

Trait anger predicts relative left frontal cortical activation to anger-inducing stimuli[☆]

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Abstract

Building on past research that has suggested that relatively greater left frontal cortical activity is associated with approach-related anger and that individuals who are high in trait anger are more likely to evidence angry responses, the present research tested whether individuals high in trait anger would be more likely to evidence relatively greater left frontal cortical activity in response to anger-eliciting pictorial stimuli. In the experiment, participants were exposed to pictures intended to evoke anger, fear/disgust, positive, or neutral affective reactions. Electroencephalographic (EEG) activity was recorded continuously, and alpha power was derived from the EEG to measure cortical activity. Trait anger was measured using the Buss and Perry Aggression Questionnaire [Buss, A.H., Perry, M., 1992. The aggression questionnaire. *Journal of Personality and Social Psychology*, 63, 452–459]. Results revealed that trait anger was positively related to greater relative left frontal cortical activity to anger-evoking pictures but not to other types of pictures.

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1. Introduction

Over the past three decades, research using a variety of methodologies has revealed that the left and right frontal cortices are involved in different emotional or motivational processes (for recent reviews, see Coan and Allen, 2004; Pizzagalli et al., 2003). Early on, researchers suggested that relatively greater left frontal activity was associated with greater positive affect, whereas relatively greater right frontal activity was associated with greater negative affect (e.g., Ahern and Schwartz, 1985; Gotlib et al., 1998; Heller, 1990; Heller and Nitschke, 1998; Silberman and Weingartner, 1986). At the same time, researchers also suggested relatively greater left frontal activity was associated with greater approach motivation, whereas relatively greater right frontal activity was associated with greater withdrawal motivation (e.g., Fox, 1991; Harmon-Jones and Allen, 1997; Sutton and Davidson, 1997). Because affective

valence and motivational direction was confounded in that research, the conceptual explanation was muddled.

To clarify this conceptual quagmire, researchers began to examine anger, because anger is typically thought to be a negative emotion that evokes approach motivation. Indeed, research has revealed that anger is experienced as negative (e.g., Harmon-Jones, 2004a) and that it is associated with approach motivation (e.g., Adams et al., 2006; Carver, 2004; Harmon-Jones, 2003; Putman et al., 2004). In examinations of anger and asymmetrical frontal cortical activity, studies have revealed that trait anger relates to relatively greater left frontal activity when measured at resting baseline (Harmon-Jones, 2004a; Harmon-Jones and Allen, 1998; Rybak et al., 2006). Other research has revealed that situational manipulations of anger evoke relatively greater left frontal activity (Harmon-Jones and Sigelman, 2001). Experiments have also revealed that manipulated increases of left frontal cortical activity via repetitive transcranial magnetic stimulation increase vigilant attention toward and memory for angry facial expressions (d'Alfonso et al., 2000; van Honk and Schutter, 2006). Moreover, research has independently manipulated anger and approach motivation and found that anger associated with approach motivation produces greater left

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frontal activity than equally intense anger that is not associated with approach motivation (Harmon-Jones et al., 2003). In addition, the importance of considering approach-related anger, as compared to other types of anger, has been demonstrated in trait anger research (Hewig et al., 2004).

The effect of approach motivation and anger on left frontal activity has recently been produced using pictorial stimuli that evoke anger (Harmon-Jones et al., 2006). In this experiment, participants low in racial prejudice were shown neutral, positive, and fear/disgust pictures from the International Affective Picture System (Lang et al., 1997). Mixed among those pictures were pictures depicting instances of racism and hatred (e.g., neo-Nazis, Ku Klux Klan). Prior to viewing the pictures, half of the participants were informed that they would write an essay on why racism is immoral, unjust and unfair at the end of the experiment. This manipulation served to increase their anger-related approach motivation. Results revealed that participants showed greater relative left frontal activity to anger pictures than other picture types only when they expected to engage in approach-related behavior.

Results such as these may suggest that relatively greater left frontal activity will occur in response to an angering situation only when there is an explicit approach motivational opportunity. However, it is possible that an explicit approach motivational opportunity is not necessary for increased left frontal activity to anger to occur, but that it only intensifies left frontal activity. In other words, there may be other features of the situation or person that make it likely that an angering situation will increase approach motivational tendencies and activity in the left frontal cortical region. One possibility along these lines is the personality characteristic of anger. That is, individuals who are chronically high in anger may evidence increased left frontal activity (and approach motivational tendencies) in response to angering situations that would not necessarily cause such responses in individuals who are not as chronically angry. This prediction is predicated on the idea that angry individuals have more extensive angry associative networks than less angry individuals, and that anger-evoking stimuli should therefore activate parts of the network more readily in these angry individuals (Berkowitz, 1990, 1993; Bower, 1981; Bushman, 1996). That is, among individuals high in trait anger, even mild anger cues might activate parts of the anger network, and through established associations, lead to angry expressive-motor responses, physiological reactions, feelings, thoughts, and memories.

Along the lines suggested by the cognitive neo-associative model of aggression (Berkowitz, 1990, 1993), research has revealed that participants high in trait anger show selective perceptual and cognitive biases toward angry words and facial expressions in Stroop-type and visual search tasks (Cohen et al., 1998; Eckhardt and Cohen, 1997; van Honk et al., 2001). However, no previous research has tested whether anger-evoking stimuli are more likely to activate neural structures involved in approach motivational tendencies in individuals who are high as compared to low in trait anger. Such results would extend our knowledge of the neural circuitry underlying angry individuals' enhanced likelihood of engaging in angry responses. Therefore, the primary goal of the current study was to assess whether

individuals high in trait anger would show relatively greater left frontal cortical activation to mild anger cues even when explicit approach motivation opportunities were not made salient.

In the present study, participants were exposed to affective pictures used in previous research and found to evoke neutral, fearful/disgusting, positive, or angry affective reactions (Harmon-Jones et al., 2006). The current participants were given no explicit opportunities for approach-related behavior, but were instead simply informed that their brain wave responses would be recorded while they viewed pictures that might elicit various emotions. Following the completion of the viewing of the pictures and the simultaneous recording of EEG to the pictures, participants viewed the pictures a second time and rated how pleasant, aroused, and angry they felt while viewing each picture. Finally, they completed measures of trait anger and racism. It was predicted that individuals high in trait anger would be most likely to show increased relative left frontal activity to the anger-evoking pictures.

2. Method

Participants were 76 European American right-handed introductory psychology students (25 men and 51 women) at the University of Wisconsin — Madison. They participated in exchange for extra credit points. Gender did not interact with any of the results; therefore, it is not discussed further.

After greeting the participant, the experimenter explained that the session would involve a few tasks — viewing pictures of various types while brain waves were recorded and then completing personality questionnaires. Afterward, all participants viewed a series of pictures while EEG was recorded. The first three pictures presented were neutral practice trials and were not analyzed. Four types of pictures were presented in randomized order; there were 16 pictures of each type. Three of the types were obtained from the IAPS, and they were selected because they had been found to evoke negative (fear or disgust; e.g., bloody accident victims), positive (e.g., attractive couples), or neutral affect (e.g., neutral facial expressions) in past studies.¹ The fourth type was obtained from the internet (except two were from the IAPS); the pictures were selected because they evoke anger in individuals who were opposed to racism and prejudice (the same pictures were used in Harmon-Jones et al., 2006). Thus, these pictures depicted instances of racism and prejudice (e.g., Ku Klux Klan, Hitler, Neo-Nazis). Each picture trial consisted of a fixation cross presented for 1 s, a picture presented for 6 s, and an ITI of 14–19 s. After viewing

¹ IAPS picture numbers that were used are listed here. For negative (fear/disgust), the following pictures were used: 1050, 1090, 1200, 1300, 3060, 3150, 3400, 3550, 6230, 7380, 9250, 9300, 9405, 9500, 9620, and 9630. For positive, the following were used: 4608, 4611, 4641, 4653, 4658, 4659, 4670, 4672 (the penis was cropped out, to avoid the possibility of making some participants uncomfortable), 5470, 5621, 5626, 7270, 8080, 8170, 8190, and 8370. For neutral, the following were used: 2190, 2200, 2440, 2480, 2500, 2620, 2850, 2880, 7000, 7004, 7006, 7010, 7020, 7031, 7080, and 7175. For anger, 9800 and 9810 were used; the other 14 were found on the web and can be obtained from the author.

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