Behavioural Brain Research 312 (2016) 355–361

Contents lists available at ScienceDirect

Behavioural Brain Research

journal homepage: www.elsevier.com/locate/bbr

Research report

The brain structure and spontaneous activity baseline of the behavioral bias in trait anxiety

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HIGHLIGHTS

- Brain structure and instinct activity correlations with trait anxiety were studied to understand what trait anxiety is better.
- The high trait anxiety group may show attenuated image processing on consciousness level (cognitive processing bias).
- The high trait anxiety group may presents stronger induced sensibility and over processing ability to the relationships (emotional processing bias).

ARTICLE INFO

Article history:
Received 2 May 2016
Received in revised form 17 June 2016
Accepted 18 June 2016
Available online 23 June 2016

Keywords:
Trait anxiety
Voxel-based morphometry
Resting-state fMRI

ABSTRACT

Individuals with trait anxiety are often considered to be predisposed to psychiatric disorders. However, there is great heterogeneity in the development of psychiatric disorders in this group of people and the nature of the trait anxiety is still unclear. So, we decided to explore the correlations of brain structure and brain activity with trait anxiety in normal individuals. Specifically, we investigated the correlations between trait anxiety and regional grey matter volume (rGMV) and regional BOLD, using the Amplitude of Low Frequency Fluctuations (ALFF) as an index in 382 university students. The results showed that the level of trait anxiety was negatively correlated with rGMV in the right middle occipital gyrus. This result indicates that individuals with high trait anxiety tend to have less image processing on conscious level. Furthermore, we found that trait anxiety was positively correlated with the ALFF in the bilateral superior frontal gyrus and the right supplementary motor area, and negatively correlated with the ALFF in the cerebellum and the thalamus. These results indicate that individuals with high trait anxiety may be more sensitive to relationships and sensory information. Overall, this study's findings suggest that individuals with high trait anxiety have attenuated image processing on the conscious level, and exhibit stronger induced sensibility and over-processing of relationships, which is a brain imaging precondition for psychiatric disorders.

1. Introduction

Trait anxiety, as a personality trait, reflects an individual's disposition to have a bias in anxiety-related emotional and cognitive processing [36]. Trait anxiety, which is a stable predisposition in normal persons, is often considered to be a risk factor for anxiety disorders and other psychiatric illnesses [6,9,27,42]. Previous research found that individuals with high trait anxiety showed fear to nonspecific stressors [35]. However, thus far, there is no published report on the proportion of individuals with high trait anxiety who develop psychiatric disorders. In addition, the nature of trait anxiety, which is a stable personality trait with biological underpinnings, is still unclear. Although many researchers have used individuals with trait anxiety to study anxiety, trait anxiety exhibits great heterogeneity. Overall, we aimed to explore the correlation of brain structure and brain spontaneous activity with trait anxiety in order to gain a better understanding of what trait anxiety is.

Anxiety may be triggered by stressors, and the verbal stream of consciousness associated with persistent fear could gradually

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http://dx.doi.org/10.1016/j.bbr.2016.06.036

result in a more anxious state if self-regulation fails. Anxiety disorder is characterized by a state of vigilance to threat cues, apprehensive expectations, fear, hyperarousal, avoidance behaviors, and negatively valenced cognitions (American Psychiatric Association [DSM-V-TR], 2013). In sum, individuals with anxiety-related disorders show more fear of uncertainty, attenuated image processing, and an increased verbal stream of consciousness. A previous study found that self-reported levels of trait anxiety were negatively correlated with cortical thickness in the right medial orbitofrontal cortex (mOFC) and positively correlated with the bilateral volume of the NAcc [17]. The mOFC consistently has been found to be a key brain region underlying anxiety disorders in many studies; for example, panic disorder [1,29,32] and posttraumatic stress disorder (PTSD) [26]. Due to the small sample size (34 subjects) in the Kühn et al. [17] study, the correlation between cortical thickness and trait anxiety needs to be validated by a large sample. Li et al. [19] employed a shape-analysis approach to determine the relationship between amygdala morphology and trait anxiety in 24 healthy young participants, and the results revealed significant correlations between the two amygdala surface metrics and trait anxiety, which were located around the lateral and central nucleus of right amygdala.

In the present study, we set out to explore the relationships between individual differences in the brain (including brain structure and the brain regional baseline) and individual differences in level of trait anxiety in a normal sample. Based on previous findings, we hypothesized: (1) there will be no correlation between trait anxiety and sub-cortical rGMV, because there are no reports that indicate that high trait anxiety must develop into anxiety disorder or other psychiatric disorders; (2) the level of self-rated trait anxiety will be sensitive to a bias in conscious cognitive processing, e.g., image processing will be attenuated (decreased grey matter volume in the occipital gyrus), the verbal stream of consciousness will be higher (increased grey matter volume in the language areas), and there will be greater sensitivity to relationships (high baseline or potential activity of the "where" pathway); and (3) individuals with high trait anxiety will be more sensitive to sensory and body information.

2. Methods

2.1. Participants

Three hundred and eighty-two subjects (172 females; mean age: 19.97 years old) participated in the study as part of our ongoing project to investigate the associations among brain imaging, creativity, and mental health. The participants were undergraduate or postgraduate university students in Southwest University, China. They were recruited either through advertisements on a bulletin board in Southwest University or introduced by subjects who participated in previous experiments in our laboratory. None of the participants had visual difficulties, substance abuse disorders, or histories of neurological or psychiatric illnesses. All participants gave their written informed consent in accordance with the Declaration of Helsinki (1991). The Institutional Review Board of Southwest University's Brain Imaging Center approved the study protocol. The screening process was carefully conducted by an experienced researcher with a Ph.D.

All subjects were screened, using the Structured Clinical Interview for the DSM-IV, by two well-trained and experienced Ph.D. candidates in the Faculty of Psychology of Southwest University. Potential subjects were excluded who met the DSM-IV criteria for any neurologic diseases or psychiatric disorders, had conditions which made them unsuitable for scanning, had suffered a head trauma, were taking medications that may change brain function, had a history of loss of consciousness, were pregnant, or were breast-feeding.

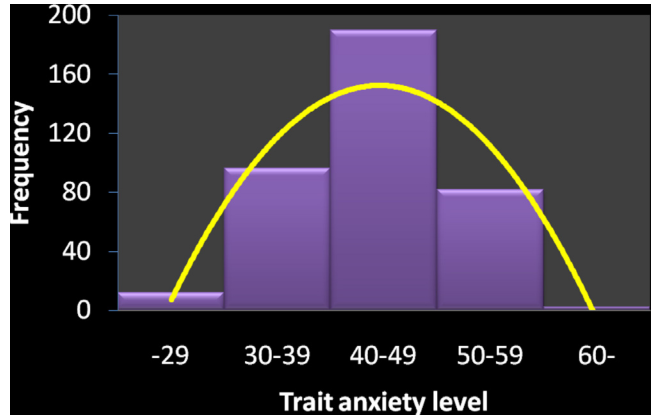

Fig. 1. The frequency distribution of the trait anxiety scores in the study's normal sample.

2.2. Behavioral assessments

Each participant was evaluated for their levels of trait anxiety and depression. Trait anxiety was assessed using the Trait Anxiety Inventory (T-AI), which is a Chinese version self-report questionnaire that consists of 20 items that measure anxiety-related trait personality [36,37,20]. The T-AI is valued for its high reliability based on its internal consistency and a test-retest reliability ranging from 0.73 to 0.86 across multiple samples [36]. The Zung Self-Rating Depression Scale was used to assess the level of depression of the subjects [43].

2.3. MRI data acquisition

2.3.1. T1 data acquisition

MR images were obtained by a 3.0-T Siemens Trio MRI scanner (Siemens Medical, Erlangen, Germany). High-resolution T1-weighted anatomical images were acquired using a magnetization-prepared rapid gradient echo sequence (repetition time = 1900 ms; echo time = 2.52 ms; inversion time = 900 ms; flip angle = 9°; resolution matrix = 256 × 256; slices = 176; thickness = 1.0 mm; voxel size = 1 × 1 × 1mm3).

2.3.2. Resting-state MRI data acquisition

Resting-state fMRI images were acquired by a 3.0-T Siemens Trio MRI scanner (Siemens Medical, Erlangen, Germany) at the Brain Imaging Research Center in Southwest University, Chongqing, China. Whole-brain resting-state functional images were acquired using gradient echo planar imaging sequences, with the following parameters: slices = 32, TR/TE = 2000/30 ms, flip angle = 90°, field of view = 220 mm × 220 mm, thickness/slice gap = 3/1 mm, and matrix = 64 × 64, resulting in a voxel with 3.4 × 3.4 × 3 mm^3. As a result, 242 functional volumes were acquired for each participant. During the resting-state fMRI scanning, participants laid supine with their heads comfortably positioned within an 16-channel birdcage head-coil, which was padded with foam to minimize head movements. Earplugs were used to reduce the influence of scanner noise. All subjects were instructed to relax, keep their eyes closed, and stay awake.