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Neural Correlates of Trait Rumination During an Emotion Interference Task in Women with PTSD

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Abstract

Rumination, defined as repetitive, negative, self-focused thinking, is hypothesized to be a transdiagnostic factor that is associated with depression, anxiety, and posttraumatic stress disorder (PTSD). Theory has suggested that in individuals with PTSD, rumination serves as a cognitive avoidance factor that contributes to the maintenance of symptoms by inhibiting the cognitive and emotional processing of the traumatic event, subsequently interfering with treatment engagement and outcome. Little is known about the neural correlates of rumination in women with PTSD. The current study utilized functional magnetic resonance imaging (fMRI) to examine neural correlates, during an emotion interference task, of self-reported rumination in women with PTSD. Women with PTSD (39) were recruited through a university-based trauma clinic and completed a clinical evaluation that included measures of PTSD symptoms, rumination, and depressive symptoms, as well as a neuroimaging session in which the participants were administered an emotion interference task. There was a significant relationship between self-reported rumination and activity in the right orbital frontal cortex, BA 11; $t(37) = 5.62$, $p = .004$, $k = 46$ during the task. This finding suggests that women with PTSD who have higher levels of rumination, may experience greater difficulty inhibiting negative emotional stimuli as compared to women with lower levels of rumination.

Rumination, defined as repetitive, negatively valenced, self-referential thinking about the past, was originally thought to be uniquely associated with depression (Nolen-Hoeksema, 1991; Papageorgiou & Wells, 2003). More recent research, however, has suggested that it is a transdiagnostic factor (a mechanism that is associated with multiple mental health disorders) that spans mood, anxiety, and trauma-related disorders (Birrer & Michael, 2011; McLaughlin & Nolen-Hoeksema, 2011) possibly underlying comorbidities between these diagnoses. Research on rumination as a transdiagnostic factor has highlighted

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uncontrollable, repetitive thinking (McLaughlin & Nolen-Hoeksema, 2011; Olatunji, Naragon-Gainey, & Wolitzky-Taylor, 2013). Although rumination has often been differentiated from anxiety-related worry, defined as future oriented perseverative thinking, the two have been conceptually and empirically associated with each other through the common element of a repetitive thinking style that interferes with interpreting and processing information (Olatunji et al., 2013; Smith & Alloy, 2009). Specifically, rumination appears to inhibit the regulation of negative information. For example, healthy individuals who endorsed a high level of ruminative thinking had difficulty disengaging from negative stimuli (Vanderhasselt, Kühn, & De Raedt, 2011; Zetsche, D'Avanzato, & Joormann, 2012), demonstrating a connection between rumination and deficits in the inhibition of negative information.

In one study, posttraumatic stress disorder (PTSD) and rumination were found to have a positive relationship, and participants with PTSD had greater levels of rumination compared to participants without PTSD (Michael, Halligan, Clark, & Ehlers, 2007). Pretrauma rumination has been associated with the development of PTSD after trauma (Spinhoven, Penninx, Krempeniou, van Hemert, & Elzinga, 2015), and posttrauma rumination shortly after the experience of a traumatic event has been found to predict PTSD symptoms and severity in the future (Ehlers, Mayou, & Bryant, 1998; Ehling, Frank, & Ehlers, 2008; Kleim, Ehlers, & Glucksman, 2007), implicating rumination as a possible vulnerability factor for the development of PTSD (Bomyea, Risbrough, & Lang, 2012). Ehlers and Clark (2000) have incorporated rumination as an avoidant coping strategy in their Cognitive Model for PTSD. Within this model, rumination is described as a maladaptive cognitive strategy that disrupts the healthy processing of the traumatic memory and interferes with cognitive change through the repetition of negative trauma appraisals. Rumination focuses individuals' thinking on irrelevant negative information instead of the traumatic memory, preventing the individual from engaging in productive cognitive and emotional processing of the traumatic event (Echiverri, Jaeger, Chen, Moore, & Zoellner, 2011; Michael et al., 2007). This contributes to avoidance behaviors associated with PTSD and provides internal triggers that lead to intrusive memories of the traumatic event (Ehlers & Clark, 2000; Ehling et al., 2008).

We know of no functional magnetic resonance imaging (fMRI) research on the neural correlates of rumination in PTSD. Examining the neural correlates of ruminative thinking in individuals with PTSD through fMRI may identify possible neural mechanisms that contribute to difficulties in processing negative information due to habitual perseverative thinking and provide information regarding how rumination affects brain circuitry in PTSD. Given rumination is a transdiagnostic factor, it is likely that patterns of brain activation related to rumination in PTSD are similar to patterns observed in healthy individuals and people with depression. Generally, areas related to cognitive control such as the dorsolateral prefrontal cortex (dlPFC), medial prefrontal cortex (mPFC), and parts of the anterior cingulate cortex (ACC) have been identified as brain regions that underlie ruminative thinking (Cooney, Joormann, Eugène, Dennis, & Gotlib, 2010; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008).

One study (Kross, Davidson, Weber, & Ochsner, 2009) reported that healthy individuals engaged in ruminative thinking had increased activation in parts of the ACC and the mPFC when the rumination condition was contrasted with an acceptance condition. In another fMRI study, individuals who endorsed higher levels of rumination, as compared to those who reported less ruminative thinking, evidenced greater dlPFC activity during an emotional inhibition task, perhaps indicating that these individuals needed to recruit more resources to inhibit their responses to or disengage from negative stimuli (Vanderhasselt et al., 2011). Similarly, during a task related to cognitive control, activation of the posterior parts of the dorsal anterior cingulate cortex (pdACC) was positively associated with rumination scores in healthy individuals (Vanderhasselt et al., 2013).

The current study is the first of which we are aware to use fMRI to examine the neural correlates of rumination in PTSD. Since women are more likely than men to engage in rumination (Nolen-Hoeksema, 2012), the sample contained only women. The aim was to examine the neural correlates of self-reported rumination in women with PTSD during an emotion interference task (see Bruce et al., 2012; Fales et al., 2008). The goal was to show that rumination had a similar pattern of brain activation in PTSD as it does in people with depression and healthy individuals. Therefore, it was hypothesized that women with PTSD who reported relatively higher levels of rumination compared to other members of the sample would have greater activation in the vmPFC and ACC during a task in which participants ignored images of fearful faces to attend to images of houses. Second, during the same task, it was hypothesized that a positive relationship between reported rumination and the dlPFC would exist based on prior research finding greater dlPFC activation during disengagement from negative stimuli in individuals who reported more rumination (Vanderhasselt et al., 2011).

Methods

Participants and Procedure

Institutional Review Boards of the University of Missouri-St. Louis and Washington University Medical Center approved the current study, and all participants were consented by research staff prior to entering the study. Recruitment took place at the University of Missouri-St. Louis Center for Trauma Recovery and Washington University Medical Center. All participants in the current study were recruited for a larger neuroimaging treatment study. Study advertisements were posted in regional newspapers, websites, and local businesses. Potential participants who contacted the study completed an initial phone screen, and individuals not excluded by the screen completed an in-person assessment to determine eligibility and gather clinical data. Inclusion criteria required fluency in English and the capacity to understand and participate in informed consent procedures. Exclusion criteria included current use of psychotropic medication, previous trauma focused therapy, male gender, current drug or alcohol dependence, history of any psychotic disorder or bipolar disorder, history of head trauma, active suicidal or homicidal ideation, and MRI contraindications such as metallic implants, implanted medical devices, pregnancy, claustrophobia, and ferromagnetic foreign bodies.

Participants included 39 right-handed women (53.8% Caucasian, 30.8% African American, 2.6% Hispanic, 5.1% other, and 7.7% unreported) between the ages of 18 to 55 years ($M = 31.33$ years, $SD = 9.38$ years). The sample had an average of 15.37 years of education ($SD = 2.30$ years). All participants had a primary diagnosis of current PTSD, meeting full symptom criteria for the past month as assessed by the Clinician Administered PTSD Scale (CAPS; Blake et al., 1995) with an interpersonal traumatic event as the target trauma (43.6% physical abuse/assault, 7.7% assault with a weapon, 48.7% sexual abuse/assault). Age at the time of the target trauma ranged from 5–47 years old. The majority of participants had childhood abuse (74.4%) and chronic trauma (76.9%).

Current comorbid psychological disorders, assessed by the Structured Clinical Interview for the DSM-IV (SCID-IV; First, Spitzer, Gibbon, & Williams, 2002), included major depressive disorder ($n = 13$), dysthymia ($n = 2$), panic disorder ($n = 4$), agoraphobia without panic ($n = 2$), social phobia ($n = 6$), specific phobia ($n = 9$), obsessive compulsive disorder ($n = 2$), and generalized anxiety disorder ($n = 4$). Additionally, participants had a history of problematic alcohol use ($n = 9$ met for past dependence, $n = 5$ for past abuse), cannabis use ($n = 3$ met for past dependence, $n = 5$ for past abuse), cocaine use ($n = 3$ met for past dependence, $n = 3$ for past abuse), opioid use ($n = 1$ met for past dependence, $n = 3$ for past abuse) and other substances such as stimulants, hallucinogens, and sedatives ($n = 1$ for past dependence, $n = 4$ for past abuse). One participant had current cannabis abuse, and one other participant had current opioid abuse.

First through fifth-year doctoral students trained to administer the CAPS and SCID diagnosed PTSD based on DSM-IV-TR criteria. Only participants with a CAPS score of 45 or higher (Weathers, Ruscio, & Keane, 1999) in addition to meeting all symptom criteria assessed for the past month were included in the analysis. All eligible participants completed the fMRI session within a month of the initial assessment. Medical center research staff trained in collecting MRI data conducted the scanning sessions and provided participants with instruction for the tasks. Participants were compensated for the fMRI scan and free trauma-focused therapy was provided to participants after the completion of the scan as part of the larger study.

Measures

Rumination was measured by the Ruminative Thought Style Questionnaire (RTS; Brinker & Dozois, 2009). The RTS is a 20-item, single factor, self-report measure that assesses a global style of ruminative thinking. The measure examines rumination independent of emotional valence and temporal focus. Items include statements such as, “I find that my mind often goes over things again and again” and “when I am trying to work out a problem,” “it is like I have a long debate in my mind where I keep going over different points.” Participants rated the degree to which each item described their thinking style on a Likert scale ranging from 1 = *Not at all* to 7 = *Very well*. The psychometric properties of the RTS are good with α ranging from .87 to .94 (current study $\alpha = .93$), test-retest reliability of $r = .80$, and convergent validity with other rumination measures (Response Style Questionnaire $r = .40$ and Global Rumination Scale $r = .60$; Brinker & Dozois, 2009; Claycomb, Wang, Sharp, Ractliffe, & Elhai, 2015). The RTS has been used in college students ($M = 88.00$, $SD =$

16.17 and $M = 89.00$, $SD = 17.72$; Brinker & Dozois, 2009), an adult trauma-exposed sample ($M = 74.53$, $SD = 33.49$; Roley et al., 2015), and a primary care sample ($M = 77.59$, $SD = 25.46$; Claycomb et al., 2015). Scores range from 0 to 120. Both the trauma exposed and primary care samples included individuals with and without PTSD and depression.

The CAPS (Blake et al., 1995) is a semi-structured, clinician-administered interview for the assessment of PTSD (Weathers, Keane, & Davidson, 2001). It has 25-items that assess frequency and intensity of posttraumatic stress symptoms based on DSM-IV-TR criteria for the last 30 days. Each item contains separate 5-point frequency and intensity rating scales (0–4). A score of zero on the frequency scale indicates an absence of the symptom and a rating of four is assigned when the interviewee reports experiencing the symptom on a daily basis. The intensity scale ranges from 0 = *no distress or discomfort* to 4 = *severe distress or discomfort*. The CAPS has good psychometric properties with α ranging from .64 to .88 (current study $\alpha = .82$) and two to three day test-retest reliability of .86 to .95 (Weathers et al., 2001). Clinical significance of individual symptoms was determined by a rating of at least 1 on frequency and at least 2 on intensity (Weathers et al., 1999).

The Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996) is a 21-item self-report questionnaire designed to assess symptoms related to depression based on the DSM-IV-TR criteria over the past two weeks. Participants rate items on a 4-point severity scale ranging from zero to three. Total scores equal the summed item ratings; scores can range from 0 to 63. Psychometrics are good with α of .91 (current study $\alpha = .89$) and a test-retest reliability of .93 (Beck, Steer, Ball, & Ranieri, 1996; Beck et al., 1996).

The Structured Clinical Interview for DSM-IV (SCID; First et al., 2002) is a semi-structured, diagnostic interview based on criteria from the DSM-IV-TR. At the initial assessment trained graduate research assistants administered SCID modules to assess for current and lifetime Axis I disorders including: Mood, Psychotic, Anxiety, Somatoform, and Eating Disorders.

The emotion interference task has been described in detail elsewhere (see Bruce et al., 2012; Fales et al., 2008). PsyScope (Cohen, MacWhinney, Flatt, & Provost, 1993) was used to present stimuli, and a fiber-optic, light-sensitive key press interfaced with the PsyScope Button box was used to record participants' behavioral performance. Stimuli comprised displays of four pictures, two faces and two houses, arranged in vertical and horizontal pairs (Figure 1). Twenty images of faces (10 fearful and 10 neutral) and 20 houses, all unfamiliar to the subjects, were presented on a grey background. The emotion interference task stimuli were projected on a screen behind the imaging chamber, and a mirror placed on the head coil enabled participants to see the images.

The event-related task included four blocks of 52 trials each counterbalanced. Each block contained 13 trials from four conditions, attend fear, ignore fear, attend neutral, and ignore neutral. Before each block, participants were instructed to attend to either the vertical or horizontal pair of images. Trials started with a fixation cross displayed for 1000ms followed by the presentation of the four images for 250ms. Participants then indicated whether the

images of the cued pair matched by pressing one of two buttons on the button box. Inter-trial intervals varied randomly between 2150, 4660, 7170, 9680, and 12,190ms.

Utilizing the emotion regulation task, Fales and colleagues (2008) found that healthy controls and individuals with depression had increased left amygdala activation in response to different contrasts: attend fear vs. attend neutral (AF>AN) and ignore fear vs. ignore neutral (IF>IN) respectively. Further, healthy controls evidenced increased dorsolateral prefrontal cortex activation in the IF>IN contrast. In another study, Bruce and colleagues (2012) reported that individuals with PTSD demonstrated higher left insula activation in the AF>IF condition, and controls demonstrated decreased activation in the left insula in the same contrast.

A Siemens 3T TrioTim MRI scanner (Siemens, Erlangen, Germany) was used to collect imaging data. Scanning sessions included acquisition of localizer images, a high-resolution structural image (magnetization prepared rapid gradient echo [MPRAGE]), and functional images from resting state and emotion interference tasks. Structural images were collected with $1 \times 1 \times 1$ resolution using a sagittal three-dimensional (3-D) T1-weighted sequence with repetition time (TR) of 2.4 s, time-to-echo (TE) of 3.16 ms, flip angle = 8° , and inversion time (TI) of 1000 ms. Functional images were acquired in runs using an asymmetric spin-echo echo-planar sequence: volume TR = 2.2 s (slice TR = 64.10 ms), TE = 27 ms, flip angle = 90° degrees, and field of view (FOV) of 256 cm. A single acquisition was composed of 36 transverse slices, 4 mm thick (no gap), and an in-plane resolution of 4×4 mm. Each functional run started with three volume images followed by 180 acquisitions for the paradigm.

Data Analysis

Statistics for demographic and clinical measure data were generated using IBM SPSS Statistics 22. Preliminary data screening for univariate normality and outliers was conducted on the clinical data, and there were no missing data. Preparation of functional images for data analysis was conducted using Statistical Parametric Mapping software, version 12 Beta (SPM12; Wellcome Department of Cognitive Neurology, London, UK). Head motion was adjusted for by aligning images to a subject-specific mean fMRI image. To account for interslice temporal differences, images were slice time corrected. Coregistration of structural and functional images was conducted, and the coregistered structural images were segmented using the New Segment tool for SPM12 (Ashburner & Friston, 2005). Normalization of MRI data to Montreal Neurological Institute space was conducted utilizing deformation fields. An 8mm full width at half maximum (FWHM) Gaussian kernel was used to filter normalized images. For further quality control, the Artifact Detection Tool (ART; Whitfield-Gabrieli, 2011) software package was used to identify signal and movement outliers and then entered into each subject's first-level general linear model (GLM) as regressors of no interest.

For first-level analyses, an event-related design using a canonical hemodynamic response function was used to model activation during each condition of the emotion interference task (attend fear, attend neutral, ignore fear, ignore neutral). The SPM12 default high pass-filter cutoff of 128 seconds was used to account for slow signal drift and serial correlations were

corrected with an autoregressive AR(1) model. To isolate the effects of inhibition of fearful stimuli, three contrasts were created at the subject level; first, the ignore fear condition contrasted with the ignore neutral condition (IF>IN), second, the attend fear condition contrasted with the attend neutral condition (AF>AN) and third, the ignore fear condition contrasted with the attend fear condition (IF>AF). Two separate regions of interest (ROI) masks were created to test the two hypotheses using the Wake Forest PickAtlas toolbox (Maldjian, Laurienti, Kraft, & Burdette, 2003). Anatomically defined regions based on automated anatomical labeling (aal; Tzourio-Mazoyer et al., 2002) in the Wake Forest PickAtlas toolbox were used to construct the masks. The dlPFC mask included the left and right middle frontal cortices. The vmPFC and ACC mask included bilateral regions of the superior and middle orbital frontal and anterior cingulate cortices.

Second-level analyses were conducted using SPM, version 8. Two separate multiple regressions were conducted for the two ROI masks to examine their relationship with RTS scores for each contrast. The models were repeated adjusting for chronic trauma versus single incident, posttraumatic stress symptoms (CAPS scores), and depressive symptoms (BDI-II scores). Reported findings were significant at a threshold of $p < .05$ corrected for family wise error (FWE) after small volume corrections utilizing the ROI masks.

Whole brain analysis was also conducted in SPM8 using the IF>IN, AF>AN, and IF>AF contrasts. A multiple regression with pretreatment RTS scores and activation across the whole brain was conducted. To adjust for trauma chronicity, posttraumatic stress symptoms, and depressive symptoms, a second regression was run with trauma chronicity, CAPS, and BDI-II scores entered as other variables in the model. For the whole brain analysis, a significance threshold of $p < .05$ corrected for family-wise error was utilized.

Results

The mean RTS score was 101.33 ($SD = 24.36$), indicating a high level of rumination in the sample. The mean CAPS score was 73.05 ($SD = 15.89$), and the mean BDI-II score was 25.97 ($SD = 10.65$). RTS was related to the CAPS ($r = .41$, $p = .009$) and the BDI-II ($r = .47$, $p = .003$). The CAPS and BDI-II were also correlated ($r = .64$, $p < .001$).

The IF>IN and AF>AN contrasts did not yield any significant results with or without adjustment for either ROI mask or in the whole brain analysis. A summary of significant results for the IF>AF contrast is presented in Table 1 for both ROI masks. No positive relationships were found between RTS scores and activation in the ACC for the IF>AF contrast. A single significant positive relationship was observed between RTS scores and activation in the right inferior orbital frontal cortex, which survived FWE correction, BA 11; $t(37) = 5.62$, $p_{FWEcorr} = .004$, $k = 46$; Figure 2. This region remained significant, $t(34) = 5.32$, $p_{FWEcorr} = .012$, $k = 50$ in the adjusted models. No negative relationships were found between RTS scores and activation for the IF>AF contrast in any of the two ROI masks with or without adjustments.

For the whole brain analysis, a significance threshold of $p < .05$ corrected for family-wise error was utilized to control for type I error since the analysis was exploratory. RTS scores

predicted activation in the right inferior orbital frontal cortex, BA 11; peak coordinates 38, 40, -14, $t(37) = 5.62$, $p_{FWE} = .044$ in the IF>AF contrast. When the covariates were entered into the model, the finding was no longer significant.

Discussion

Our findings partially supported our hypothesis that individuals with PTSD who had relatively higher levels of rumination compared to the rest of the sample would have greater recruitment of brain regions related to cognitive control over emotions while ignoring images of fearful faces. The analysis of the IF>AF contrast found a positive relationship between the right inferior orbital frontal cortex (OFC; BA11) and the participants' habitual rumination levels during a task in which participants ignored images of fearful faces versus directly attending to these images. Research on both healthy and depressed individuals has suggested that rumination is associated with difficulty inhibiting or disengaging from negative stimuli (Vanderhasselt et al., 2013, 2011). Various fMRI studies on individual differences in rumination have found greater recruitment of regions related to cognitive control in individuals with more rumination, indicating inefficiency in neural processes of emotion inhibition in habitual ruminators (Vanderhasselt et al., 2013). This is consistent with the finding of the current study.

The inferior (or ventral) OFC is considered part of the ventral medial prefrontal cortex (vmPFC). It has reciprocal connections with the amygdala (Croxson et al., 2005), and it has been implicated in processing negatively valenced information (Rolls, 2004). The OFC is associated with decision making, subjective valuation, and reward (see Rolls & Grabenhorst, 2008 for review), and it appears to be responsible for monitoring and updating emotional information and the value of stimuli over time. This temporal assessment of the context of information contributes to decision making and reward driven behaviors (Dolan, 2007; Rolls & Grabenhorst, 2008). Additionally, research has identified the right inferior OFC as a region that is recruited to assist in emotion interference resolution in working memory indicating that activation in the right inferior OFC underlies the process of inhibiting emotional information within working memory by providing information on the context of the emotional information (Levens & Phelps, 2010). Furthermore, individuals with lesions in the right inferior OFC have demonstrated increased emotion interference in a working memory task (Levens, Devinsky, & Phelps, 2011). This prior research suggested that the right inferior OFC contributes to the inhibition of emotional information. The current finding that women with PTSD who have higher levels of rumination, compared to lower, have greater recruitment of the right inferior OFC during inhibition of negative stimuli suggested that greater rumination was associated with an inefficiency in emotional inhibition. Women with higher pretreatment rumination had more difficulty ignoring irrelevant negative stimuli while attempting to match the images of houses.

The whole brain analysis evidenced a significant positive relationship between rumination and the right inferior OFC (BA 11) in the IF>AF contrast. Although this relationship did not remain significant after adjusting for pretreatment symptom severity, it was of note that the same region was positively related to RTS scores in the ROI analysis even when pretreatment symptom severity was added into the model.

The lack of findings for the IF>IN and AF>AN contrasts were surprising. It is possible that the lack of findings may be related to how women in the current study interpreted the face stimuli. All participants had a history of interpersonal trauma, and faces with neutral expressions may have appeared threatening to our participants. If this was the case, all images of faces would have been processed as negative stimuli leading to no differences between the ignore fear and ignore neutral conditions. Therefore, when the ignore fear condition was contrasted with the attend fear condition (IF>AF), findings reflected an attempt to inhibit the stimuli.

The current study was not without limitations. First, this study recruited only female participants with interpersonal trauma, and therefore the results might not generalize to men or other trauma types. The stimuli of fearful and neutral faces may be particularly salient to women with a history of interpersonal violence, also affecting generalizability. Additionally, the current study only included participants with PTSD. Therefore, it was not possible to speak to the specificity of these results to PTSD versus any other group of people. It should also be noted that the current study had a relatively small sample size.

Another limitation of the study was the use of a single measure of rumination. Rumination is a multifaceted construct that includes a variety of repetitive thought processes such as brooding and reflection (Mandell, Siegle, Shutt, Feldmiller, & Thase, 2014; Siegle, Moore, & Thase, 2004). Previous research has found that rumination is not a singular construct, but rather one that comprises different components. Although various measures of rumination have appeared to assess different, sometimes unrelated aspects of rumination; when these measures were used in aggregate, they measured a single construct (Siegle et al., 2004). Additionally, the RTS measures a repetitive thinking style that is not specifically focused on negative content. A valenced measure may have better addressed the hypothesis of the current study. Therefore, future research should utilize a battery of rumination measures including ones that focus specifically on negative content.

Despite these limitations, the current study provided new information on rumination in women with PTSD. The current study suggested that individual differences in levels of ruminative thought in women with PTSD were reflected in underlying neural circuitry, specifically the right inferior orbital cortex (BA11), when inhibiting fear stimuli. This region has been associated with the facilitation of control over the interference of emotional information suggesting that women with PTSD who report high levels of rumination potentially have a more difficult time inhibiting distracting emotional information.

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Figure 1.

An example of a single trial from the emotion interference task. The images of fearful faces are aligned vertically while the images of houses are aligned horizontally.

Figure 2. Image and graph of the significant relationship between RTS scores and the area of the right inferior orbital cortex (BA 11; 38, 40, -14) in 39 women with PTSD in the ignore fear > attend fear contrast.

Table 1

Regression Results for Participants with PTSD in the Positive Direction between RTS Scores and Both ROI Masks in the IF>AF Contrast.

x, y, z	Region	Cluster	t
Unadjusted models			
38, 40, -14	Right inferior orbital frontal gyrus (BA 11)	46	5.62*
Adjusted for chronicity of trauma, CAPS, and BDI-II			
38, 38, -14	Right inferior orbital frontal gyrus (BA 11)	50	5.32*

Note. $N = 39$. All results were significant after small volume correction for family-wise error ($pFWE$) at $p < .05$. Coordinates are listed in Montreal Neurological Institute (MNI) Space. PTSD = posttraumatic stress disorder; RTS = Ruminative Thought Style Questionnaire; ROI = regions of interest; IF>AF = ignore fear > attend fear; R = right, BA = Brodmann areas; CAPS = Clinician Administered PTSD Scale; BDI-II = Beck Depression Inventory II.