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The vasovagal response during confrontation with blood-injury-injection stimuli: The role of perceived control☆

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ABSTRACT

The vasovagal response (VVR) is a common medical problem, complicating and deterring people from various procedures. It is an unusual stress response given the widespread decreases in physiological activity. Nevertheless, VVR involves processes similar to those observed during episodes of strong emotions and pain. We hypothesized that heightened perceived control would reduce symptoms of VVR. Eighty-two young adults were randomly assigned to perceived control or no perceived control conditions during exposure to a stimulus video of a mitral valve surgery, known to trigger VVR in non-medical personnel. Perceived control was manipulated by allowing some participants to specify a break time, though all received equivalent breaks. Outcomes included subjective symptoms of VVR, anxiety, blood pressure, heart rate, and other measures derived from impedance cardiography. Compared to participants with perceived control, participants with no perceived control reported significantly more vasovagal symptoms and anxiety, and experienced lower stroke volume, cardiac output, and diastolic blood pressure. Participants who were more fearful of blood were more likely to benefit from perceived control in several measures. Perceived control appears to reduce vasovagal symptoms. Results are discussed in terms of cognition and emotion in VVR.

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1. Introduction

Over one million people are evaluated for syncope in the United States annually (Fenton, Hammill, Rea, Low, & Shen, 2000) accounting for 1% of emergency department visits (Blanc et al., 2002; Brignole et al., 2003) and 3.6% of hospital admissions (Morichetti & Astorino, 1998). Many more cases do not come to the attention of medical personnel. Of the various possible causes of syncope, the vasovagal response (VVR) is the most common (Manolis, Linzer, Salem, & Estes, 1990). VVR, with or without syncope, also causes significant distress and can deter people from routine medical activities such as immunization, dental care, and blood donation (Enkling, Marwinski, & Jöhren, 2006; France, France, Roussos, & Ditto, 2004; Marks, 1988; Nir, Paz, Sabo, & Potasman, 2003; Page, 1996).

The vasovagal process is complex and can be triggered by different physical and psychological stimuli such as a hot environment, prolonged standing, hemorrhage, and psychological stress. For many years, theorists have emphasized low control or submission to a threat as key determinants of the likelihood of a stress-related VVR (Engel, 1962, 1978; Sledge, 1978). While all stress responses are related to at least some lack of perceived control over the environment – life problems with easy and available solutions are unlikely to cause a stress response (Lazarus & Folkman, 1984; Sanderson, Rapee, & Barlow, 1989) – the emphasis has been especially strong in models of VVR.

Graham, Kabler, and Lunsford (1961) argued that vasovagal syncope is the result of parasympathetic rebound related to a state of relief that follows a period of strong uncontrollable stress. Although his ideas changed with time, Engel consistently emphasized the

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idea of an adaptive surrender to uncontrollable stress (Engel, 1978; Engel & Romano, 1947). Page (1994) suggested that vasovagal syncope results from a dual process in which fear is accompanied by a sense of disgust perhaps due to the possibility of unavoidable body envelope violation. More recent models have suggested that stress-related vasovagal syncope develops as a physiological preparation for unavoidable injury, perhaps as a means of deterring aggression (Bracha, 2004) or stemming blood loss (Barlow, 1988; Diehl, 2005; Ditto, Balegh, Gilchrist, & Holly, 2012; Ditto, Gilchrist, & Holly, 2012). Relatedly, it is interesting to note that VVR is the most common in medical settings in which people are required to passively endure unpleasant procedures (Enkling et al., 2006; France et al., 2004; Nir et al., 2003; Page, 1996) and is especially common among individuals with pre-existing fears of blood, injury, and injections (Marks, 1988).

Given this focus on lack of control, it is reasonable to predict that enhancing an individual's sense of control over stress would reduce VVR. Indeed, it has been argued that the fear of losing control may be central to the progression of VVR (Ritz, Meuret, & Ayala, 2010). Fainting and related vasovagal symptoms are often a primary complaint and a central treatment focus in cognitive-behavioral therapies for Blood-Injury-Injection Phobia (Hellström & Fellenius, 1996; Öst, Fellenius, & Sterner, 1991). In a recent review, Ritz et al. (2010) discussed successful treatment studies of Blood-Injury-Injection-Phobia which did not focus on treatment of fainting. Patients who had improved at follow-up also reported no longer using a technique designed to manage fainting or other symptoms of VVR, (i.e., applied tension). The authors point to perceived control as a possible explanation (Ritz et al., 2010).

The primary goal of this study was to examine the effects of an experimental manipulation believed to enhance participants' sense of perceived control on their responses to a "prototypical" VVR-inducing stimulus, i.e., passively watching a video of a surgical procedure. It was predicted that an increased sense of perceived control would reduce physiological correlates of VVR and vasovagal symptoms. A secondary aim of the study was to examine the relative effects of individual differences in fear of blood and fear of needles on VVR, and their interaction with perceived control. In the previous study (Gilchrist & Ditto, 2012), we found that a video of blood withdrawal elicited stronger VVR than a virtually identical video of an intravenous injection. Thus, in the present study, it was predicted that participants who were especially fearful of blood loss would be most likely to display VVR and to benefit from enhanced perceived control.

2. Method

2.1. Participants and experimental conditions

Eighty-two undergraduate and young adult community volunteers (51 female) aged 18–30 years ($M = 22.3$, $SD = 3.1$) participated in the study. Participants were unobtrusively (i.e., without their knowledge and randomly) assigned to either the perceived control ($N = 41$) or no perceived control ($N = 41$) condition. Potential participants who reported any neurological or cardiovascular illness, hearing problems, or English not as a first or second language were excluded. Three participants were excluded due to technical issues with the physiological recordings and computer. As it was expected that responses would be seen in non-phobic populations and for purposes of generalizability, a phobic sample was not used in this study. Participants were asked to refrain from vigorous physical activity on the day of the study, to avoid caffeine for 4 h and smoking for 2 h prior to the experiment.

2.2. Materials and apparatus

Medical Fears Survey (Kleinknecht, 1991). Participants completed an abbreviated 30-item version of the Medical Fears Survey that included two subscales especially relevant to medical contexts: blood-related fears and needle-related fears (Kleinknecht, Thorndike, & Walls, 1996). Participants rated their fearfulness of a number of events on a 5-point Likert-like scale anchored at 0, "no fear at all", and 4, "terror." Total scores on these subscales range from 0 to 50, with higher scores indicating higher fears. The Medical Fears Survey correlates well with other Blood-Injury-Injection-Phobia measures and shows good internal consistency (Kleinknecht, Kleinknecht, Sawchuk, Lee, & Lohr, 1999). Consistent with previous studies, the correlation between these subscales was within the moderate to high range, Pearson's $r = .465$ (Kleinknecht et al., 1996; Warfel, France, & France, 2012). Cronbach's alpha for the needle and blood subscales in this study was .883 and .892, respectively.

Blood Donation Reactions Inventory (*BDRI*; France, Ditto, France, & Himawan, 2008; Meade, France, & Peterson, 1996). Subjective vasovagal symptoms were assessed with the Blood Donation Reactions Inventory, a well-validated 11-item survey including ratings of symptoms such as dizziness, lightheadedness, and weakness. Participants indicated on a six-point Likert-like scale the degree to which they experienced these sensations from "not at all" to "an extreme degree."

State-Trait Anxiety Inventory (*STAI*; Spielberger, Gorsuch, & Lushene, 1970). State anxiety was assessed using the State-Trait Anxiety Inventory, a 20-item questionnaire scored on a four-point Likert-type scale from "not at all" to "very much." Total scores range from 20 to 80, with higher scores representing higher anxiety. State anxiety scores have been found to increase in response to psychological stress and physical danger and to decrease following relaxation (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983).

Blood pressure. Measurements of systolic and diastolic blood pressure were obtained at baseline and 4 min into the stimulus video, before participants took their breaks. Measurements were obtained using an oscillometric monitor (Accutorr Plus™, Data Scope Corp., Mont Vale, NJ, USA) with the cuff attached to the upper non-dominant arm.

Heart rate and heart rate variability (HRV). A three-lead electrocardiogram (ECG) was used to extract heart rate and HRV data. Two spot electrodes were placed bilaterally on the rib cage, with a ground spot electrode on the right ankle. A Biopac MP150 (Biopac Systems Canada Inc.) system was used to obtain ECG and impedance cardiography data (sampling rate: 1000 Hz). HRV provides a non-invasive means of assessing short-term effects of the autonomic nervous system on the heart (Task Force, 1996). HRV reflects the variation in inter-beat intervals produced by the interplay of the sympathetic and parasympathetic activity.

Impedance cardiography. Several physiological measures were obtained through impedance cardiography analyses: stroke volume, cardiac output, and pre-ejection period (total peripheral resistance was not analyzed due to too much missing data). A tetrapolar configuration of spot electrodes was used: one recording- and one current-electrode (3 cm apart) on the dorsal surface around the base of the neck, and the same arrangement around the thorax at the level of the xiphoid process (Allen, Fahrenberg, Kelsey, Lovallo, & Doornen, 2007). Pre-ejection period is the time interval during ventricle contraction and closure of aortic and mitral valves and is a good noninvasive measure of cardiac sympathetic activity (Burgess, Penev, Schneider, & Van Cauter, 2004; Newlin & Levenson, 2007).

Stimulus video. This 5-min video includes clips from surgical education videos on an open heart mitral valve surgery, including scenes of initial blood-taking with spilling, the opening of a

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