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Resting RSA is associated with natural and self-regulated responses to negative emotional stimuli

Heath A. Demaree,[a,*] Jennifer L. Robinson,[a] D. Erik Everhart,[b] and Brandon J. Schmeichel[a]

[a] *Department of Psychology, Case Western Reserve University, Mather Memorial Building, Room 109, 11220 Bellflower Road, Cleveland, OH 44106-7123, USA*

[b] *Department of Psychology and Program in Neuroscience, East Carolina University, Rawl Building, Greenville, NC 27858, USA*

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Abstract

Resting respiratory sinus arrhythmia (RSA) was assessed among 111 adult participants. These individuals were then asked to watch a positive or negative affective film in either a natural manner or while exaggerating their facial response. Facial reactions to the film were video-recorded and subsequently rated in terms of facial affect. Participants also self-reported the valence of their emotional experience. Results from regression analyses revealed that persons with low resting RSA behaviorally evidenced a more negative facial response to the negative film under natural-watch conditions. Low RSA individuals were also less able to modulate (i.e., amplify) their facial response to the negative film. In terms of self-report measures, persons in the exaggerate condition reported more positive affect to the positive film than did those in the natural-watch condition. Results suggest that cardiac vagal control is inversely associated with negative facial expression but positively associated with facial regulation ability to negative stimuli.

Keywords: RSA; Emotion; Affect; Regulation; Modulation; Expression; Cardiac vagal control

1. Introduction

Increased emotional display and a relative inability to regulate affect are hallmark characteristics of over half of the non-substance use Axis I Disorders and all of the Axis II Disorders in the Diagnostic and Statistical Manual, 4th edition (American Psychiatric Association, 1994). The physiological bases of such emotional tendencies have been increasingly studied over the last decade, with much of the research involving participants with affective disorders. Notably, reduced cardiac vagal control [as measured by respiratory sinus arrhythmia (RSA) and high frequency heart rate variability (HF)[1]] has been found among persons with elevated levels of anxiety, depression, and hostility. The present research was designed to test the generalizability of these findings in a healthy adult population reporting no history of affective or cardiovascular problems.

Individuals diagnosed with an anxiety disorder have reduced cardiac vagal control (Friedman & Thayer, 1998a, 1998b; Thayer, Friedman, & Borkovec, 1996; Watkins, Grossman, Krishnan, & Sherwood, 1998). For

* Corresponding author. Fax: 1-216-368-4891.
E-mail address: heath.demaree@case.edu (H.A. Demaree).

[1] RSA accounts for respiration rate and inspiratory depth whereas HF does not. However, because both measures have been found to measure cardiac vagal control and correlate highly with one another (Berntson et al., 1997; Denver & Porges, 2001; Houtveen, Rietveld, & de Geus, 2002; Task Force, 1996), just one term—RSA—will be used throughout this paper. Please see the "Physiological Recording Procedures" section for an in-depth review of our RSA quantification procedures.

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example, Friedman and Thayer (1998a) found that, relative to controls, both blood phobics and persons who experience frequent panic attacks have reduced RSA. Thayer and colleagues (1996) obtained similar results among persons diagnosed with Generalized Anxiety Disorder (GAD). Specifically, relative to controls, individuals suffering from GAD evidenced reduced RSA during baseline, relaxation, and worry conditions. Such findings make theoretical sense, as developmental and adult literatures have speculated that reduced cardiac vagal control is associated with poor self-regulation ability (Porges, 1992; Thayer & Lane, 2000).

Depression symptomatology has also been associated with decreased cardiac vagal control (Carney et al., 2000; Rechlin, Weis, & Kaschka, 1995; Rechlin, Weis, Spitzer, & Kaschka, 1995; Roose, Glassman, & Dalack, 1989). For example, Carney et al. (2000) collected 24-h ambulatory electrocardiogram (ECG) data from 37 depressed and 26 non-depressed participants. Using the average of the SD of normal-to-normal intervals for each 5-min interval, these investigators found that severely depressed individuals had significantly reduced cardiac vagal control as compared to the non-depressed group. Interestingly, the alleviation of depressive symptomatology has been found to correspond to simultaneously increased cardiac vagal control (Carney et al., 2000; Chambers & Allen, 2002). In the Carney et al. (2000) study, for example, cardiovascular differences were no longer observed between groups after the depressed participants attended 16 sessions of cognitive behavioral therapy (their Beck Depression Inventory scores were also significantly reduced). Taken together, these findings suggest that cardiac vagal control may be associated with another form of affect dysregulation, namely depression.

Hostility, too, has been associated with decreased cardiac vagal control (Demaree & Everhart, 2004; Sloan et al., 1994). Sloan et al. (1994), for example, found that RSA and Cook-Medley Hostility Scale score (Cook & Medley, 1954) were significantly and inversely related among persons less than 40 years of age. This finding was recently replicated by Demaree and Everhart (2004). Because the two constructs covary with one another (Koh, Kim, & Joong, 2002), it should not be surprising that both depression and hostility are associated with reduced cardiac vagal control. Combining empirical data from persons with relatively anxious, depressed, or hostile temperaments, the above clinical research suggests that persons with low RSA may be more affectively labile and intense with a diminished ability to modulate their emotional expression.

The authors anticipated that persons with relatively low RSA levels would be more facially expressive when naturally watching an affective stimulus and less effective in modulating (in this study, exaggerating) their facial expressions when asked to do so. It should be noted that, while it was expected that they would be relatively poor regulators of facial expression to both positive and negative stimuli, an RSA by Valence effect is plausible because prior clinical research has found that low RSA individuals are prone to affect dysregulation problems solely within the negative affective domain (i.e., anxiety, depression, and hostility). It was also expected that exaggerating one's response to a positive stimulus would induce greater self-reported positive affect, whereas greater negative affect would not be reported when exaggerating one's response to a negative stimulus. Last, because lower RSA individuals were expected to be worse exaggerators, it was expected that their exaggeration of positive stimuli would produce less of an increase in self-reported positive affect relative to higher-RSA individuals. A more detailed discussion of these hypotheses is provided below.

Will the differential ability of low- and high-RSA individuals to modulate emotional expression influence their self-reported emotion? Prior research on suppression (like exaggeration, a "response-focused" strategy during which facial expressions are altered *after* an emotional experience has been initiated) has demonstrated decreased positive affect to positive stimuli but no change in self-reported affect to negative stimuli (Buck, 1980; Duclos & Laird, 2001; Duclos et al., 1989; Flack, Laird, & Cavallaro, 1999; Gross & Levenson, 1993, 1997; Hess, Kappas, McHugo, Lanzetta, & Kleck, 1992; Larsen, Kasimatis, & Frey, 1992; Levenson, Ekman, & Friesen, 1990; Levenson, Ekman, Heider, & Friesen, 1992; Matsumoto, 1987; Soussignan, 2002; Strack, Martin, & Stepper, 1988). Likewise, we anticipate that facial exaggeration may lead to increased self-reported positive affect to a positive stimulus but no change in emotional experience to a negative stimulus.

No research designed to investigate the relationship between cardiac vagal control, emotional expression, facial expression regulation ability, and self-reported affect among a healthy adult population has been performed. The present study was designed to fill this void by asking people to watch either an amusing or disgusting film and to either watch the film *naturally* or to *exaggerate* their emotional response (4 groups: natural-positive, natural-negative, exaggerate-positive, and exaggerate-negative). The use of both positive and negative films is important because it allows for the determination of whether baseline physiology predicts behavioral, experiential, and regulatory responses in reaction to a specific affective valence (i.e., negative or positive) or across different hedonic valences (e.g., a generalized pattern of response). The exaggeration condition was used because the vast majority of affect regulation research has studied suppression and the valence effect of suppression on self-reported emotion has already been well-established (Gross & Levenson, 1993, 1997; Richards & Gross, 1999; Wegner, Shortt,