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Frontal electrocortical and cardiovascular reactivity during happiness and anger

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Abstract

The present study investigated electrocortical and cardiovascular reactivity during positive and negative emotion, and examined the relation of asymmetric frontal lobe activation to cardiovascular responses. Participants were 30 healthy, right-handed university students (mean age, 23.9; 60% female; 76% Caucasian). Electroencephalographic (EEG), blood pressure (BP), and heart rate (HR) responses were assessed while subjects engaged in laboratory tasks (personally-relevant recall tasks and film clips) designed to elicit happiness or anger. Happiness-inducing tasks evoked more prominent left than right frontal EEG activation, and greater left frontal EEG activation than anger-inducing tasks. However, anger-inducing tasks were, on average, associated with comparable left and right frontal EEG activation. Irrespective of emotional valence, cardiovascular activation was more pronounced during personally-relevant recall tasks than during the viewing of film clips.

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During anger recall, both greater left frontal EEG response ($r = -0.46$, $P < 0.02$) and greater right frontal EEG response ($r = -0.45$, $P < 0.02$) were correlated significantly with increased HR reactivity during the task. In addition, a right lateralized frontal EEG response during anger-inducing tasks was associated with greater concomitant systolic BP ($P < 0.03$) and diastolic BP ($P < 0.008$) reactivity. Exploratory analyses also indicated that men who displayed a left lateralized frontal EEG response during happiness-inducing tasks showed the greatest concomitant systolic BP and HR reactivity (P's < 0.03). These findings suggest that asymmetric frontal EEG responses to emotional arousal may elicit different patterns of cardiovascular reactivity in healthy adults.

Keywords: Electroencephalography; Lateralization; Frontal brain asymmetry; Cardiovascular reactivity; Blood pressure; Emotion

Intense emotional arousal is posited to play a role in the onset of acute coronary events such as myocardial infarction and sudden cardiac death (Kamarck and Jennings, 1991; Lane and Jennings, 1995; Mittleman et al., 1995; Krantz et al., 1996). It is hypothesized that emotions activate regions of the brain that stimulate sympathetic outflow, thus promoting elevations in various cardiovascular parameters. Cardiovascular responses (reactivity) of sufficient magnitude may, in turn, elicit coronary events via myocardial ischemia and a lowered threshold for ventricular arrhythmias (Kamarck and Jennings, 1991). Repeated cardiovascular responses during emotional arousal have also been hypothesized as a link between dispositional psychological traits (e.g. anger, anxiety) and cardiovascular disease (Manuck, 1994; Rozanski et al., 1999).

Although numerous investigations have linked central nervous system (CNS) activation to emotional arousal, and others have related emotional arousal to cardiovascular reactivity (see below), actual brain–heart interconnections remain poorly understood (Armour and Ardell, 1994). Indeed, despite that CNS activation may partially mediate associations between emotion and cardiovascular reactivity, it is unusual for each of these parameters to be examined in conjunction in a single investigation. Yet, such studies are critical first steps in the identification of brain–heart linkages during emotional activation that may ultimately prove to have relevance to the development of cardiovascular disease or the elicitation of acute coronary events.

The primary goal of the present study was, therefore, to examine whether laboratory tasks designed to elicit happiness or anger, both of which are emotions that may play a role in eliciting cardiac arrhythmias or sudden cardiac death (Kamarck and Jennings, 1991), evoke concomitant increases in regional cerebral (particularly frontal lobe) and cardiovascular activation in healthy young adults. Evaluating the feasibility of such an investigation in a healthy sample was also deemed an important initial step prior to studying a more pertinent, yet biologically vulnerable, patient population that is prone to cardiac arrhythmias and sudden cardiac death (such as patients with implantable defibrillators).

Rationale pertinent to this study's hypotheses regarding patterns of cerebral and cardiovascular responses during positive (happiness) and negative (anger) emotion