International Journal of Psychophysiology xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

International Journal of Psychophysiology

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

Exploring the relationship between frontal asymmetry and emotional dampening☆

James P. Loveless[a,*,1], Alexandra J. Nicoletta[a], Andrea R. Winters[a], Robert A. Carels[a], Karl L. Wuensch[a], Matthew C. Whited[a], James A. McCubbin[b], D. Erik Everhart[a]

[a] Department of Psychology, East Carolina University, United States
[b] Department of Psychology, Clemson University, United States

ARTICLE INFO

Keywords:
Emotional dampening
Frontal asymmetry
Emotion processing
Blood pressure

ABSTRACT

Cardiovascular emotional dampening is the term used to describe the inverse relationship between resting blood pressure and emotional responsivity which extends from normotensive to hypertensive ranges. Little is known about its underlying physiological mechanisms, but it is thought to involve some disruption in emotion processing. One area that has yet to be explored in the literature is the relationship between emotional dampening and frontal asymmetry, a psychophysiological indicator for motivational direction and emotional valence bias. The present study explored that relationship using data from a sample of 48 healthy college students. Measures of baseline resting blood pressure and frontal cortical activity were recorded, after which participants completed a series of emotion-related tasks. Results revealed a significant relationship between resting systolic blood pressure and left frontal activity. Likewise, left frontal activity was associated with neutral appraisal of emotionally valenced stimuli within the tasks. The findings from the present study yield support for a link between emotional dampening and left frontal activity. Implications are discussed.

1. Introduction

Higher resting blood pressures are related to increased difficulties with appraising and responding to emotionally laden stimuli (Delgado et al., 2014; McCubbin et al., 2014; McCubbin et al., 2011; Pury et al., 2004). This phenomenon suggests an intimate link between cardiovascular functioning and emotion regulation, and has been termed cardiovascular emotional dampening. Researchers have hypothesized that chronic stress plays a role in its development, and that it could be a contributing factor to many cardiovascular and psychiatric health concerns. Despite all of the potential implications, findings from the emotional dampening literature are limited by the novelty of the construct. Further research is needed to better understand the phenomenon and associated mechanisms before we can understand the potential consequences.

Interest in the relationship between blood pressure and emotion appraisal was derived from research related to blood pressure and pain sensitivity. There is a well- documented inverse relationship between blood pressure and pain sensitivity. Both hypertensive animals and humans display reduced sensitivity to painful stimuli as compared to their normotensive counterparts (Bruehl and Chung, 2004; Ghione, 1996; Randich and Maixner, 1984). Furthermore, it has been observed that the inverse relationship between pain algesia and blood pressure extends throughout the normotensive range (Bruehl et al., 1992; McCubbin and Bruehl, 1994; McCubbin et al., 2006). Those experiencing blood pressure related hypoalgesia have also demonstrated blunted affective responses to pain; thus, it was hypothesized that the phenomenon may be indicative of a more generalized dampening of emotional responsivity (Duschek et al., 2009; Fillingim et al., 1998; McCubbin et al., 2006). Results from several emotional dampening studies have lent support to that conclusion (Delgado et al., 2014; McCubbin et al., 2014; McCubbin et al., 2011; Pury et al., 2004).

Emotional dampening occurs within the context of a complex psychophysiological system which allows for individuals to respond to environmental demands. Emotions are transient reactions to specific eliciting stimuli, and each emotion state promotes a specific range of responses (Buck, 1985; Frijda, 1988; Gross, 2002; Gross, 1998; Thayer and Lane, 2000). The process by which emotions are managed is known

☆ No grant support was received for this project.
* Corresponding author at: Behavioral Medicine Center, Department of Psychiatry & Neurobehavioral Sciences, University of Virginia Health System, PO Box 800223, Charlottesville, VA 22908-0223, United States.
E-mail address: Jpl4g@virginia.edu (J.P. Loveless).
[1] Now at the Department of Psychiatry & Neurobehavioral Sciences at the University of Virginia.

https://doi.org/10.1016/j.ijpsycho.2017.12.003
Received 29 October 2017; Received in revised form 6 December 2017; Accepted 6 December 2017

as emotion regulation (Gross, 1998, 2002). Emotional dampening may prevent optimal emotion regulation via interfering with how emotion-related information is processed in higher cortical structures.

The exact physiological processes which underlie emotional dampening are unknown. It was initially hypothesized that acute increases in blood pressure could lead to emotional dampening via afferent inhibitory signaling, as similar processes have been observed in the pain literature (Pury et al., 2004). McCubbin et al. (2014) found that acute changes in blood pressure were unrelated to emotion recognition accuracy and thus went on to hypothesizes that the phenomenon may be due to some alteration in central nervous system control of blood pressure set point. The findings from Delgado et al. (2014) demonstrated evidence for both hypotheses as individuals identified as emotional dampeners (when compared to those who reported having a high emotional sensitivity) not only had higher blood pressures and measures of HRV at rest, but also after the induction of a startle response via a loud unexpected auditory stimulus. Adding further ambiguity to this puzzle is the fact that the way in which emotional dampening interferes with central nervous system processing of emotion is poorly understood. It has been hypothesized that emotional dampening perhaps represents a developmental phenomenon that could parallel the development of hypertension (McCubbin et al., 2014; McCubbin et al., 2011). Just as resting blood pressure increases overtime, so too might the degree of disruption in emotion processing.

There are two overlapping pathways within the central nervous system which process emotion-related information (LeDoux and Phelps, 2008; McRae et al., 2012). One pathway runs through structures in the neocortex and is primarily involved in slower top-down emotion processing, while the other pathway runs through subcortical structures and is primarily involved in quick bottom-up emotion processing. Both pathways converge on the amygdala which allows for the subjective experience of emotion through its effects on the autonomic nervous system, the endocrine system, and other higher cortical structures and systems (Gur et al., 2002; Habel et al., 2007; LeDoux and Phelps, 2008; Phelps and LeDoux, 2005). Each pathway can operate independently, or in parallel with the other. Loveless (2015) hypothesized that emotional dampening might be less profound among younger and healthier populations, and thus might be easier to detect using tasks which require a sensitivity to bottom-up emotion processing to complete. It was suggested that emotional dampening studies should include both types of tasks to control for this possibility.

One phenomenon which has yet to be explored in the emotional dampening literature is its potential relationship to frontal asymmetry. Frontal asymmetry refers to differences in neural activity between the left and right hemispheres of the frontal region of the forebrain. Measured via electroencephalography (EEG), frontal asymmetry is traditionally thought to be related to the experience of a valence bias when processing emotion-related information. Specifically, those with greater right frontal activity have a bias towards the experience of negative emotions, while those with greater left frontal activity have a bias towards the experience of positive emotions (Davidson and Fox, 1982; Stewart et al., 2011; Tomarken et al., 1992).

Other research on frontal asymmetry has yielded an alternate way of conceptualizing the phenomenon. Several studies have linked frontal asymmetry to motivational direction. Specifically, those with greater right frontal activity tend to avoid punishing stimuli in their environment, while those with greater left frontal activity tend to approach rewarding stimuli (Amodio et al., 2008; Balconi et al., 2012; Coan & Coan and Allen, 2003; Demaree et al., 2005; Harmon-Jones and Allen, 1998; Harmon-Jones et al., 2010; Sutton and Davidson, 1997). Frontal asymmetry findings have therefore been conceptualized as a biological indicator of Gray's Reinforcement Sensitivity Theory (RST; Gray and McNaughton, 2000). RST is a theory of individual differences which posits that behavior is governed by independent systems which influence an individual's sensitivity to punishment and reward (Gray, 1990; Gray and McNaughton, 2000). This theory provides a framework for two interacting motivational systems: the Behavioral Activation System (BAS) and the Behavioral Inhibition System (BIS). The BAS governs appetitive motivation through approach related behavior, while the BIS governs aversive motivation through withdrawal or avoidance related behavior (Gray, 1990).

Consistent with what would be predicated by RST, studies have shown that individuals who have greater left frontal activity also have a tendency to experience negatively valenced emotions that are linked with approach-related behaviors. For example, Harmon-Jones and Allen (1998) found left-frontal activity was positively related to trait anger in a sample of adolescent boys. Watson et al. (2016) found similar results among a sample of young adult college students. Left-frontal activity was related to participants' trait anger scores, and scores related to behavioral approach on the BIS/BAS scales (Watson et al., 2016). Similar findings have been demonstrated with hostility (Everhart et al., 2008).

Exploring the relationship between cardiovascular emotional dampening and frontal asymmetry may help us to understand if emotionally dampened individuals tend to favor a particular motivational direction. Either a tendency towards approach or avoidance could be plausible. For example, it could be that emotional dampeners have a tendency to engage in more approach-related behaviors because they have a reduced ability to recognize threats. Likewise, emotional dampeners may engage in more thrill seeking (i.e. approach-related) behaviors to achieve a sense of excitement that they would otherwise not experience in their normal routine. Finally, it is possible that reduced emotion responsivity among emotional dampeners is in part due to a tendency to avoid emotionally evocative stimuli. Regardless of which motivational direction might be favored, a relationship between frontal asymmetry and emotional dampening could have important implications for how those with emotional dampening process and respond to emotion-related information.

The present study seeks to explore the relationship between emotional dampening and frontal asymmetry among a sample of healthy college students by comparing their baseline physiological recordings to their performance on a series of tasks designed to promote top-down and bottom-up emotion processing. It was hypothesized that: 1) resting blood pressure would be related to measures of frontal asymmetry; and 2) measures of frontal asymmetry will be related to task performance.

2. Materials and methods

2.1. Statement of IRB approval

All methods, materials, and procedures described below were reviewed and approved by the ECU University and Medical Center Institutional Review Board.

2.2. Participants

The current study utilized a sample of 48 (23 women) healthy right-handed undergraduate student participants with ages ranging from 18 to 31 (M = 19.38, SD = 2.07). All participants were recruited from the East Carolina University psychology department participation pool. Those with a history of significant cardiovascular, endocrine, or psychiatric disorders were excluded from participation. Additionally, anyone currently using cardiovascular or psychoactive medications was also excluded. All participants consented to participate in the study, and all received course credit for their participation.

2.3. Psychometric measures and questionnaires

2.3.1. BIS/BAS scales

The behavioral inhibition scale (BIS) and behavioral activation scale (BAS), developed by Carver and White (1994), are comprised of 20 items which span four domains: BIS, BAS reward responsiveness, BAS