A Pilot Study of Neural Correlates of Mindfulness and Anger Using fMRI

C. Fulwiler[1], N. Zhang[1], A. Lee[2], R. Hardaway[1], D. Gansler[2], M. Jerram[2], A. Bourisly[3], J. King[1]

[1] Department of Psychiatry, UMass Medical School; [2] Department of Psychology, Suffolk University ; [3] Worcester Polytechnic Institute

INTRODUCTION

Mindfulness-based interventions may be helpful in treating anger and aggression. Kabat-Zinn (2003) has defined mindfulness as *"The awareness that emerges through paying attention on purpose, in the present moment, and non-judgmentally to the unfolding of experience moment to moment."* Previous studies have found trait mindfulness to be associated with lower self-ratings for aggressiveness and hostile attribution (Heppner, et al. 2008). Using functional MRI (fMRI), another study found that higher trait mindfulness was associated with greater activation of prefrontal cortex and lower activation of amygdala during an affect labeling task. The limbic areas of PFC have been shown in animal models to regulate emotional expression via inhibitory control over the amygdala. These findings suggest that mindfulness training may lead to reduction in anger and other negative emotions by enhancing inhibitory control of the amygdala by prefrontal cortex. Here we describe a preliminary study of the relationship between trait measures of mindfulness, anger and other negative emotions and response to an emotional arousal stimulus paradigm in areas of prefrontal cortex and amygdala. We hypothesize that in response to viewing facial expressions of anger, trait mindfulness will be positively related to activation of prefrontal cortex and that anger will be positively related to activation of amygdala.

METHODS

Subjects: 8 right-handed, healthy, native English-speaking males, mean age 34, S.D. 15.8, including two long-time meditation practitioners of meditation (>25 yrs). Exclusion criteria included taking psychotropic medications, using drugs of abuse, serious mental disorder, and traumatic brain injury.

Psychometric Measures: State-Trait Anger Expression Inventory-2 (STAXI-2; Spielberger, 1999); Positive and Negative Affect Schedule (PANAS; Watson, et al.,1988); Kentucky Inventory of Mindfulness Skills (KIMS; Baer, Smith & Allen, 2004)

Emotional arousal paradigm: Three 5-minute acquisition scanning runs using block design with randomized sequences of photographs from the Pictures of Facial Affect series (Ekman & Friesen, 1976), a widely used set of black and white images of male and female posers exhibiting facial expressions. Pictures displaying fear, anger and neutral emotion were used. The fMRI session was composed of four 5-minute acquisition scanning runs. Subjects respond by button press each time the image changes to ensure that the participant attends to the images. Afterwards, participants are asked to identify the emotion of the poser with a forced-choice response to examine each participant's ability to discriminate between emotional states.

Data Analysis: fMRI data was preprocessed using Statistical Parametric Mapping (SPM8) software (Wellcome Department of Cognitive Neurology, London, UK) running under the MATLAB environment (Mathworks, Inc., Sherborn, MA) and analyzed using the general linear model (GLM).

RESULTS

Psychometric Measures

	Subjects Mean (SD)	Range	Norms (males) Mean (SD)
STAXI-2 (Anger)			
State Anger	15.9 (0.99)	15-17	19.25 (6.89)
Trait Anger	17.8 (6.67)	11-30	18.4 (5.42)
PANAS			
Positive affect	36.9 (4.67)	28-44	15-17
Negative affect	20.3 (8.59)	12-38	11-30
KIMS (Mindfulness)			
Observe	39.8 (6.34)	31-49	36.6 (6.92)
Act with awareness	28.6 (5.89)	22-39	28.9 (5.40)
Accept without judgment	30.9 (6.58)	23-39	30.1 (6.01)

Behavior measures were not correlated with age or education. Subjects exhibited minimal variance on the STAXI-2 State Anger subscale, but trait measures for mindfulness, anger and positive and negative emotion showed adequate variance for examining individual differences (Table 1). As expected, negative affect was correlated positively with Trait Anger (r=.79, p<.02).

BOLD Activation in Response to Angry Faces

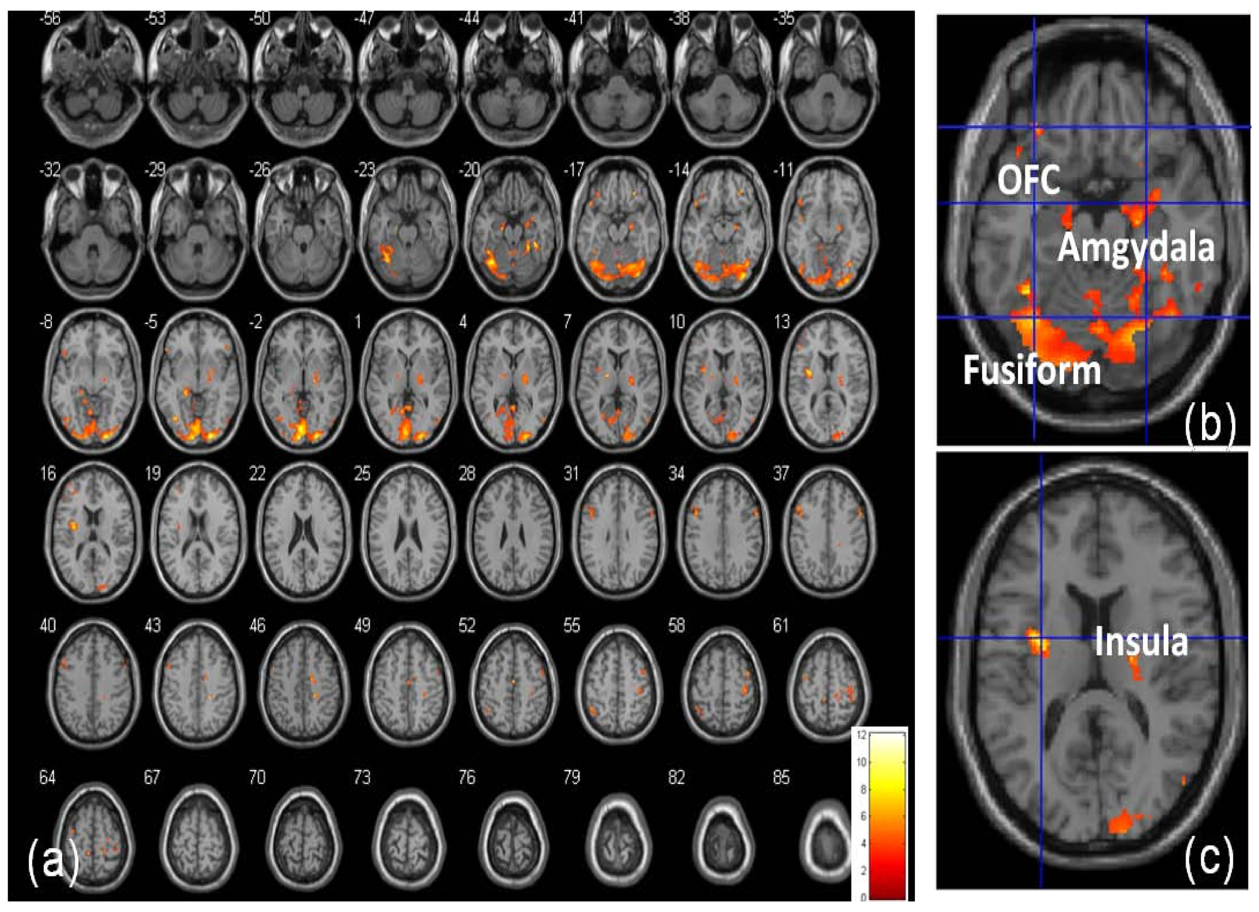

Figure 1a. BOLD response to angry faces across the whole brain. Brain regions related to emotion regulation such as amygdala (Fig 1b), OFC (Fig 1b), middle frontal gyrus, medial frontal gyrus, superior frontal gyrus and insular cortex (Fig. 1c) demonstrated significant activation. We also observed activation in cingulate gyrus. Visual spatial attention network also showed response including fusiform (Fig. 1b), lingual gyrus, middle temporal gyrus. We also observed activation in caudate, claustrum, hippocampus and thalamus.

Group analysis of correlations between BOLD activation response to angry faces did not reveal significant correlations with trait mindfulness or trait anger for either orbitofrontal cortex or amygdala. Trait mindfulness showed a trend toward an inverse correlation with activation in insular cortex (KIMS subscale Observe – r = .68, p<.10; Accept without judgment r = -.65, p<.10). Trait anger showed a significant positive correlation with insula activation (r = .73, p = 0.038; Fig. 2), as did PANAS negative affect (r = .81, p = .014). This result suggests a tight linkage between the neural representation and trait measurement of negative emotions.

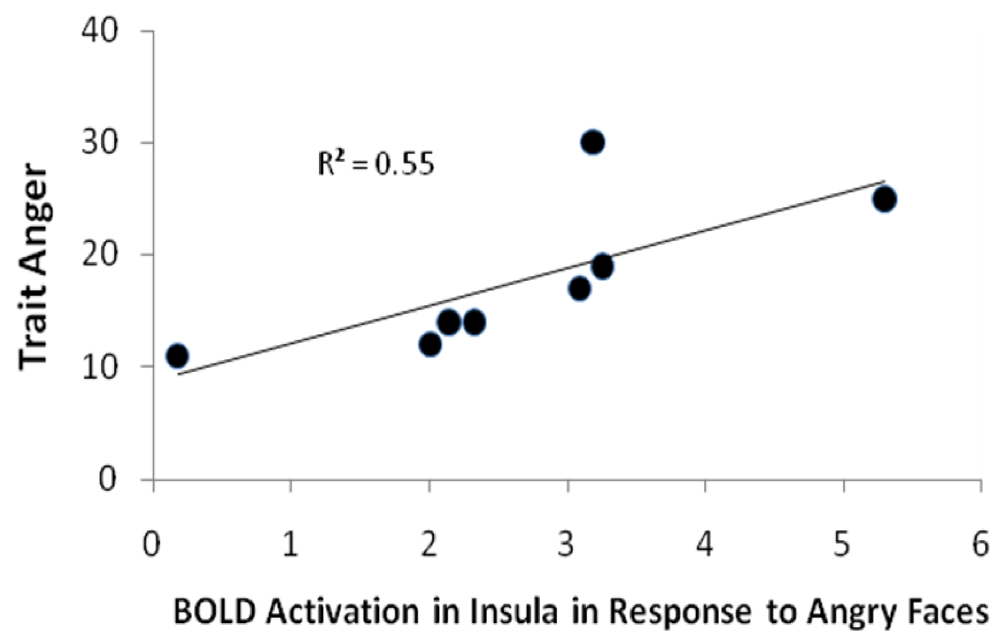

Figure 2. Correlation between Anger trait and BOLD activation in insula in response to angry faces in the emotion arousal paradigm.

DISCUSSION

The purpose of this preliminary investigation was to assess the feasibility of using self-report trait measures and pictures of facial affect to examine neural correlates of anger and mindfulness. Preliminary results with healthy controls support the use of these measures. Previous studies have reported activation of insular cortex by recall or visual induction of anger and other emotions, consistent with anatomic evidence that the insula receives signals from the internal milieu that allow it to monitor the internal emotional state and act as an "alarm center' for internally-sensed dangers. Future directions include studies of clinical populations in which anger is a prominent feature and developing an mindfulness-based intervention aimed at increasing trait mindfulness and diminishing trait levels of anger and negative emotion.

ACKNKOWLEDGEMENTS

This work was supported by a Psychiatry Research Fellowship Award from the UMass Department of Psychiatry to C.F. and a Summer Research Fellowship from the Umass Clinical/Translational Pathway Program to R.H.