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Trait dominance is associated with vascular cardiovascular responses, and attenuated habituation, to social stress

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ABSTRACT

Both exaggerated and diminished levels of cardiovascular reactivity have been associated with cardiovascular ill health. Dysregulation of hemodynamic mechanisms which control cardiovascular functioning may account for some individual differences in health outcomes. Trait dominance has also been associated with poor cardiovascular health in studies of humans and animals. The current study investigated the relationship between trait dominance and cardiovascular habituation to repeated social stress in humans.

Forty-seven undergraduate women completed two consecutive speech tasks, preceded by a baseline period, and separated by an inter-task resting phase. Continuous cardiovascular functioning was monitored using the Finometer device. The trait dominance subscale of the Jackson Personality Research Form was completed.

Mixed ANCOVA with trait dominance revealed a significant 3 (dominance) × 4 (phase) interaction for total peripheral resistance (TPR), such that TPR varied across experimental phases and was associated with trait dominance, $F(1, 43) = 12.88$, $p = .001$, partial $\eta^2 = .23$. Further mixed ANCOVA for TPR reactivity to Exposures 1 and 2 revealed a significant 3 × 2 interaction with trait dominance, $F(2, 40) = 7.77$, $p = .001$, partial $\eta^2 = .28$, such that higher dominance was associated with attenuated TPR habituation to Exposure 2.

Trait dominance was significantly associated with vascular-oriented cardiovascular functioning, and with attenuated habituation to social stress. Vascular-dominated stress responses have in some instances been associated with ill-health, suggesting that a failure to habituate to stress, and a vascular response style could reflect potential mechanisms through which dominance is associated with poor future cardiovascular health.

1. Introduction

It is increasingly acknowledged that both smaller and larger physiological stress responses may be associated with poorer long-term cardiovascular health (Carroll et al., 2009). Extending the wide research on the harmful effects of exaggerated cardiovascular functioning stemming from the cardiovascular reactivity (CVR) hypothesis (Obrist, 1976), a range of other physiological stress response profiles have since been implicated in the aetiology of cardiovascular disease (CVD), including delayed recovery following stress (Schuler and O'Brien, 1997; Stewart et al., 2006), disrupted habituation to stress (Hughes et al., 2011), and blunted reactivity to stress (Phillips et al., 2013). While there is robust evidence that CVR to stress can predict future negative health outcomes, many of the moderating and mediating mechanisms are not yet fully understood (Treiber et al., 2003).

For cardiovascular stress responses, determining whether reactivity is exaggerated or blunted is complicated by the way blood pressure is derived from a dynamic and compensatory interaction between cardiac output (CO) and total peripheral resistance (TPR). The operation of this reciprocal relationship can be conceptualised as a process of flow and resistance (Levick, 2010). Increased CO results in greater ejection of blood from the ventricles of the heart to surrounding arteries, reflecting a physiological preparedness of the body to execute an action. In contrast, increased TPR reflects increased vascular constriction, causing an opposition or resistance in the blood vessels that serves to regulate blood flow (Levick, 2010). The term hemodynamic profile has been advocated by as a means of describing this specific compensatory relationship (James et al., 2012). This complexity of the cardiovascular system is such that it is possible for two different people to have the same mean level of blood pressure, despite their individual blood pressure having different hemodynamic determinants (as long noted by Brod et al., 1959). Individual variations in the magnitude, pattern, and duration of stress-induced hemodynamic responses could have implications for the nature and extent of pathophysiological changes leading to CVD (James et al., 2012). In terms of the hemodynamics underlying blood pressure changes, individuals may be referred to as either vascular (TPR-dominated) or cardiac (CO-dominated) reactors, categories which have been shown to have some temporal stability (Sherwood et al., 1990). Additionally, it should be considered whether the classification of hemodynamic patterns (and cardiovascular functioning more

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broadly), stems from higher general levels of cardiovascular activity, or whether such classifications are derived from large changes in cardiovascular functioning over time, such as in response to a stressor, and are thus indicative of reactivity.

Active stress tasks (like public speaking or mental arithmetic) have been shown to be associated with increased myocardial reactivity, which may be adaptive initially, demonstrating an increased active physiological response to something that is stressful. Subsequent exposures to the same stressor have shown reduced myocardial stress responses in several studies (al'Absi et al., 1997; Frankish and Linden, 1991; Kelsey et al., 1999). In contrast, vascular profiles of stress responding are typically evoked by tasks requiring passive coping, such as the cold pressor task. Prolonged vascular responses to stress have been associated with negative cardiovascular health outcomes, including increased vascular resistance and excessive vascular reactivity (Palatini and Julius, 2009).

Stronger dispositions towards some trait dimensions of personality, such as neuroticism, anger and hostility, and a desire for social dominance have been shown to be associated with future cardiovascular ill-health, such as increased incidence of coronary heart disease (CHD) and atherosclerosis (see Booth-Kewley and Friedman, 1987; Everson-Rose and Lewis, 2005; Suls and Bunde, 2005). Trait (or social) dominance is an individual difference variable encapsulating social competitiveness and the degree to which persons innately desire to exert a dominant position within their social group (Pratto et al., 1994). While dominance may have conferred evolutionary advantages, higher levels of dominance in modern society may have health consequences. Trait dominance has been linked to CVD consequences, including increased odds of both fatal and non-fatal cardiovascular events (Siegman et al., 2000). In contrast, greater submissiveness has been found in some instances to be protective against ill-health (Siegman et al., 2000; Whiteman et al., 2000).

Socially-salient stressors have been shown to elicit considerable and reliable cardiovascular stress responses (e.g., al'Absi et al., 1997; Gramer, 2003), and such forms of stress may be especially pertinent for individuals with strongest interpersonal trait influences such as trait dominance. Research has supported a positive association between trait dominance and CVR to socially-relevant forms of stress, but not asocial stress (Gramer and Berner, 2005; Hughes and Callinan, 2007; Newton, 2009). A recent review (Newton, 2009) concluded that in the main, studies involving socially relevant stressors show significant positive associations between trait dominance and acute cardiovascular responses.

Investigation of individual differences in personality, coupled with a consideration of the diversity of hemodynamic responding to repeated stress could elucidate variations in CVR more clearly. Thus, the present study sought to assess whether individual differences in trait dominance influenced the extent to which healthy adults adapted to stress across time, as represented by hemodynamic responses observed during repeated exposures to a stress-inducing social stress task.

2. Materials and methods

2.1. Participants

Participants were 54 undergraduate women. For the purposes of this study, only women under the age of 35 years (ages ranged from 17 to 34; $M = 20.98$, $SD = 3.42$), without a personal history of hypertension, with baseline blood pressure within normal ranges (blood pressure < 140/90 mm Hg), and with a BMI of less than 30 ($M = 22.92$, $SD = 2.98$) were included in the final sample ($n = 46$). Nine smokers were included for reasons of power as it was determined that the inclusion of smokers did not alter the trend of the results. No restrictions were placed on participants prior to participation in the study with regard to smoking, exercise, or caffeine intake. All procedures and materials were approved by an institutional ethics review panel prior to commencement of the research.

2.2. Measures

2.2.1. Cardiovascular responses

Cardiovascular functioning was assessed using a Finometer hemodynamic cardiovascular monitor (Finapres Medical Systems BV, BT Arnhem, The Netherlands). The Finometer measures beat-to-beat cardiovascular functioning non-invasively and is the successor of previous cardiovascular monitoring devices, the TNO Finapres-model-5 and the Ohmeda Finapres 2300e, which have been used in the previous research (e.g., Beckham et al., 2002; Gregg et al., 2002; Philippsen et al., 2007; Van Rooyen et al., 2004). The Finometer has been shown to provide accurate blood pressure measurement in young populations (Schutte et al., 2003). Determination of cardiovascular functioning using the Finometer is premised on the volume-clamp method, first developed by Peňaz (1973), while individualised determination of the volume at which the artery should be clamped is automatically calculated using the Physiocal algorithm (see Wesseling et al., 1995). Continuous measures of arterial CO, and TPR are estimated from arterial blood pressure waveforms using the validated Modelflow modelling method (Wesseling et al., 1995; Wesseling et al., 1993). Some of the precise operating procedures of the Finometer have been detailed elsewhere (see Hughes et al., 2011).

2.2.2. Psychometric measurement

Trait dominance was measured using the Jackson Personality Research Form (JPRF) social dominance subscale (Jackson, 1999). Sixteen items assessed trait dominance ($M = 5.24$, $SD = 4.10$; possible scores ranged 0–16). Sample items include *I feel confident when directing the activities of others*, and *I would make a poor military leader* (reverse-scored). High scorers on the trait dominance subscale of the JPRF attempt to control their environments and influence or direct other people; they are forceful, decisive, authoritative, and domineering (Pratto et al., 1994). Reliability in the current study for trait dominance was good ($\alpha = .88$).

2.2.3. Subjective task ratings

Participants provided subjective ratings for three separate items measuring task engagement; perceived stress, interest, and difficulty. Participants were asked *how stressful/interesting/difficult did you find the task* following their completion of the stress tasks. Answers were obtained using a five-point Likert response scale, with possible scores ranging from 0 (not at all; stressful, interesting or difficult) to 4 (extremely; stressful, interesting or difficult).

2.2.4. Speech task

Participants were asked to perform two of three possible speech task scenarios. Assignment to the speech tasks was randomised by the experimenter, and participants each performed two different speech tasks during the course of the experiment. The speech tasks chosen were similar in format and content to procedures previously employed in published research (e.g., Bostock et al., 2011; Hamer et al., 2006, 2007). The scenario was described, participants were given 2 min to prepare their defensive speech, and following this they were asked to deliver their speech to a video camera for 2 min, and they were aware that their performance was being video recorded. The scenarios involved false accusations of shoplifting, cheating on an exam, or an accusation of occupational disinterest. Participants were told that their speeches would be recorded, and that the tape would later be evaluated by the researcher for overall content, clarity and delivery. The experimenter remained in the room throughout the duration of the experiment, but remained behind an opaque screen, except when delivering instructions to the participant.