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Extraversion and cardiovascular responses to recurrent social stress: Effect of stress intensity☆

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ABSTRACT

The present study sought to establish whether the effects of extraversion on cardiovascular responses to recurrent social stress are contingent on stress intensity. A 2 × 5 × 1 mixed-factorial experiment was conducted, with social stress intensity as a between-subject variable, study phase as a within-subject variable, extraversion as a continuous independent variable, and cardiovascular parameter (HR, SBP, DBP, or RSA) as a dependent variable. Extraversion (NEO-FFI), subjective stress, and physiological stress were measured in 166 undergraduate students randomly assigned to undergo moderate (n = 82) or high-intensity (n = 84) social stress (a public speaking task with different levels of social evaluation). All participants underwent continuous physiological monitoring while facing two consecutive stress exposures distributed across five laboratory phases: baseline, stress exposure 1, post-stress 1, stress exposure 2, post-stress 2. Results indicated that under moderate-intensity social stress, participants higher on extraversion exhibited lesser HR reactivity to stress than participants lower on extraversion, while under high-intensity social stress, they exhibited greater HR, SBP, DBP and RSA reactivity. Under both moderate- and high-intensity social stress, participants higher on extraversion exhibited pronounced SBP and DBP response adaptation to repeated stress, and showed either better degree of HR recovery or greater amount of SBP and DBP recovery after stress. These findings suggest that individuals higher on extraversion exhibit physiological flexibility to cope with social challenges and benefit from adaptive cardiovascular responses.

1. Introduction

It is widely understood that personality traits exert important influences on stress responses. A number of studies have investigated the effect of extraversion on physiological responses to different type of stress, but have produced mixed findings. Studies conducted with social stress tasks (e.g., public speaking or emotion-based tasks, which can be considered as trait-relevant to extraversion) have generally found individuals high on extraversion to be less reactive than individuals low on extraversion (Harvey and Hirschmann, 1980; Jonassaint et al., 2009; Lü and Wang, 2017; Park et al., 2014). However, whether this pattern is equally true regardless of stress intensity remains an open question. Moreover, individuals high on extraversion have been found to exhibit better physiological response recovery after social stress, as well as pronounced physiological response adaptation to recurrent social stress, compared to individuals low on extraversion (Lü and Wang, 2017). It is similarly unknown whether this effect is contingent on stress intensity. Therefore, the present study sought to examine whether stress intensity influences the relationship between extraversion and social stress responses.

Extraversion is regarded to be a stable personality trait encapsulating social competence, and involving tendencies of sociability, talkativeness, assertiveness, energy, and warmth (McCrae and John, 1992). Individuals high on extraversion typically prefer excitement, stimulation, and social interaction (Costa and McCrae, 1992a; Duffy and Chartrand, 2015), report less perceived stress (Ebstrup et al., 2011), exhibit more effective stress coping (Connor-Smith and Flachsbart, 2007), and enjoy positive health (Jackson and Schneider, 2014; Wilson et al., 2005). Extraverts are supposedly less arousable than introverts (Eysenck, 1967; Eysenck and Eysenck, 1985). Specifically, compared to individuals low on extraversion, individuals high on extraversion are likely to be less physiologically responsive to stress.

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This is especially so when the stressor contains social-evaluative elements, because of their tendency to experience positive affect and to be less inhibited in social situations (Eysenck and Eysenck, 1985; Evans et al., 2016). Accordingly, the association between extraversion and physiological stress responses induced by social-evaluative events has been examined in a number of studies. Although one study with adolescent participants observed no effect for extraversion on physiological responses to social stress (Evans et al., 2016), the majority of studies have confirmed that individuals high on extraversion show reduced physiological responses to such stress compared to individuals low on extraversion. Lü and Wang (2017) found that individuals high on extraversion exhibited reduced heart rate (HR) reactivity and respiratory sinus arrhythmia (RSA) withdrawals to public-speaking stress. Jonassaint et al. (2009) found that individuals high on extraversion exhibited lower diastolic blood pressure (DBP) and total peripheral resistance index (TPRI) reactivity during anger recall emotional stress. Park et al. (2014) found that individuals high on extraversion exhibited lower HR reactivity and RSA withdrawals in response to painful and sad situations. Similar results showing that individuals high on extraversion exhibit lower HR reactivity were also found in an early study using aversive emotional stimuli (Harvey and Hirschmann, 1980).

Previous findings have generally related to moderate (or low) levels of social stress, for which tempering of stress responses is likely to be adaptive. However, where environmental events are more challenging, higher physiological responses can be helpful in assisting individuals to properly handle the demands, by enhancing alertness, speed of cognition, and other relevant aspects of the mental processing of stressors. Assuming that acute physiological stress responses quickly subside after initial exposure, they are likely to reflect physiological flexibility and so can be classified as adaptive. Echoing this principle with regard to extraversion, Eysenck's hypothesis of transmarginal inhibition (TMI) proposed that extraverts may be more reactive than introverts if the intensity of stimulation is sufficiently high (e.g., Eysenck, 1981, 1997). A number of early studies found extraverts to show reduced physiological (e.g., skin conductance) responses to moderate-intensity signal stimuli, but equal or greater responses to high-intensity signal stimuli, compared to introverts (Fowles et al., 1977; Geen, 1984; Nielsen and Petersen, 1976). Given that extraverts are high in sociability, they are likely perceive many social stressors to be only moderately challenging, and thus, in laboratory studies, to exhibit lesser cardiovascular responses to social stress (Jonassaint et al., 2009; Lü and Wang, 2017; Park et al., 2014). If social stress were of high intensity, whether individuals high on extraversion would show greater physiological responses has not been studied to date. Relatedly, while previous studies have shown that individuals high on extraversion exhibit better HR and RSA recovery after moderate-intensity social stress (Lü and Wang, 2017), whether this pattern is contingent on stress intensity is also unknown.

A further aspect of stress responses to consider is physiological response adaptation (or habituation, i.e., decreased responses across recurrent stressors), which has important long-term health implications (Eisenstein et al., 2001; Hughes et al., 2011; Kelsey, 1993; McEwen, 1998). Extraverts have been found to exhibit quite pronounced systolic blood pressure (SBP) response adaptation to repeated (moderate-intensity) social stress (Lü and Wang, 2017), as well as more rapid electrodermal response habituation to (high-intensity) auditory stimuli (Smith and Wigglesworth, 1978). The effect of extraversion on adaptation of physiological responses to recurrent high-intensity social stress has not previously been explored.

In summary, the present study aimed to augment our understanding of how stress-intensity affects the association between extraversion and cardiovascular (HR, SBP, DBP and RSA) responses to social stress. Stress response is examined in terms of reactivity, recovery, and habituation. We hypothesized that under moderate-intensity social stress, participants higher on extraversion would demonstrate lower cardiovascular stress responses, more efficient cardiovascular recovery after stress, and better cardiovascular response adaptation to repeated stress, compared to participants lower on extraversion. In line with Eysenck's TMI hypothesis, we further hypothesized that, under *high*-intensity social stress, participants higher on extraversion would show *greater* cardiovascular response to stress, as well as more efficient cardiovascular responses recovery after stress and better cardiovascular response adaptation.

2. Method

2.1. Study design

A 2 × 5 × 1 mixed-factorial experimental design with social stress intensity (moderate vs. high intensity social stress) as a between-subject variable, study phase (baseline, stress exposure 1, post-stress 1, stress exposure 2, post-stress 2) as a within-subject variable, extraversion as a continuous independent variable, and cardiovascular parameter (HR, SBP, DBP, or RSA) as a dependent variable was employed to investigate individual differences in cardiovascular responses to social stress across time, as a function of stress intensity and extraversion.

2.2. Participants

One hundred and sixty-six undergraduate students (103 female, 63 male; M age = 19.16 years, SD = 1.42) completed the shortened Chinese version of the Revised NEO Personality Inventory (NEO–FFI; Costa and McCrae, 1992b), which contains five 12-item scales and shows good reliability and validity (Yang et al., 1999). Cronbach's alpha of extraversion scale in the present study was 0.81. All participants were normotensive (resting SBP of 90 to 140 mm Hg and/or resting DBP of 60 to 90 mm Hg), with a BMI of 16 kg/m^2–25 kg/m^2 (M = 20.69 kg/m^2, SD = 2.11), and physically healthy (reporting no history of cardiovascular disease, and no history of alcohol or drug abuse within the last 6 months). This study was approved by a local institutional review board, and written informed consent was obtained from all participants prior to the experiment. After the experiment, participants received compensation of 30 RMB (approximately $5).

2.3. Manipulation of social stress intensity

Social stress comprised a speech task, in which participants were presented with a hypothetical scenario where they had to verbally defend themselves against possible unemployment in front of two confederates. The scenarios included ‘finding a job in high school as a teacher’ or ‘finding a job as an office secretary’, reflecting the most popular job positions sought by college-aged participants in the sampling population. In the present study, the social stress intensity was manipulated by the same speech task but with different levels of social evaluation. In the moderate-intensity social stress group, a standard social stress task was used in which participants were informed that their performance would be videotaped and evaluated by the two confederates (Lü and Wang, 2017). In the high-intensity social stress group, the same speech task was used in a more challenging situation. Participants were informed that their performance would be videotaped and evaluated by two confederates and another three professionals, and that the evaluated score will be saved as a record. In addition, during speech delivery, participants were twice given feedback (after 2 and 3 min) by the confederates (e.g., “your performance is falling behind the other participants' performances, please try your best”; “your performance is still falling behind the other participants' performances, you need try your best in the last 2 min”). Pre-experiment testing showed that the high-intensity social stress task induced significantly higher subjective and physiological responses than the moderate-intensity social stress task.[3] Each participant was presented with both scenarios, with order of presentation of scenario counterbalanced across the sample.