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The association between openness and physiological responses to recurrent social stress☆

Wei Lü [a,*], Zhenhong Wang [a], Brian M. Hughes [b]

[a] Shaanxi Key Laboratory of Behavior and Cognitive Neuroscience, School of Psychology, Shaanxi Normal University, China
[b] School of Psychology, National University of Ireland, Galway, Ireland

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ABSTRACT

The association between openness (assessed by shortened Chinese version of NEO Five-Factor Inventory, NEOFFI) and physiological reactivity to, and recovery from, social stress (a video-recorded, timed public speaking task with evaluators present in the room), and physiological adaptation to repeated social stress was examined in the present study. Subjective and physiological data were collected from 70 college students across five laboratory stages: baseline, stress exposure period 1, post-stress period 1, stress exposure period 2, and post-stress period 2. Results indicated that higher openness was associated with lesser heart rate (HR) reactivity to the first and second stress exposure, and lesser systolic blood pressure (SBP) reactivity to the second stress exposure. Higher openness was associated with higher resting respiratory sinus arrhythmia (RSA), lesser RSA withdrawals to the first stress exposure, and more complete RSA recovery after the first stress exposure. Moreover, higher openness was associated with pronounced systolic and diastolic blood pressure (SBP, DBP) adaptation with greater decreases in SBP and DBP reactivity across the two successive stress exposures. These findings might shed light on the biological basis linking openness to health.

1. Introduction

Openness refers to a variety of tendencies including curiosity, appreciation for complexity, a desire for variety, esthetic appreciation, imagination and fantasy, and non-traditional values (Connelly et al., 2014; Costa and McCrae, 1992). Individuals with different levels of openness have distinct social adaptation, mental health, and physical health outcomes. Accumulating studies have shown that high openness is an independent and protective factor associated with improved concurrent and future health prospects (Jonassaint et al., 2007; Lee et al., 2014; Taylor et al., 2009). Individuals high in openness are generally more resilient, find novelty more rewarding than familiarity, and are effective in coping with interpersonal stress (Lee-Baggley et al., 2005; Shiner and Masten, 2012). The behavioral response agility inherent in such a trait may also be reflected in the autonomic nervous system responses (Čukić and Bates, 2014, Williams et al., 2009), and the way openness influence physiological responses to social stressors might duly influence associated health processes. Recently, Williams et al. (2009) found higher openness to be associated with increases in parasympathetic activity, and with lesser cardiovascular reactivity to social stress (operationalized as a social competence interview). However, whether their findings can be replicated in other type of social stress among participants of other cultural backgrounds remains an open question. Notably, a number of studies have suggested that the way physiological responses habituate across repeated stressors might further elucidate different adaptation and health consequences (al'Absi et al., 1997; Hughes et al., 2011; McEwen, 1998; Kelsey, 1991, 1993; Kelsey et al., 1999, 2000). The role of openness in shaping patterns of physiological habituation across recurrent social stressors has yet to be identified. Therefore, these two issues were addressed in the present study.

Previous studies suggest that the magnitude, pattern, and/or duration of physiological responses to stress might be related to different health consequences (James et al., 2012; Schneiderman et al., 2005). In the main, this research has suggested that moderate (i.e., neither exaggerate nor blunted) cardiovascular reactivity to stress (Allen, 2013; Chida and Steptoe, 2010; Manuck, 1994; Obrist, 1976; Phillips et al., 2013; Treiber et al., 2003), as well as efficient cardiovascular recovery after stress (Haynes et al., 1991; Pieper and Brosschot, 2005) are most likely to underlie healthful physiological outcomes. In addition, respiratory sinus arrhythmia (RSA), which refers to the variability in heart rate that corresponds to changes in respiration, has received much attention from researchers as a physiological marker of stress regulation (Berntson et al., 1997; Grossman and Taylor, 2007). High resting RSA,

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* Corresponding author at: School of Psychology, Shaanxi Normal University, 199 South Chang'an Road, Xi'an 710062, China.
E-mail address: xuan006@126.com (W. Lü).

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modest reductions in RSA (i.e., RSA withdrawals) under stress, and efficient physiological recovery after stress each indicates better social and emotional competence and adaptive regulation (Porges, 2007; Thayer and Lane, 2000; Santucci et al., 2008). Adaptive physiological outcomes have also been associated with physiological adaptation to repeated stress. Adaptation (or habituation) is most simply computed as a decreased response to a repeated stimulus (Eisenstein et al., 2001). Pronounced physiological adaptation to repeated stress may represent one's ability to cope successfully with an adverse stimulus (al'Absi et al., 1997; Bremner et al., 1995; Frankish and Linden, 1991; Kelsey, 1991, 1993; Kelsey et al., 1999, 2000), whereas lack of adaptation may reflect an inability to adapt, and so may possibly lead to health problems (Hughes et al., 2011; McEwen, 1998) and serve as a physiological marker of anxiety vulnerability (Turner et al., 2005).

As mentioned above, individuals high in openness are believed to favor novel challenges and cope effectively with interpersonal events. A number of researchers have thus sought to examine associated patterns of physiological responses, albeit producing mixed findings. Bibbey et al. (2013) reported that higher openness was related to greater cardiovascular reactivity to a series of stressors (Stroop, mental arithmetic, mirror tracing, and speech); Jonassaint et al. (2010) found persons high in openness to exhibit lower levels of C-reactive protein in response to mental arithmetic; Čukić and Bates (2014) failed to find any relationship between openness and sympathetic or parasympathetic autonomic activity during cognitive stress (mental arithmetic task and Stroop task). These mixed findings may be due to the fact that the nature of stressors was not identical across the studies. Social stress (such as that induced by public speaking or social competence interviews) is likely to differ from cognitive stress (such as that induced by mental arithmetic or Stroop tasks) in its effects on physiological activity (al'Absi et al., 1997; Pertaub et al., 2002; Slater et al., 2006; Westenberg et al., 2009). Openness, as a typical trait involving social dimensions, might be of particular relevance to social stress. As noted previously, Williams et al. (2009) examined the physiological responses of openness to social stress, and found that higher openness was associated with increases in RSA and lesser cardiovascular (SBP, DBP) reactivity during a social competence interview task. However, it is unknown that whether the findings of Williams et al. (2009) can be replicated in other types of social stress, such as socially evaluative stress (a type of social stress that elicits considerable emotional challenges, as well as cardiovascular stress responses; Hofmann, 2006). Therefore, one aim of the present study was to examine this issue.

Additionally, existing studies have found that purportedly maladaptive personality characteristics, such as neuroticism, trait rumination, type D personality, and trait dominance (Hughes et al., 2011; Johnson et al., 2012; Howard and Hughes, 2013; Lee and Hughes, 2014) are positively related to disrupted or dampened physiological adaptation, which might in turn result underlie psychosomatic processes. Comparatively, purportedly adaptive personality characteristics such as low neuroticism, non-type D personality, or high openness, may be related to better physiological adaptation to repeated stress, and so be beneficial to health outcomes. However, no study to date has examined the impact of openness on physiological adaptation to repeated stress. This issue was also addressed in the present study.

In summary, while there are sound conceptual reasons to predict that openness promotes health by assisting stress adaptation, our understanding of how openness is associated with physiological responses to social stress, especially to recurrent social stress, is currently limited. The present study was to investigate the association between openness and physiological reactivity, physiological recovery, and physiological adaptation to repeated socially evaluative stress (public speaking) among Chinese college students. Based on existing findings, it was hypothesized that higher levels of openness would be associated with lesser physiological reactivity to social stress, more complete physiological recovery after social stress, and more pronounced physiological adaptation to repeated social stress.

2. Method

2.1. Participants

Seventy sophomore students were eligible to take part in our study (45 female; M_{age} = 19.23 years, SD = 0.78; 98% Han nationality). All of them were normotensive (resting SBP of 90 to 140 mm Hg and/or resting DBP of 60 to 90 mm Hg), and physically healthy (reporting no diagnoses of diabetes mellitus, hypertension, hyperlipaemia, renal or hepatic dysfunction, no history of cardiovascular disease, and no history of alcohol or drug abuse within the last 6 months).

2.2. Measures

2.2.1. Openness

Openness was assessed using the shortened Chinese version of Costa and McCrae's (1992) NEOFFI, which contained five 12-item scales and showed good reliability and validity on the Chinese sample (Yang et al., 1999). In the present study, Cronbach's alpha was 0.82 for openness.

2.2.2. Socially evaluative stress

In the present study, social stress was induced using speech tasks, which were designed based on the subtask (speech) of the Trier Social Stress Test (TSST) as employed in past research (e.g., Hofmann, 2006; Jönsson et al., 2010; Weeks and Zoccola, 2015). Participants were given 30 s to prepare a 5-min speech about a hypothetical scenario in which they had to verbally defend themselves against the threat of unemployment to two confederates. The hypothetical scenarios included "finding a job in high school as a teacher" and "finding a job as an office secretary", reflecting the most popular job positions sought by college-aged participants in the sampling population. Both scenarios were shown to elicit comparable subjective and physiological responses in our pre-experiments. Participants were asked to speak for the full 5-min and refrain from using any hand gestures. If the participant stopped speaking before the 5-min period was up, one committee member said "Please continue, I will tell you when your time is up". If participants were unable to speak spontaneously, they were prompted with a series of standard questions to continue speaking (e.g., "Do you have any previous experiences of the specific kind of job?"). The majority of participants were able to deliver the speech without prompts or with no more than one prompt. Participants were informed their speech would be videotaped and later evaluated by expert judges for both content and quality. The two confederates maintained neutral facial expressions and avoided smiling and nodding during the stress task. Across the two consecutive stressors, the assignment of the two hypothetical scenarios was counterbalanced between participants.

2.2.3. Physiological measures

Physiological data were recorded by an integrated system and software package (Biopac MP150, AcqKnowledge; Biopac System Inc., 42 Aero Camino, Goleta, CA 93117, USA). The ECG data were amplified using a Biopac ECG100 electrocardiogram amplifier and collected from participants using 3 Ag-AgCl disposable electrodes placed in the standard lead II configuration. The Biopac ECG100C amplifier used a band-pass filter of 35 Hz and 0.5 Hz, sampling at 1000 Hz. Continuous non-invasive beat-to-beat blood pressure was recorded by CNAP™ monitor 500 (CNAP™ Monitor 500; CNSystems Medizintechnik AG, Graz, Austria). The CNAP™ 500 devices were attached to the participant with a CNAP™ finger cuff placed on the second and third digits of one hand, and a calibrating noninvasive BP (NIBP) cuff placed on the upper arm in the same side. The CNAP™ monitor was set to obtain single beat detection from the infrared sensor located in the finger cuff (Saugel et al., 2014; Winklewski et al., 2015). Systolic (SBP) and diastolic (DBP) blood pressure values were captured every minute for analysis from the CNAP device. The raw data were given in a standard Excel spreadsheet and were