association, 2013), Bardeen and Fergus (2016) found that the moderating effect of executive attention was especially relevant to hyperarousal symptoms. Conceptually, executive attention may serve to down-regulate heightened autonomic and behavioral reactivity that are activated by trauma reminders even among those who are more likely to experience physiological arousal associated with the hyperarousal symptom cluster. Research indicates that hyperarousal symptoms are related to a more chronic course of posttraumatic stress and appear to have the greatest impact on PTSD recovery (Schell, Marshall, & Jaycox, 2004). Elucidating modifiable variables, such as executive attention (e.g. Badura-Brack et al., 2015), that attenuate the association between individual difference factors and hyperarousal symptoms could aid in identifying novel treatment efforts.

The purpose of the present study was to replicate and extend Bardeen and Fergus (2016) study findings in at least two ways. First, we examined whether the moderating effect of executive attention extends to trait anxiety, an individual difference factor that, as reviewed, is of particular relevance to posttraumatic stress symptom severity. Physiological arousal is a central component of anxiety (Endler & Kocovski, 2001) and the hyperarousal
symptom cluster is perhaps the domain of posttraumatic stress that most clearly captures this aspect of anxiety (American Psychiatric Association, 2013). Executive attention may thus buffer the impact of trait anxiety on hyperarousal symptom severity following trauma exposure. Such findings would further strengthen Bardeen et al.’s (2015) proposal that executive attention helps down-regulate the impact of negative affective states in relation to posttraumatic stress. A second extension offered through the present study relates to the assessment of executive attention, as Bardeen and Fergus used a self-report index of executive attention that seems best conceptualized as assessing self-perceptions of the ability to flexibly control attention rather than actual cognitive performance per se (Williams, Rau, Suchy, Thorgusen, & Smith, 2017). A performance-based measure of executive attention was used in the present study to address that limitation.

Study predictions were that executive attention would moderate the association between trait anxiety and hyperarousal symptoms, such that the inclination to respond fearfully to stimuli perceived as aversive or threatening would relate to hyperarousal symptom severity less strongly as executive attention increased. Predicted study findings would add to the growing body of literature suggesting that executive attention may buffer against posttraumatic stress symptoms, even among those who may be at a heightened risk for developing such symptoms. If so, interventions targeting deficits in executive attention might lead to greater self-regulatory control of attention and subsequent reductions in symptom severity. Such interventions also may be beneficial as prevention efforts among individuals with trauma exposure who are more vulnerable to developing PTSD. As reviewed, because of vulnerability to trauma exposure and resulting posttraumatic stress, undergraduate women are one group of individuals who could benefit from improvements to prevention and treatment efforts for PTSD (Frazier et al., 2009).

Method

Participants

As part of a larger study examining trauma exposure among undergraduate women, 88 undergraduate women were recruited from undergraduate psychology courses at a private Southern US university. The mean age of the sample was 19.4 years (SD = 3.3) and participants self-identified as White (60.2%), Latina (20.5%), Black (8.0%), multi-racial (8.0%), Asian (2.3%), or other (1.1%). The most commonly reported exposure to a traumatic event on the Life Events Checklist for the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5; American Psychiatric Association, 2013) developed by Weathers et al. (2013a) involved sexual trauma (39.8%). Other reported trauma exposures included severe human suffering (11.4%), sudden violent death (10.2%), sudden accidental death (6.8%), life-threatening illness or injury (5.7%), natural disaster (4.5%), transportation accident (4.5%), or physical assault (4.5%).

Measures and materials

PTSD Checklist for DSM-5 (PCL-5; Weathers et al., 2013b)
The PCL-5 is a 20-item self-report measure of posttraumatic stress symptoms and was created to reflect changes in PTSD symptom criteria in the DSM-5 (American
Psychiatric Association, 2013). The PCL-5 produces a total score, as well as a score for each of the four PTSD symptom clusters (i.e. intrusions, hyperarousal, avoidance, and negative alterations in cognition and mood). Participants are asked to consider a single stressful event when completing the measure and indicate how much they have been bothered by the event in the past month on a 5-point scale from 0 (not at all) to 4 (extremely). Higher scores reflect greater symptom severity. The PCL-5 scales demonstrated good internal consistency (Cronbach’s α: total = .93; intrusions = .86; hyperarousal = .82; avoidance = .90; negative alterations in cognition and mood = .84) in the present study.

State Trait Inventory for Cognitive and Somatic Anxiety (STICSA; Ree, French, Macleod, & Locke, 2008)
The STICSA is a 21-item measure of cognitive and somatic anxiety. To assess trait anxiety, participants rate the degree to which each item indicates how they “generally feel” on a 4-point scale from 1 (almost never) to 4 (almost always). The cognitive dimension includes items measuring symptoms related to thought processes (e.g. “I think the worst will happen”), whereas the somatic dimension includes items measuring physical symptoms (e.g. “My muscles feel weak”). Higher scores reflect greater trait anxiety. The STICSA demonstrated good internal consistency (α = .86) in the present study.

Attention Network Test (ANT; Fan, mccandliss, sommer, Raz, & Posner, 2002)
The ANT is a laboratory-based task designed to independently evaluate three attention networks (i.e. alerting, orienting, and executive attention) within a 30-min testing session. Fan et al. (2002) refer to alerting as achieving and maintaining an alert state; orienting as the selection of information from sensory input; and executive attention as resolving conflict among responses. Participants indicate the direction of a central arrow flanked by four arrows either pointing in the same (congruent condition) or opposite (incongruent condition) direction of the central arrow. In the neutral condition the central arrow is presented without flanker arrows. Preceding the arrows is the presentation of one of three temporally informative cues or no cue. Two of the cues indicate that the arrow will soon appear, and the third cue is spatially informative of the target location of the arrow. In the neutral condition the central arrow is presented without flanker arrows. Preceding the arrows is the presentation of one of three temporally informative cues or no cue. Two of the cues indicate that the arrow will soon appear, and the third cue is spatially informative of the target location of the arrow. In the neutral condition the central arrow is presented without flanker arrows. Preceding the arrows is the presentation of one of three temporally informative cues or no cue. Two of the cues indicate that the arrow will soon appear, and the third cue is spatially informative of the target location of the arrow. In the neutral condition the central arrow is presented without flanker arrows. Preceding the arrows is the presentation of one of three temporally informative cues or no cue. Two of the cues indicate that the arrow will soon appear, and the third cue is spatially informative of the target location of the arrow. After completing a 24-trial practice block that provides feedback regarding response speed and accuracy, participants complete three 96-trial blocks (288 total trials). The ANT provides a measure of response time (speed) for each of the three attention networks, with higher scores on the executive attention scale indicating poorer executive attention.

**Procedure**
The local institutional review board approved the research protocol for the present study. In exchange for partial course credit toward a research participation requirement, participants initially completed an online battery of the self-report measures assessing trait anxiety and posttraumatic stress symptom severity. Women who reported experiencing a traumatic event on the LEC-5 were eligible to participate in an in-person follow-up session. During the follow-up session, participants completed
the ANT. The average length of time between the self-report measure completion and ANT completion was 24 days ($SD = 17$).

**Data analytic strategy**

Zero-order correlations were used to examine bivariate associations among the study variables. Moderation analyses were completed using Hayes’s (2018) PROCESS macro, which included hierarchical multiple linear regression models that examined the moderating effect through an interaction term between trait anxiety and executive attention. The PROCESS macro includes a 95% confidence interval (CI) for the interaction term, which involves running the analyses with 1000 bootstrapped samples. A 95% CI not containing zero is indicative of a significant effect. Simple effects examined the association between trait anxiety and hyperarousal symptoms at low ($-1 SD$) and high ($+1 SD$) scores from the mean executive attention score (Hayes, 2018).

**Results**

Descriptive statistics and zero-order correlations among the study variables are presented in Table 1. Trait anxiety positively correlated with two of the posttraumatic stress symptom clusters (i.e. negative alterations in cognition and mood, hyperarousal). Trait anxiety positively correlated with deficits in executive attention. Deficits in executive attention did not correlate with any posttraumatic stress symptom cluster.

Regression results examining executive attention as a moderator of the association between trait anxiety and hyperarousal symptoms are presented in Table 2. Executive attention moderated the relationship between trait anxiety and hyperarousal symptoms [bootstrapped 95% CI = 0.001, 0.003] after controlling for the days between completion of the online self-report battery and the in-person follow-up session. The moderating effect of executive attention was not found in relation to any other symptom cluster (bootstrapped 95% CIs: intrusions: trait anxiety = −.001, .002; avoidance: trait anxiety = −.001, .001; negative alterations in cognition and mood: trait anxiety = <−.001, .003).

Simple effects depicting the moderating effect of executive attention in relation to trait anxiety and hyperarousal symptoms are presented in Figure 1. When there were relative executive attention deficits, trait anxiety and hyperarousal symptoms shared a positive association ($\beta = .32, p < .001$) that was significantly stronger than when there

| Table 1. Descriptive statistics and zero-order correlations. |
|-----------------|---------|---|---|---|---|---|---|
| Variable        | Mean    | SD | 1  | 2  | 3  | 4  | 5  | 6  |
| 1. STICA        | 39.93   | 9.00 | –  | –  | –  | –  | –  | –  |
| 2. PCL-5-Total  | 20.61   | 15.38 | .31** | –  | –  | –  | –  | –  |
| 3. PCL-5-Intrusion | 5.83 | 4.74 | .17 | .85** | –  | –  | –  | –  |
| 4. PCL-5-Avoidance | 3.31 | 2.59 | .14 | .78** | .71** | –  | –  | –  |
| 5. PCL-5-Cognition and Mood | 6.63 | 5.99 | .25* | .87** | .59** | .54** | –  | –  |
| 6. PCL-5-Hyperarousal | 4.85 | 4.73 | .45** | .87** | .62** | .59** | .69** | –  |

Notes. N = 88. ** $p < .01$, * $p < .05$ (two-tailed). STICA = State Trait Inventory for Cognitive and Somatic Anxiety; PCL-5 = PTSD Checklist for DSM-5; ANT = Attention Network Test.
was a relative strength in executive attention (β = .15, p = .017). The significant omnibus interactive effect indicates the slopes of those simple effects significantly differ (Aiken & West, 1991), suggesting the strength of relation between trait anxiety and hyperarousal is weaker as executive attention strengthens.

**Discussion**

There is a need to more fully understand associations between individual difference factors and posttraumatic stress among undergraduate women, as this group of individuals experiences heightened posttraumatic stress following trauma exposure (Frazier et al., 2009). The purpose of the present study was to extend prior findings of the potential buffering effects of executive attention in relation to posttraumatic symptom severity by examining whether executive attention moderated the relationship between trait anxiety and hyperarousal symptoms among undergraduate female survivors of trauma. Consistent with study hypotheses, executive attention moderated the association between trait anxiety and hyperarousal symptoms.
The findings from the present study were consistent with the results from Bardeen and Fergus (2016) in at least two ways. The present findings further suggest that executive attention weakens the association between relevant individual difference factors and posttraumatic symptom severity following trauma exposure. In addition, the moderating effect of executive attention was specific to the hyperarousal symptom cluster and was unrelated to the other three symptom clusters. An important extension was the use of a performance-based assessment of executive attention in the present study, which may provide a more objective measure of one’s cognitive performance than self-reported executive attention (Williams et al., 2017).

The observed pattern of findings may be explained, in part, by considering the relevance of the hyperarousal symptom cluster to trait anxiety. Indeed, physiological arousal is a central component of anxiety (Endler & Kocovski, 2001) and the hyperarousal symptom cluster is perhaps the domain of posttraumatic stress that most clearly captures this aspect of anxiety. For example, diagnostic criteria for hyperarousal symptoms include “feeling jumpy or easily startled” and “being superalert” or “watchful or on guard” (American Psychiatric Association, 2013). Lang and McTeague (2009) propose that physiological reactivity becomes increasingly pronounced as a readiness to respond defensively to threat increases. Trait anxiety represents the tendency to respond fearfully to stimuli perceived as aversive or threatening (Spielberger, 1985); thus, one may expect close ties between trait anxiety and hyperarousal symptoms.

Importantly, the association between trait anxiety and hyperarousal appears best understood by concurrently considering executive attention. For example, prefrontal regulatory processes, such as executive attention, serve to down-regulate heightened autonomic reactivity and behavioral responses that are activated in particular contexts (Nigg, 2006). Even among those with a high propensity to experience physiological arousal (i.e. those with heightened trait anxiety), strong top-down prefrontal control (i.e. executive attention) could lead to the down-regulation of hyperarousal symptoms. The ability to attenuate hyperarousal symptoms is important, as this symptom cluster has the strongest impact on PTSD recovery and is related to higher levels of symptom chronicity (Schell et al., 2004).

Taken together with Bardeen and Fergus’s (2016) findings, the present results further support the possibility that targeting executive attention could help reduce hyperarousal symptoms among individuals vulnerable to those symptoms. Some evidence suggests that training procedures designed to modify threat-related attention biases reduce posttraumatic symptom severity (e.g. Badura-Brack et al., 2015; Kuckertz et al., 2014). Although these studies underscore the clinical utility of attention modification programs in reducing PTSD symptoms, published findings do not yet speak to the extent to which such training programs impact specific symptom clusters. Given that the buffering effect of executive attention may be particularly relevant to hyperarousal symptoms, future studies could benefit from examining the differential effect of attention modification programs on each of the four PTSD symptom clusters.

Although prior research has examined the effects of attention modification programs concurrently among men and women, there is reason to believe that training programs designed to strengthen executive attention among women may be particularly important in buffering against posttraumatic stress. For example, the combination of heightened physiological reactivity and greater avoidant coping strategies in the aftermath of
Trauma is associated with greater PTSD symptom severity among women (Pineles et al., 2011). Strengthening executive attention may be one avenue to reduce avoidant coping strategies that interfere with emotional processing and thereby increase the likelihood for trauma recovery among women. The ability to implement attention-based interventions using technology may help address barriers to treatment-seeking (Teachman, 2014), including for college students where computer-delivered interventions may increase help-seeking behavior for anxiety (Davies, Morriss, & Glazebrook, 2014).

Trait anxiety is conceptualized as one facet of negative affectivity or neuroticism, which constitutes a broader construct encompassing additional facets related to the propensity to experience negative emotional states (Costa & McCrae, 2017; Watson & Clark, 1984). Whereas neuroticism is linked to greater posttraumatic stress (Kotov, Gamez, Schmidt, & Watson, 2010), there may be value in specifically examining trait anxiety in the context of posttraumatic stress (Kok et al., 2016). Nonetheless, the present study did not assess for negative affectivity or neuroticism. As such, it cannot be ruled out that the effect found is not specific to trait anxiety and, rather, is due to a broader propensity to experience negative emotional states.

The above discussion should be considered in light of additional study limitations. The present sample was limited to female undergraduate students, the majority of whom identified as White (≈ 60%). Prior research examining the buffering effect of executive attention in relation to posttraumatic stress has used predominantly female samples (e.g. Bardeen & Fergus, 2016; 67.5% female; Bardeen et al., 2015; 63.5% female); however, these studies did not control for sex in their analyses or examine sex as a moderator. Whereas the present results indicate that executive attention moderates the impact of trait anxiety on posttraumatic symptom severity among women, it remains unclear whether the buffering effect of executive attention is unique to women or if the effect holds across sex. It will be important for future research to utilize a more demographically diverse sample to examine that possibility.

Prior research supports the notion of conceptualizing posttraumatic stress symptoms along a continuum (Ruscio, Ruscio, & Keane, 2002), thus supporting the use of a sample with a range of symptom severity. Nevertheless, the present results require replication among a clinical population in order to generalize these findings to those with a diagnosis of PTSD. Moreover, the current study was limited by the use of a self-report measure to assess for posttraumatic symptom severity and did not assess for lifetime history of psychopathology. Prior research suggests that preexisting depression and anxiety disorders predict an increased risk for PTSD (Breslau, 2009); thus, future research would benefit from using a structured trauma interview and collecting relevant life history data to provide a fuller understanding of the index trauma and symptomatology.

A relative strength of the present research was the assessment of executive attention through use of a performance-based measure. There are a number of performance-based tasks used to assess executive attention (e.g. Miyake et al., 2000) and, thus, it is important to acknowledge the potential influence of task variation. Whereas the ANT has been previously used to assess executive attention in the context of posttraumatic stress (e.g. Leskin & White, 2007), task-specific idiosyncrasies may have influenced associations among the study variables. The present results suggest that the buffering effect of executive attention in relation to posttraumatic stress symptoms extends to a
performance-based index, but it is important to note that the moderation effect size was still only small in size. The magnitude of the effect suggests that, although a possibly important variable, executive attention is unlikely to be the only variable linking trait anxiety to posttraumatic stress. Extending the current cross-sectional study, the relative importance of executive attention would be strengthened via findings that the moderating effect of executive attention extends to influencing temporal relationships between trait anxiety and posttraumatic symptom severity in future longitudinal studies.

With these study limitations in mind, the present findings provide an important extension of prior research by demonstrating that the moderating effect of executive attention applies not only to the capacity to tolerate negative emotion, but also to the propensity to experience specific negative emotions linked to PTSD (in this case, anxiety). That is, strong executive attention weakens the association with hyperarousal symptoms among those who possess a general tendency to respond fearfully in stressful situations. To this end, the present findings underscore a potential clinical benefit of interventions aimed at enhancing executive attention in the acute aftermath of trauma exposure, as well as enhancing executive attention among those with relatively higher levels of posttraumatic stress symptoms. Further examination and understanding of the associations between the proneness toward negative emotions, posttraumatic stress symptoms, and executive attention may lead to the use of interventions designed to target executive attention in the treatment of PTSD.

**Disclosure statement**

No potential conflict of interest was reported by the authors.

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