Brain, Behavior, and Immunity 23 (2009) 27–35

Contents lists available at ScienceDirect

Brain, Behavior, and Immunity

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

Named Series: Health, Psychology and Immunity

Neurobiological correlates of coping through emotional approach

Sarah L. Master [a], David M. Amodio [b], Annette L. Stanton [a], Cindy M. Yee [a], Clayton J. Hilmert [c], Shelley E. Taylor [a,*]

[a] Department of Psychology, University of California, Los Angeles, 1285 Franz Hall, Los Angeles, CA 90095-1563, USA
[b] Department of Psychology, New York University, 6 Washington Place, Room 782, New York, NY 10003, USA
[c] Department of Psychology, North Dakota State University, 105J Minard Hall, Fargo, ND 58105-5075, USA

ARTICLE INFO

Article history:
Received 29 January 2008
Received in revised form 10 April 2008
Accepted 24 April 2008
Available online 16 June 2008

Keywords:
Emotional approach coping
Frontal asymmetry
EEG
Approach motivation
Trier social stress test
Cortisol
Proinflammatory cytokines
sTNFαRII
IL-6

ABSTRACT

This investigation considered possible health-related neurobiological processes associated with "emotional approach coping" (EAC), or intentional efforts to identify, process, and express emotions surrounding stressors. It was hypothesized that higher dispositional use of EAC strategies would be related to neural activity indicative of greater trait approach motivational orientation and to lower proinflammatory cytokine and cortisol responses to stress. To assess these relationships, 46 healthy participants completed a questionnaire assessing the two components of EAC (i.e., emotional processing and emotional expression), and their resting frontal cortical asymmetry was measured using electroencephalography (EEG). A subset ($N = 22$) of these participants' levels of the soluble receptor for tumor necrosis factor-alpha (sTNFαRII), interleukin-6 (IL-6), and cortisol (all obtained from oral fluids) were also assessed before and after exposure to an acute laboratory stressor. Consistent with predictions, higher reported levels of emotional expression were significantly associated with greater relative left-sided frontal EEG asymmetry, indicative of greater trait approach motivation. Additionally, people who scored higher on EAC, particularly the emotional processing component, tended to show a less-pronounced TNF-α stress response. EAC was unrelated to levels of IL-6 and cortisol. Greater left-sided frontal EEG asymmetry was significantly related to lower baseline levels of IL-6 and to lower stress-related levels of sTNFαRII, and was marginally related to lower stress-related levels of IL-6. The findings suggest that the salubrious effects of EAC strategies for managing stress may be linked to an approach-oriented neurocognitive profile and to well-regulated proinflammatory cytokine responses to stress.

1. Introduction

According to functionalist views of emotions, emotions are complex systems that developed over the course of human evolution to coordinate adaptive responses to the demands of physical and social stimuli and challenges in the environment (cf. Keltner and Gross, 1999). This view conflicts with more traditional accounts that view emotions as maladaptive and disruptive to rational thought and other cognitive abilities (see Damasio, 1994). In terms of stress-related coping processes, this discrepancy between views of emotions as adaptive versus maladaptive is an important one, as the functionalist view suggests that coping via intentional efforts to process and express emotions is beneficial, whereas the more traditional view contends that focusing coping efforts on emotions is detrimental to successful coping (Stanton et al., 1994). This debate is of relevance to health, as one's mental and physical well-being are linked, in part, to how effectively one copes with stress (Penley et al., 2002; Taylor and Stanton, 2007). The present investigation sought to shed some light on this matter by considering relationships between emotion-focused coping strategies and health-related neurobiological processes.

1.1. Assessing the role of emotional approach coping

Some prior research has found that an individual's tendency to engage in emotion-focused coping (i.e., coping aimed at regulating the negative emotional consequences of a stressor), particularly through emotional expression, is associated with distress and dysfunction (see Stanton et al., 1994, 2002 for reviews). However, in their review of the coping literature, Stanton et al. (1994) observed that many items on emotion-oriented coping scales are confounded with distress or self-deprecation, potentially creating a spurious relationship in these prior studies between emotion-focused coping and maladjustment. In light of this confound and clinical and empirical research citing benefits of processing and expressing emotions associated with stressful events (e.g., Horowitz, 1976; Mendolia and Kleck, 1993; Pennebaker et al., 1988), Stanton and colleagues (1994; Stanton et al., 2000b) developed and validated self-report measures of *emotional approach coping*

* Corresponding author. Fax: +1 310 206 8940.
E-mail address: taylors@psych.ucla.edu (S.E. Taylor).

0889-1591/$ - see front matter © 2008 Elsevier Inc. All rights reserved.
doi:10.1016/j.bbi.2008.04.007

(EAC), which are unconfounded with distress and self-deprecation. *Emotional processing* refers to active efforts to acknowledge one's emotions and to explore their meanings, in order to gain a better understanding of one's emotional response to a stressor. *Emotional expression* involves active verbal and/or nonverbal attempts to communicate or symbolize one's emotional responses to a stressor.

A growing body of research shows that greater use of emotion-oriented coping strategies, as assessed with the EAC scales, is associated with more adaptive psychological and physical health outcomes in young adults and medical patient samples (see Austenfeld and Stanton, 2004 for a review). For instance, greater emotional expression predicted decreased distress, improved self-perceived physical health status, increased vigor, and fewer medical appointments for cancer-related morbidities among women completing treatment for breast cancer (Stanton et al., 2000a). In a study of couples undergoing an insemination treatment for infertility, higher emotional processing and expression scores prior to the insemination attempt predicted less distress in both women and men one week after receiving a negative pregnancy result (Berghuis and Stanton, 2002). Higher EAC scores (both emotional processing and expression) were also associated with lower affective pain and depressive symptoms in chronic myofascial pain patients, and for men, the emotional expression component of EAC was uniquely related to lower sensory pain and physical impairment (Smith et al., 2002).

Findings demonstrating health correlates of EAC are important, not only because they contradict the conclusions drawn from research using the confounded emotional coping measures, but also because they suggest possible methods for coping with stress that may improve people's mental and physical health outcomes. Despite the evidence that a focus on emotions is adaptive when dealing with stress, the specific mechanisms through which EAC contributes to positive health outcomes are not well-understood. Although much recent research has revealed important connections between neural and physiological processes and health outcomes, the relation between EAC strategies and neurobiological measures associated with well-being have not yet been examined. The present investigation was designed to address this gap in the literature. Specifically, the associations of EAC strategies with neural profiles of approach/avoidance motivational tendencies and with proinflammatory cytokine and neuroendocrine responses to stress were examined.

1.2. Neurocognitive and biological processes associated with EAC

1.2.1. Neurocognitive correlates of EAC

A critical component of the EAC strategy is the tendency to adopt an approach-oriented response when coping with stress. However, the relation between EAC and basic neurocognitive mechanisms of approach motivation have not previously been examined, and elucidating this relationship was a primary concern of the present investigation. In the psychophysiology literature, individual differences in approach motivation have been associated with greater baseline activation of the left prefrontal cortex (PFC), a region involved in self-regulation and the coordination of goal-directed action (Amodio et al., 2004; Miller and Cohen, 2001), among other related functions. Much of the research linking left PFC activity to approach motivation has used baseline electroencephalography (EEG) to assess left vs. right asymmetries in frontal cortical activity, which have been localized to dorsolateral regions of the PFC (Pizzagalli et al., 2005). This body of research has demonstrated consistent links between greater left-frontal asymmetry and both state and trait forms of approach motivation (e.g., Amodio et al., 2008; Coan and Allen, 2003; Harmon-Jones and Sigelman, 2001), independent of the objective valence (i.e., positivity or negativity) of the approach motivation (e.g., Harmon-Jones, 2003).

A link between EAC and frontal asymmetry would be significant because frontal asymmetry has been associated with a range of psychological profiles and biological processes associated with health. For instance, individuals with greater resting left-frontal asymmetry perceive environmental stress as less aversive, are less likely to suffer from depression, and are less likely to show negative affect in response to certain stressors (Davidson, 1992; Henriques and Davidson, 1990, 1991; Tomarken et al., 1990, 1992a). Similarly, manipulated decreases in left-frontal asymmetry through neurofeedback can cause depressed mood (Allen et al., 2001). Also, a recent study reported that a naturalistic stressor, examination stress, was associated with a shift from relatively greater left-frontal activity in students during the low examination stress period to relatively greater right-frontal activity during the high stress examination period (Lewis et al., 2007).

Increased activity in the left neural hemisphere has also been related to increased immunocompetence and to cortisol levels. For example, women with extreme left-frontal asymmetry had higher levels of natural killer (NK) cell function than those with extreme right-frontal activation (Kang et al., 1991), and participants with greater relative left-sided activation had a smaller decrement in NK cell activity *in vitro* after an emotional stressor (Davidson et al., 1999). A study using an *in vivo* immune measure found that individuals displaying greater relative left-sided activity produced a larger antibody titer rise (i.e., a healthier immune response) to influenza vaccination (Rosenkranz et al., 2003). The right hemisphere also appears to be more involved in cortisol release than is the left hemisphere (Wittling, 1995), and relatively greater left-frontal activity has been related to lower cortisol levels (Buss et al., 2003; Kalin et al., 1998).

Although underlying mechanisms are not yet fully understood, these findings suggest that, in addition to its relationship with approach motivation, greater left-sided frontal EEG activity is associated with healthier psychological and biological profiles. If a stronger tendency to engage in EAC reflects a stronger underlying approach motivational orientation, a relationship between EAC and resting frontal EEG asymmetry would be expected in this study. If found, this relationship would thus suggest one way in which EAC may be related to health.

1.2.2. Biological correlates of EAC

This study also assessed the direct relationships between EAC and biological stress responses. Increases in proinflammatory cytokine activity are often seen in response to stressful events, such as laboratory stressors and some psychological stressors (e.g., examinations, public speaking) (Ackerman et al., 1998; Brydon et al., 2004; Dickerson et al., 2004; Maes et al., 1998; Pace et al., 2006; von Känel et al., 2006; see Steptoe et al., 2007 for a review). Proinflammatory cytokine activity, including tumor necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6), has been tied to negative emotional states and ultimately to adverse changes in physical and mental health, and there is evidence indicating that proinflammatory cytokines may cause depressive illness (Das, 2007). The hypothalamic–pituitary–adrenal (HPA) axis is also commonly activated in response to stress, leading to the production of glucocorticoids, including cortisol (Sapolsky et al., 2000). Although this response is protective in the short term, chronic or recurrent activation can cause dysregulation of the HPA axis and of cortisol, leading to deleterious effects with implications for health (e.g., Cannon, 1932; Seeman and McEwen, 1996; Uchino et al., 1996). If, as the functionalist view of emotions posits, EAC aids a person in managing stressful situations, biological stress responses may be more well-regulated for people reporting higher EAC. To assess these