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Greater cortical thickness within the limbic visceromotor network predicts higher levels of trait emotional awareness



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ABSTRACT

Previous studies of trait emotional awareness (EA) have not yet examined whether differences in cortical structure might account for differences in EA. Based on previous research on the relationship between EA and both emotion conceptualization and visceromotor control processes, we tested two hypotheses in a sample of 26 healthy participants: that higher EA would be predicted by greater cortical thickness within (1) regions of the default mode network (DMN; linked with conceptualization processes), and/or (2) regions of the limbic network (linked with affect generation and visceromotor control processes). A non-significant correlation was found between EA and cortical thickness in the DMN. In contrast, a significant positive correlation was observed between EA and cortical thickness within the limbic network. These findings suggest that the structural integrity of cortical regions involved in the generation of affective bodily reactions may play a more important role in explaining differences in EA than previously thought.

1. Introduction

The construct of trait emotional awareness (EA) reflects the commonplace observation that some individuals possess a greater ability than others to recognize, understand, and clearly articulate, their own emotional responses. One widely used measure of this individual difference is the Levels of Emotional Awareness Scale (LEAS) (Lane, Quinlan, Schwartz, Walker, & Zeitlin, 1990; Lane & Schwartz, 1987). In previous research, higher LEAS scores, reflecting higher EA, have been found to predict many adaptive traits/abilities, suggesting it plays an important role in facilitating well adjusted social functioning. Such traits/abilities associated with higher LEAS scores include better self-reported impulse control (Bréjard, Bonnet, & Pedinielli, 2012), greater openness to feelings (Lane et al., 1990), greater emotion recognition ability (Lane, Sechrest, Riedel, Shapiro, & Kaszniak, 2000; Lane et al., 1996), higher levels of empathy (Barchard & Hakstian, 2004), and a more stable sense of well-being independent of current mood (Ciarrochi, Caputi, & Mayer, 2003). In further support of the clinical relevance of EA, lower LEAS scores have previously been linked to several maladaptive clinical phenomena, such as essential hypertension (Consoli et al., 2010), eating disorders (Bydlowski et al., 2005), post-traumatic stress disorder (Frewen et al., 2008), schizophrenia (Baslet, Termini, & Herbener, 2009), depression (Berthoz, Ouhayoun, & Parage, 2000; Donges et al., 2005), borderline personality disorder (Levine, Marziali, & Hood, 1997), somatoform disorders (Subic-Wrana, Bruder, Thomas, Lane, & Köhle, 2005), a “disorganized attachment style” (Subic-Wrana, Beetz, Paulussen, Wiltnik, & Beutel, 2007), impaired insight in the context of cocaine abuse (Moeller et al., 2014), and greater pain in patients with irritable bowel syndrome (IBS) (Lackner, 2005). EA therefore appears to represent an important individual difference variable in relation to social/

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emotional functioning. Current theories of the interactions between emotional and physical health, which appeal to the way autonomic, endocrine, visceral, and immune system processes are regulated by the brain as part of an emotional reaction, further suggest that EA may have an influence on other physical health outcomes as well (Slavich & Irwin, 2014; Thayer, Ahs, Fredrikson, Sollers, & Wager, 2012; Thayer & Lane, 2000, 2009).

The neural systems underlying EA have now also been the topic of a number of studies. For example, two functional neuroimaging studies have shown that higher LEAS scores predict greater activity in the dorsal anterior cingulate cortex (dACC) in the context of specific cognitive tasks (Lane et al., 1998; McRae, Reiman, Fort, Chen, & Lane, 2008). A third study also found that, during recall of life-threatening experiences, healthy subjects with higher LEAS scores showed greater activity in the rostral ACC (rACC) (Frewen et al., 2008). The ACC, and surrounding medial prefrontal cortex (MPFC), make up the anterior portion of the “default mode network” (DMN) – a large-scale cortical network believed to play an important role in the process of conceptualization (Barrett & Satpute, 2013; Buckner, Andrews-Hanna, & Schacter, 2008; Li, Mai, & Liu, 2014; Raichle et al., 2001). With regard to emotion, the DMN has been suggested to play an important role in assigning conceptual significance to bodily feelings (Lane, Weihs, Herring, Hishaw, & Smith, 2015; Smith & Lane, 2015) – a function central to self-related emotion recognition, and therefore also central to EA.

At the same time, it is unclear at present whether higher levels of EA are primarily accounted for by differences in such emotion recognition/conceptualization processes. Another important possibility is that differences in EA could reflect differences in the neural circuitry underlying the *generation* of affective bodily responses (i.e., as opposed to differences in the neural circuitry associated with the subsequent recognition/conceptualization of those responses). While the DMN is thought to play a primary role in conceptualization, another cortical network consisting of visceromotor control regions within the orbitofrontal and temporopolar cortex – termed the “limbic” network (LN) – is thought to play a primary role in generating affective bodily responses (Barrett & Satpute, 2013; Yeo et al., 2011). A leading theory of the link between emotion and visceromotor control – the neurovisceral integration model – further suggests that higher EA should be associated with more adaptive visceral regulation processes within these LN regions (Smith, Thayer, Khalsa, & Lane, 2017; Thayer & Lane, 2000, 2009; Thayer et al., 2012). However, the direct association between EA and the LN has not yet been thoroughly examined.

More generally, it is also notable that all neuroimaging studies of EA to date have focused on functional responses. No study has yet examined if differences in EA might relate to differences in brain structure within the cortical networks discussed above. Cortical thickness is one morphometric measure that can be used to assess structural differences in the brain. It is known that cerebral cortex exhibits regional variation in thickness, ranging from 1.5 to 5 mm, with an average of 2.5 mm (Zilles, 2004). Cortical thinning has been found in various clinical populations, including those with schizophrenia (Rimol et al., 2010), Alzheimer’s disease (Dickerson et al., 2009), attention-deficit/hyperactive disorder (Makris et al., 2007), and posttraumatic stress disorder (Geuze et al., 2008). Changes in cortical thickness have also been shown to result from development and normal aging (Zilles, 2004), as well as from learning various cognitive/behavioral skills (e.g., Bermudez, Lerch, Evans, & Zatorre, 2009; Klein, Mok, Chen, & Watkins, 2014). Thus, measures of cortical thickness might provide insight into underlying neurological mechanisms related to EA.

In this study we therefore specifically examined the relationship between EA and cortical thickness within the DMN and the LN. In doing so, we examined two complementary hypotheses based on the literature reviewed above. The first hypothesis was that greater structural integrity in the cortical regions making up the DMN, as indexed by greater average cortical thickness, would predict higher LEAS scores – potentially reflecting more adaptive conceptualization processes. The second hypothesis was that greater average cortical thickness across regions of the LN would instead predict higher LEAS scores – potentially reflecting more adaptive visceral control in relation to affective response generation.

2. Materials and methods

2.1. Participants

Twenty-six healthy adults (mean age = 23.12 ± 4.03; 13 female) were recruited from the general population via flyers and internet advertisements to participate in the present study. Participants did not have any history of psychiatric or neurological disorders (assessed via a phone screen questionnaire based on criteria within the Diagnostic and Statistical Manual for Mental Disorders, 4th edition; DSM-IV-TR) and all provided written informed consent prior to participation. The research protocol of the present study was also reviewed and approved by the Institutional Review Board of the University of Arizona.

2.2. Measures

2.2.1. Emotional awareness

Participants also completed an on-line version of the levels of emotional awareness scale (LEAS) (www.eleatest.net), in conjunction with a validated automatic scoring program (Barchard, Bajgar, Leaf, & Lane, 2010). When taking the LEAS, participants are presented with 2–4 sentence descriptions of 20 social situations, each involving 2 people. These descriptions are designed to elicit four types of emotion (happiness, sadness, anger, and fear) at 5 complexity levels. Each electronically presented page displays a single situation description, followed by two questions: “How would you feel?” and “How would the other person feel?” Separate response boxes are provided for typing in the answers to each question. Participants are instructed to use as much or as little space as needed to answer. The only rule provided is that they must use the word “feel” in each response.

Scores for the LEAS are assigned based on the EA level assigned to the words used in each participant’s responses. The lowest scores are given to non-feeling words (Level 0; e.g., confused). Level 1 scores are awarded to feeling words related to physiological

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