Brain and Behavioral Responses to Ambiguous Facial Expressions in Identical Twins Discordant for Trauma Exposure and Posttraumatic Stress Disorder

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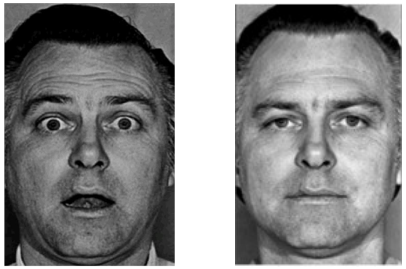
Background

The amygdala is a region of the brain relevant in the process of fear conditioning (Davis & Whalen, 2001), as well the detection of threat (Whalen et al., 1998). The medial prefrontal cortex (mPFC) is involved in the regulation of negative emotions, including inhibition of the amygdala (Koenigs & Grafman, 2009). Researchers believe that these are key structures in the etiology of PTSD. In particular, research demonstrates that individuals with PTSD have amygdala hyperresponsivity and mPFC hyporesponsivity (VanElzakker et al., 2014), which could bias one's interpretation of stimuli as more negative or threatening.

Neuroimaging studies have examined the response of individuals with posttraumatic stress disorder (PTSD) to threatening stimuli, however little research has been conducted to determine how individuals with PTSD respond to ambiguous stimuli, such as surprised facial expressions. It is possible that individuals with PTSD may be more likely to interpret surprise faces as negative and demonstrate heightened amygdala activation and diminished mPFC activation. Furthermore, the origin of these abnormalities is unknown. A twin design allows for researchers to determine whether observed abnormalities represent a familial vulnerability, a result of exposure to trauma, or an acquired characteristic of the disorder. We examined this response to ambiguous facial expressions in PTSD.

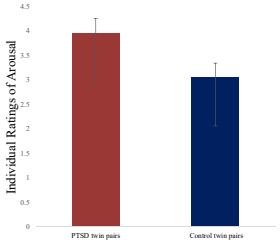
Methods

Participants were male combat-exposed Vietnam War veterans with PTSD (ExP+, n = 16) and their trauma-unexposed identical cotwins (UxP+, n = 16), as well as combat-exposed controls without PTSD (ExP-, n = 12) and their trauma-unexposed cotwins (UxP-, n = 12). While in an fMRI, participants viewed 8 blocks of surprise and neutral faces. All fMRI scans were completed using a Siemens Trio Tim 3.0 Tesla MRI with a 12 channel gradient head coil. Following the procedure in the scanner, participants were given questionnaires asking them to categorize the 16 surprise and neutral facial expressions they had previously seen out of seven possible emotions (fear, disgust, anger, surprise, neutral, happy, or sadness). They also were asked to rate each expression on valence from a scale to -4 (very negative) to 4 (very positive). Using SPM8, statistical analyses were conducted to create contrast images including Surprise v. Neutral, Surprise v. Fixation, and Neutral v. Fixation.



Surprise vs. Neutral facial expressions (Ekman & Freisen, 1976)

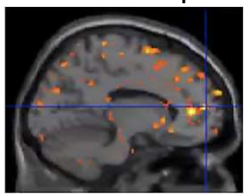
Behavioral Results

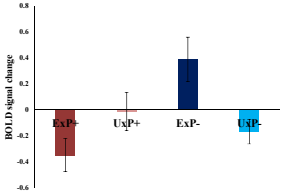


Individuals with PTSD and their cotwins rated all racial expressions as more arousing than trauma-exposed controls and their cotwins. There were no between group differences in valence ratings or categorization.

Neuroimaging Results

Surprise v. Neutral Contrast:

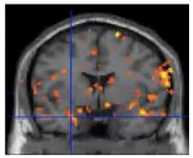


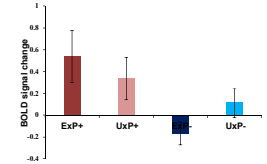


Medial frontal gyrus: (-12, 56, 12), z = 3.85

There was significantly diminished activation in the medial frontal gyrus in individuals with PTSD relative to all other groups. There were no significant differences in amygdala activation between groups.

Neutral v. Fixation Contrast:

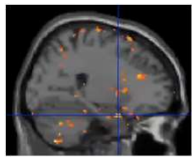


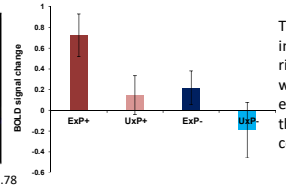


There was significantly increased activation in the left amygdala in individuals with PTSD and their cotwins relative to trauma-exposed controls and their cotwins.

Left amygdala: (-26, 2, -26), z = 3.49

Surprise v. Fixation Contrast:





There was significantly increased activation in the right amygdala in individuals with PTSD and trauma-exposed controls relative to their trauma-unexposed cotwins.

Right amygdala: (24, 6, -24), z = 3.78

Discussion

We did not find any any significant differences in categorization of surprised facial expressions or in ratings of valence between groups. However, we did find that individuals with PTSD and their cotwins interpreted faces as more arousing. This may be a familial vulnerability in developing the disorder.

We also found that individuals with PTSD demonstrated diminished MFG activation to surprised faces compared to neutral faces relative to other groups. This suggests that diminished activation in the MFG may be an acquired characteristic of PTSD. Furthermore, though we did not find any group differences in amygdala activation in the surprise versus neutral contrast, we did find increased activation to both surprised and neutral faces relative to a fixation cross. These findings suggest that individuals with PTSD and their cotwins may have interpreted surprise and neutral faces as threatening and that amygdala hyperresponsivity to ambiguous threat may be a familial vulnerability in developing PTSD.

Future Research

We are currently investigating other brain regions of interest relevant to fear, including the ventral medial prefrontal cortex, dorsal anterior cingulate cortex, and insula.

Future research ought to determine whether therapeutic intervention focused on the interpretation of ambiguous threat can reduce PTSD symptomatology.

References

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