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Evaluating personality as a moderator of the association between life events stress and cardiovascular reactivity to acute stress

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Abstract
The present study investigated the possible interaction between life events stress and personality in predicting cardiovascular stress responses. Participants ($N = 184$) completed psychometric measures of life event stress and personality styles and had cardiovascular responses monitored during a standardised stress testing protocol. In adjusted models, the observed blunted association between life event stress and SBP and DBP was moderated by openness; this was more evident at -1SD below the mean openness value. Further, the association between life event stress and TPR vascular resistance was found to be moderated by conscientiousness. In particular, we found conscientiousness at both the mean and 1SD above the mean buffered against the negative impact of life stress on TPR reactivity. The findings are discussed in relation to theory and future directions.

Key Words: Blood pressure; cardiovascular reactivity; life events; personality; stress.
1. Introduction

Coronary heart disease (CHD) is one of the leading causes of death among the general population, yearly claiming the lives of approximately 610,000 people in the U.S alone (American Heart Association, 2017). In addition to the established risk factors including smoking, obesity, diabetes, family history of heart disease and low physical activity (Helfand et al., 2009; Hubert et al., 1983; Stamler et al., 1993), there is an increasing literature suggesting that psychological factors may significantly contribute to CHD. In particular, the reactivity hypothesis posits that exaggerated or prolonged cardiovascular reactivity (CVR) to psychological stress may promote the development of cardiovascular disease (Obrist, 1981; Phillips & Hughes, 2011). This hypothesis has received substantial support with prospective studies finding that heightened reactivity to stress is associated with adverse cardiovascular outcomes including hypertension (Carroll et al., 2012; Markovitz et al., 1998) and atherosclerosis (Barnett et al., 1997; Matthews et al., 1998). Further, although low CVR to acute stress is often assumed to be benign, blunted cardiovascular responses also have adverse health-related implications (Phillips & Hughes, 2011; Phillips, 2011), and have been associated with myriad negative health states (Phillips et al., 2013) including obesity (Carroll et al., 2008), poor cognitive functioning (Ginty et al., 2012), and increased intima-media thickness (Ginty et al., 2016).

Importantly, research examining maladaptive patterns of reactivity has identified stressful life events as correlates of blunted responses. In a 30-year review of the literature, individuals experiencing negative life stressors were found to display a blunted cardiovascular profile in response to acute psychological stress (Chida & Hamer, 2008), implying that everyday life stressors may contribute to a diminished cardiovascular response to acute stressors. More recently, young women who experienced negative life events in childhood displayed a blunted endocrine and cardiovascular response to the Montreal
Imaging Stress Task (Voellmin et al., 2015). These findings are consistent with the theory of allostatic load whereby exposure to chronic stress disrupts the regulatory mind-body systems causing an increased vulnerability to disease (McEwen, 2005). Alongside this line of research are studies implicating individual differences in personality in maladaptive responding to stress.

Indeed, several studies have found that personality factors are associated with CVR to acute stress (see Chida & Hamer, 2008, for a review). A recent study found that those scoring higher on neuroticism and low on openness to experiences had smaller systolic (SBP), diastolic (DBP), and heart rate (HR) stress reactions (Bibbey et al., 2013), indicative of a blunted cardiovascular response. These findings are consistent with the cognitive model of stress (Lazarus & Folkman, 1984), which states that one’s internal characteristics including personality influence how one copes and manages stress. In fact, in CVR studies, personality styles have been found to influence stress appraisals, coping appraisals, effort, motivation and engagement with the stressor (Harper et al., 2016; Kemper et al., 2008; Silva et al., 2013).

For example, a recent CVR study demonstrates that participants scoring high in neuroticism perceived stress tasks as more stressful and difficult, and also perceived themselves to be less in control (Bibbey et al., 2013). In contrast, those scoring high on extraversion and openness rated the task as less stressful, less difficult, and also felt they had greater control. Other studies have also linked negative life events, personality and health. For example, neuroticism in childhood has been found to be predictive of higher life event stress and poor health, in adulthood (Van Os et al., 2001). Thus, given these associations between personality and life stress for health, it is possible that there would be a similar interaction on CVR to acute psychological stress.
In summary, it is plausible that negative personality traits are associated with diminished SBP, DBP, and HR responses. These blood pressure changes may further be underpinned by less variability in hemodynamic variables (i.e., cardiac output [CO], and total peripheral resistance [TPR]) associated with negative traits (such as Type D; Howard, Hughes, & James, 2011). However, based on the above research the interactive relationship between negative life events and personality and their impact on cardiovascular outcomes remain unclear. The present study aims to distinguish the extent to which these work in combination with one another and to what extent does personality, particularly neuroticism and openness to experience, moderate the association between negative life event stress and CVR to stress. In light of previous findings (Chida & Hamer, 2008; Bibbey et al., 2013), it is likely that both stressful life events and negative personality traits are associated with blunted reactivity. It is possible that these factors contribute additively to blunted reactivity; however, it is also plausible that stressful events and personality influence one another, and that their shared variance predicts diminished reactivity. Furthermore, the personality-reactivity literature is heavily weighted towards exploration of negative affect-related variables, meaning predictions regarding conscientiousness, for example, are difficult to generate. For this reason, and given a lack of research evaluating the interaction between these stressful life events and personality, an exploratory approach to hypothesis testing is adopted.

2. Materials and methods

2.1. Participants

One hundred and eighty-four healthy undergraduate students (62.3% female), from our local university participated in this study. Based on power calculations, a minimum sample size of 146 participants was needed to detect a significant effect (p = .05, f²=0.06) at 80% power. However, in order to account for attrition and potential outliers a higher number
were recruited. Participants were recruited by means of a course credit system within the university, by word of mouth, and the advertisement of the study throughout the campus. Participants ranged in age from 18-58 \((M = 21.65, SD = 5.33)\) with a mean body mass index (BMI) of 23.65 kg/m\(^2\) \((SD = 3.70)\).

Participants with a diagnosis of cardiovascular disease or hypertension, an immune disorder, or women who were pregnant, were excluded in order to minimize the possibility of confounding variables. Participants who were ill or taking medication influencing cardiovascular measures (other than the oral contraceptive) were also excluded. In preparation for the testing session participants were asked to refrain from alcohol and vigorous exercise 12 hours prior to testing, as well as smoking and consuming caffeine 2 hours before testing. These precautionary instructions were provided as previous research has found a subsequent change in blood pressure following smoking (Cruickshank et al., 1989; James & Richardson, 1991), caffeine consumption (Hartley et al., 2000; Savoca et al., 2005), alcohol intake (Potter et al., 1986) and exercise (Somers et al., 1991). This study was approved by the university’s research ethics committee. All participants provided written informed consent prior to participating and were debriefed following the testing session.

2.2 Design

The present study employed a within-subjects correlational design. The main predictor variables were life events stress and personality. The dependent variables were measures of CVR including SBP, DBP, HR, CO, and TPR. These included the primary variables assessed in CVR research (i.e., SBP, DBP, and HR), in addition to haemodynamic variables measured in previous CVR-personality research (e.g., Jonassaint et al., 2009; Ó Súilleabháin, Howard, & Hughes, in press). Reactivity scores were computed as the
difference between mean baseline and mean task value for each cardiovascular parameter, in line with previous research (e.g., Gallagher et al., 2014; Phillips et al., 2009).

2.3. Materials and Apparatus

2.3.1 Negative Life Events Measure

The 36-item Life Events for Students Scale (LESS; Linden, 1984) was used as to measure negative life events stress. This scale is comprised of life events that students may have encountered over the past year. Examples of items on the scale include; ‘Death of a Parent’, ‘Pregnancy’, ‘Major Car Accident’, ‘Failing a Course’, etc. Participants were required to indicate, 1) the number of life events they had experienced over the past year from the list, and 2) their rating of perceived stressfulness of each event on a scale ranging from 1 (Not At All) to 4 (Very). This scale was selected as a measure of negative life events as it is tailored to suit the needs of students within higher education rather than the general public.

2.3.2 Personality Assessment

The 10-item Personality Inventory (TIPI) (Gosling et al., 2003) was used a measure of personality. The TIPI is a short-form measure of the big five personality traits and was used to assess extraversion, agreeableness, conscientiousness, openness to experience and emotional stability. Two items assess each type of personality, both of which are averaged. Examples of items include for extraversion, ‘I see myself as extraverted/enthusiastic’ and ‘I see myself as reserved/quiet’. Participants were required to rate the degree to which each items described themselves on a 7-point Likert scale ranging from 1 (disagree strongly) to 7 (agree strongly). Several of the items are reversed coded (i.e., 2, 4, 6, 8, & 10). Scores range from 2 to 14 with higher scores implying a stronger identification with this personality style. Gosling et al., (2003) found the TIPI to display a strong test-retest reliability over a 6-week
period ($r = .72$) and close convergence with the well-established Big-Five Inventory (mean $r = .77$). Furnham, (2008) also found the TIPI to have close convergence with the NEO-FFI (mean $r = .53$), and suggested that in comparison to two other brief personality measures the TIPI displayed slightly better validity.

2.3.3 Stress Task Measures

Immediately before and after the battery of stress tasks, participants were asked to indicate how stressful they expected to find each task and how stressful they found each task. These items were scored on a 7-point Likert scale 0 (Not at all) to 6 (Extremely) and were used to confirm that the task was psychologically stressful.

2.3.4 Cardiovascular Assessment

Beat-to-beat measures were recorded using a Finometer Pro hemodynamic cardiovascular monitor (Finapres Medical Systems BV, BT Arnhem, The Netherlands). The Finometer is well-validated (e.g., Schutte et al., 2004) and takes continuous non-invasive measurements from one’s finger arterial pressure attached to the middle finger of the participant’s non-dominant hand. A second cuff is attached to the participant’s upper arm and is used to calibrate reconstructions of the intra-brachial pressure derived from the finger cuff. A hydrostatic height correction system is used to correct hand height to heart level.

2.4 Stress Task

The stress task was an adapted version of the Trier Social Stress Task (Kirschbaum, et al., 1993), which included the paced auditory serial addition test (PASAT) (Gronwall, 1977) as our math task. The order of the tasks were counterbalanced. The PASAT is a frequently
used stress task within laboratory-based studies and has been found to successfully perturb the cardiovascular system (Gallagher et al., 2014; Phillips et al., 2009). During the task participants listened to an auditory track in which single digit numbers were played aloud from a laptop. Participants were required to listen and retain the previous digit and add it to the subsequent digit. The digits were presented at a rate of 2.4 seconds during the first minute with the speed of presentation increasing by 0.4 seconds for each subsequent minute. Following this, participants gave a 4-minute speech, and had two minutes to prepare, where they were instructed to describe and provide real life examples of three of their best and worst characteristics (Bosch et al., 2009). There was approximately a one-minute break between the two tasks, during which instructions for the next task were delivered. If participants ceased speaking at any time during the four-minute period, they were immediately prompted by the experimenter to continue.

2.5 Procedure

Prior to arrival at the laboratory, participants were sent a study information sheet and were informed to direct any questions they may have had to the study team via email. Those who agreed to take part and were deemed eligible were asked to attend a 45-minute testing session at the health and psychophysiology laboratory. Upon arrival at the laboratory, participants were greeted by the researcher who went through a checklist of exclusionary criteria; any relevant questions regarding the study were answered by the researcher. Once participants signed the consent form, they completed a demographic questionnaire, had their height and weight measures for calculation of BMI, and their middle finger measured for cardiovascular reading accuracy. Participants were then seated at a desk on which a laptop and lamp were located and were requested to placed their feet in a box to control for unnecessary movements that may affect cardiovascular measures (Pickering et al., 2005). Following a 20-minute acclimatization period, baseline cardiovascular measures were
recorded for 10 minutes. During the baseline period, participants completed questionnaires and were provided additional reading material, to facilitate a ‘vanilla’ baseline in which participants engage in minimally demanding tasks during baseline cardiovascular assessment (Jennings et al., 1992). Following the formal baseline, and two minutes before the stress task began, the researcher asked the participant to compete the pre-stress task questionnaire. The main laboratory lights were turned off immediately before the task began and participants were left to complete the stress task in the spotlight of a lamp. The researcher was dressed in a white laboratory coat and asked the participant to speak aloud for both stress tasks as their results were being scored. These conditions were manufactured to increase stress levels and create a psychological divide between experimenter and participant; there were no other evaluative components. Following a post-task recovery period of 15-minutes, the Finometer was detached, participants were thanked, and were provided with a debriefing sheet.

2.6 Data analyses

Data were screened for outliers and assumptions of fit. Outliers deviating greater than +/- 3 SDs from the mean on reactivity values were excluded (n = 10 across our dependent variables). Further, seven participants were missing baseline and/or stress tasks cardiovascular measures and thus, reactivity scores for these participants could not be computed. One-way ANOVAs were used to test for sex differences, and differences between smokers and non-smokers, and repeated measures (baseline, task) ANOVAs were conducted to determine if the task was successful in perturbing the cardiovascular system and was psychologically stressful; partial eta squared ($\eta^2_p$) is reported as a measure of effect size.

Correlational analyses evaluated associations between total life events, perceived life events stress, personality, post task stress ratings and cardiovascular outcomes. Moderation analyses examined whether the relationship between life event variables (total life events and
perceived life events stress) and reactivity values were moderated by each personality trait individually. Here, interactions were tested while controlling for possible confounding variables of gender, smoking status, BMI and baseline cardiovascular measures. Separate models were conducted for each personality trait to facilitate comparison with several prior research studies evaluating associations between individual personality traits and CVR (e.g., Bibbey et al., 2013; Ó Súilleabháin et al., 2017). All moderation analyses were conducted using Hayes’ (2013) PROCESS module for SPSS. Given the number of exploratory tests conducted, and because we assessed two related measures of SLEs (i.e., total SLEs and perceptions of SLEs), the Bonferroni correction was applied to our inferential analyses. Thus, a conservative two-tailed $p$-value of $<0.025$ ($=0.05/2$) was considered statistically significant.

3. Results

3.1 Descriptive Statistics

Descriptive statistics for study variables are reported in Table 1. Personality scores are within the normal range (Gosling et al., 2003) and the mean life event scores are similar to that found elsewhere (Gallagher et al., 2008).

3.2 Manipulation check

A series of repeated measures (baseline, task) ANOVAs confirmed that the stress task increased cardiovascular responses for: SBP, $F(1, 176) = 427.93, p < .001, \eta^2_p = .71$; DBP, $F(1, 176) = 505.65, p < .001, \eta^2_p = .74$; HR, $F(1, 176) = 119.91, p < .001, \eta^2_p = .41$; CO, $F(1, 176) = 34.79, p < .001, \eta^2_p = .17$ and TPR $F(1, 176) = 46.98, p < .001, \eta^2_p = .21$. Further, repeated measures ANOVAs also revealed a significant increase from pre- to post-task rating of self-report stress for the PASAT, $F(1, 177) = 59.91, p < .001, \eta^2_p = .23$, the speech task
F(1, 179) = 82.69, p < .001, \eta^2_p = .32, and the overall stress protocol, F(1, 177) = 101.7, p < .001, \eta^2_p = .37, indicating that the task was psychologically stressful. Although the PASAT was rated as more psychologically stressful in comparison to the speech task, F(1, 180) = 14.00, p < .001, \eta^2_p = .07, there was no significant difference between tasks on measures of CVR (all ps > .43 ) our main outcome variable. Performance on the PASAT was not correlated with PASAT reactivity (all ps ≥ .06).

Total life events, perceived life events stress, reactivity variables and personality measures of extroversion, conscientiousness and openness to experience did not vary significantly by sex, though the imbalance in men and women in the sample (62.3% women) should be noted. In comparison to women, men scored significantly higher on emotional stability, F(1, 177) = 11.01, p = .001, \eta^2_p = .06, and significantly lower on agreeableness, F(1, 178) = 4.05, p = .05, \eta^2_p = .02. Although there was no significant difference between smokers and non-smokers on measures of total life events, perceived life events stress or personality variables, smokers exhibited significantly lower DBP reactivity, F(1, 173) = 5.29, p = .02, \eta^2_p = .03, and HR reactivity, F(1, 173) = 10.07, p = .002, \eta^2_p = .06. Thus, these potential confounds were controlled for in relevant analyses.

3.3 Associations between life events stress, personality, stress task ratings and cardiovascular reactivity.

As can be seen in Table 2, there were significant associations between extraversion, conscientiousness and perceived negative life events such that those scoring higher on extraversion and conscientiousness perceiving their life stressors as less stressful. Further, those scoring high in conscientiousness also experienced a lower number of negative life
events. Emotional stability was negatively associated with total life, perceived life events stress, and post-task stress rating. This indicated that those low in emotional stability experienced a higher number of negative life events, had a greater perception of negative life events stress and perceived the stress task as more stressful. For CVR, as expected, in simple models, life events stress was negatively associated with SBP (perceived), DBP (total scores and perceived) and HR (perceived), and TPR (total), responses, such that those reporting more stress displayed blunted responses to the acute stress task. There were no significant associations between either measure of life stress and CO.

The above correlations were unadjusted for potential confounds such as gender, smoking status, BMI and baseline cardiovascular measures. Thus, we conducted hierarchical linear regressions with confounds entered in Step 1, and our predictor variables at Step 2. In these analyses, total life events, but not perceived life events stress, was negatively associated with TPR reactivity ($\beta = -.18, t = 2.25, p = .03$, and $\beta = -.17, t = 2.08, p = .05$, respectively); this association did not withstand adjustment for multiple comparisons, and no other associations were observed.

The only significant correlation between personality and CVR was for agreeableness; such that SBP reactivity was higher in those who scored high on agreeableness. No significant correlations between post-stress task rating and CVR was observed.

3.4 Moderation Analyses

Our focal analyses aimed to test personality variables as moderators of life events-CVR relationships. In our moderation analyses, extraversion and agreeableness did not moderate the relationship between either total or perceived life events stress and CVR.
Similarly, conscientiousness did not significantly moderate the relationship between 
perceived life events stress and reactivity values.

**SBP, DBP, and HR**

We observed several associations between life events and CVR. First, the relationship between total life events and SBP reactivity was moderated by emotional stability, $\beta = .18$, 95% CI [.01, .34], $t = 2.11$, $p = .04$. This was only significant against the Bonferroni-corrected level at 1SD below the mean, $\beta = -.74$, 95% CI [−1.36, −.12], $t = -2.36$, $p = .02$, such that those who reported higher negative life events and were low on emotional stability had more blunted SBP reactivity. However, this association did not withstand further adjustment for sex, BMI, and smoking (in addition to baseline measures). The corresponding SBP moderation model for emotional stability and perceived life events stress was not significant, $\beta = -.06$, 95% CI [−.003, .113], $t = 1.88$, $p = .06$.

The association between total life events and SBP reactivity was also moderated by openness, $\beta = .29$, 95% CI [.07, .51], $t = 2.56$, $p = .01$ (see Figure 1). This negative relationship became more pronounced for those scoring 1SD below the openness to experience mean value, $\beta = -.99$, 95% CI [−1.66, −.33], $t = -2.96$, $p = .004$. In contrast to the findings for emotional stability, the same pattern was observed for perceived life events stress; and SBP reactivity, $\beta = .09$, 95% CI [.02, .16], $t = 2.64$, $p = .01$. Again, this association was significant at 1SD below the mean openness to experience value, $\beta = -.30$, 95% CI [−.50, −.10], $t = -3.01$, $p = .003$.

Similar, but weaker patterns were observed for DBP reactivity. The moderation model for total life events was not significant, $\beta = .12$, 95% CI [−.02, .25], $t = 1.72$, $p = .09$, though an especially blunted DBP response was observed for those scoring 1SD below the mean on openness, $\beta = -.54$, 95% CI [−.94, −.15], $t = -2.71$, $p = .01$. Similarly, the moderation model
for perceived life events was not significant, $\beta = .04$, 95% CI [-.002, .082], $t = 1.87$, $p = .06$; again, blunted responding was observed in those scoring 1SD below the mean openness value $\beta = -.16$, 95% CI [-.28, -.04], $t = -2.67$, $p = .01$.

CO and TPR

Finally, the relationship between total life events and TPR reactivity was significantly moderated by conscientiousness, $\beta = -.005$, 95% CI [-.008, -.001], $t = -2.62$, $p = .01$, as illustrated in Figure 2. This negative association was more evident at both the mean value of conscientiousness, $\beta = -.01$, 95% CI [-.020, -.002], $t = -2.41$, $p = .02$, and 1SD above this mean value $\beta = -.02$, $t = -3.25$, 95% CI [-.04, -.01], $p = .001$. No effects for CO were observed.

Adjusted moderation models

Besides the moderation analyses for emotional stability, as referred to above, the effects observed were robust to adjustment for gender, smoking status, and BMI (as well as for baseline cardiovascular measures), at the Bonferroni-adjusted alpha level.

4. Discussion

The present study sought to evaluate the interaction between negative life events and individual differences in personality in predicting CVR to acute stress. In simple models, perceptions of negative life events was associated with diminished SBP and HR responses to acute stressors; while both number of, and perceptions of, life events were associated with diminished DBP responses. In terms of personality, a significant positive association between agreeableness and SBP reactivity was observed; personality was not associated with other cardiovascular variables in simple models. However, we observed some evidence for personality as a moderator of the association between stressful life events and CVR.
Contrary to expectations, no effects were observed for emotional stability, a construct akin to neuroticism, as a moderator of associations between life events stress and CVR. To date, the majority of personality-reactivity research has focused on dimensions related to negative affect; for example, Bibbey et al. (2013) found neuroticism to be associated with blunted SBP, DBP, and HR stress reactivity. Similarly, in a study of cardiovascular adaptation to recurrent stress exposures, Hughes et al. (2011) reported that the poorer cardiac adaptation to recurrent stress associated with neuroticism could be explained by blunted HR and CO in responses to the initial stress exposure. The absence of findings for emotional instability here contrasts with a developing body of research implicating neuroticism in maladaptive stress responses. However, differences in measurement of these constructs may explain the absence of effects here.

The significant effects observed in the data related to openness to experience as a moderator of associations between stressful life events and SBP reactivity. Specifically, the blunted responding observed for those high in total life events was more pronounced for those low on openness to experience, with and without adjustment for sex, BMI, and smoking status. These exploratory effects were observed across both total life events and perceived stressfulness of life events demonstrating consistency across theoretically distinct, though inter-correlated, operationalizations of life events stress. This finding also aligns with conceptualizations of openness as a trait that predisposes a person to readily engage with novel experiences, such as acute stress exposure. For example, Ó Súilleabháin et al. (2017) found that higher openness was associated with significant SBP, DBP, and HR habituation to a stress-testing protocol involving changing acute stress exposures (counterbalanced mental arithmetic and speech tasks). It is possible, then, that openness may compensate for the blunted responses observed for individuals who have experienced relatively high stressful life
events. Given the exploratory nature of our findings, further research evaluating the protective impact of openness is warranted.

Although conscientiousness has long been viewed as an adaptive trait, researchers have recently speculated that those high in conscientiousness may be more strongly affected by uncontrollable negative experiences (Dahm et al., 2017), such as unemployment (Boyce et al., 2010). Surprisingly, our analyses found smaller increases in TPR, typically considered indicative of an adaptive cardiovascular response, to be associated with high total life events – this effect was magnified for individuals with high conscientiousness. However, given we observed only one moderation effect of conscientiousness on the life stress-CVR association, it is premature to place much weight on this finding. However, our findings extend previous research implicating stressful life events in blunted cardiovascular responding (e.g., Phillips et al., 2005) and provide the first test of interactions between stressful life events and personality on cardiovascular stress responses.

The theoretical model recently proposed by Carroll et al. (2017) describes early life event stressors as influencing brain dysregulation, with downstream effects including both blunted biological stress responding and alterations in key personality characteristics, as well as depression. In this model, blunted reactivity is viewed as a marker rather than a cause of behavioural and health outcomes. In our study, perceptions of, but not number of, stressful life events was associated with diminished cardiac reactivity (i.e., SBP and HR reactivity) to acute stress, while number and perceptions of life events were associated with diminished DBP reactivity. Our findings support the view that stressful life events are implicated in blunted cardiovascular responding, and also point to the importance of stress appraisals in explaining the impact of these events on stress responses. To date, few studies have evaluated life events and perceptions of these events on CVR, however, research demonstrates that differences in perceptions of these events are relevant to stress responding.
For example, in a study of young adults, Ginty and Conklin (2011) found that those who perceived their lives as relatively more stressful than expected, based on the number of stressful events experienced, demonstrated blunted cardiac reactivity to an acute stressor. Thus, our findings that perceptions of life events are also associated with diminished reactivity add to the literature on life events for young adult groups.

The associations between stress ratings and personality observed in the present study support our contention that stress and personality processes are intertwined and in line with the cognitive models of stress (Lazarus & Folkman, 1984). Of relevance to research focusing on negative personality traits, emotional instability (a construct comparable to neuroticism) was associated with both elevated perceptions of life events stress, and increased ratings of stressfulness in response to the lab stressor. However, individuals high in emotional instability also reported a marginally higher number of life events. Thus, it is difficult to conclude that such individuals are predisposed to interpret the same life events as relatively more stressful than their emotionally stable counterparts. It remains possible that these individuals experienced a greater number of life events, and thus tended to view the impact of these events more harshly, as reflected in the high correlation between number and perceptions of life events in our sample.

**Limitations and Future Research**

The limitations of the present study include, first, the use of a brief measure to assess personality traits. The TIPI is a not the gold standard measure for use in personality research, though it has been described as preferable to other brief measures (Furnham, 2008). Further, although the Cronbach’s α estimates for some subscales in our study were suboptimal, Cronbach’s α is not typically considered as a useful measure of scale validity for very brief measures, given its dependence on scale length (Kline, 2000). Thus, while our study provides
a first step in evaluating the interactions between personality and stressful life events on CVR, conceptual replication studies will optimally avail of extended measures such as the NEO Five Factor Inventory (NEO FFI-3; McCrae & Costa, 2010). This measure has demonstrated good internal consistency, and convergent and discriminant validity in previous research (McCrae & Costa, 2010). Further, although short personality scales have respectable psychometric characteristics (e.g., Rammstedt & John, 2007), using even slightly longer personality measures can substantially increase the validity of study findings (see Credé et al., 2012).

Second, self-report measures were used to assess both life events and personality; thus, it is possible that social desirability concerns influenced our findings. However, self-report measures for these constructs are widely used and also enable comparisons with prior research in this area. Third, no measure of task engagement was included in this study. Fourth, given a lack of previous research evaluating both personality and SLEs we adopted an exploratory approach to hypothesis-testing. Although this is a significant limitation, future research is well-positioned to adopt a confirmatory approach. Relatedly, it is challenging to isolate the effects of individual personality traits on stress-reactivity associations. In our study, and in others, small-to-moderate correlations were observed between some of the personality traits, and our inferential tests were adjusted for multiple measures of stressful events, and not for multiple (distinct) personality traits. Nonetheless, given the multiple personality traits tested in any study evaluating the Big 5 model, the potential for Type 2 error should be acknowledged. Fifth, future research including equal numbers of men and women is needed to better consider sex differences, in light of established, albeit small, sex differences in key personality traits (e.g., Costa, Terracciano, & McCrae, 2001), and in coping strategies (e.g., Martin et al., 2011), that may moderate cardiovascular stress responses. In addition, sampling a broader age range of participants is important to capture
wider variation in the occurrence of stressful life events across the lifespan. Our young adult sample were unlikely to have experienced several life events such as divorce, imprisonment, or redundancy from a significant job role, which is why a student-specific measure was used.

Finally, our observational design means that causal relationships between life events, personality, and stress responses cannot be established. However, a strength of our study is the comprehensive measurement of cardiovascular responses. Our findings require replication, and point particularly to openness as an under-explored personality construct with implications for stress responding. In addition, longitudinal research utilizing extended psychometric measures of personality is needed to determine the extent to which life events and personality, independently and interactively, may influence cardiovascular stress responses across the lifespan.

Conflict of interest: The authors report no competing interests
References

American Heart Association. Heart Disease and Stroke Statistics 2017 At-a-Glance
https://www.heart.org/HEARTORG/General/Heart-and-Stroke-Association-
Statistics_UCM_31064_SubHomePage.jsp retrieved 19/10/2017

progression of carotid artery disease. J. Hypertens. 15, 49-55. DOI 10.1097/00004872-
199715010-00004

Bibbey, A., Carroll, D., Roseboom, T.J., Phillips, A.C., de Rooij, S.R., 2013. Personality and
physiological reactions to acute psychological stress. Int. J. Psychophysiol. 90, 28-36. DOI
10.1016/j.ijpsycho.2012.10.018

responses during social evaluative threat. Psychosom. Med. 71, 877. DOI
10.1097/PSY.0b013e3181baef05

people experience greater drops in life satisfaction following unemployment. J. Res. Pers. 44,

blood pressure reactions to acute stress are associated with future hypertension status in the
Dutch Famine Birth Cohort Study. Int. J. Psychophysiol. 85, 270-273. DOI
10.1016/j.ijpsycho.2012.04.001

Carroll, D., Phillips, A.C., Der, G., 2008. Body mass index, abdominal adiposity, obesity, and
cardiovascular reactions to psychological stress in a large community sample. Psychosom.
Med. 70, 653-660 DOI 10.1097/PSY.0b013e31817b9382


Furnham, A., 2008. Relationship among four Big Five measures of different length. Psychol. Rep. 102, 312-316. DOI 10.2466/PR0.102.1.312-316


Emerging Risk Factors for Coronary Heart Disease: A Summary of Systematic Reviews Conducted for the US Preventive Services Task Force

Hubert, H.B., Feinleib, M., McNamara, P.M., Castelli, W.P., 1983. Obesity as an independent risk factor for cardiovascular disease: a 26-year follow-up of participants in the Framingham Heart Study. Circulation 67, 968-977. DOI 10.1161/01.cir.67.5.968


investigating psychobiological stress responses in a laboratory setting. Neuropsychobiology 28, 76-81. DOI 10.1159/000119004


Phillips, A.C., Carroll, D., Ring, C., Sweeting, H., West, P., 2005. Life events and acute


Potter, J.F., Watson, R., Skan, W., Beegers, D.G., 1986. The pressor and metabolic effects of alcohol in normotensive subjects. Hypertension 8, 625-631. DOI: 10.1161/01.HYP.8.7.625


Table 1

Descriptive statistics of personality and life events variables

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<tr>
<th>Personality/Life Events and Cardiovascular Variables</th>
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<th>Mean</th>
<th>Standard Deviation</th>
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Table 2
Correlations among personality traits, life events variables and cardiovascular reactivity variables

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Note: The sample size varied from N = 158-181 due to incomplete measures. This is reflected in variation in degree of freedom.
Figure 1. Interaction between Total Life Events and Openness to Experience on SBP Reactivity
Figure 2. Interaction between Total Life Events and Conscientiousness on TPR Reactivity
**Highlights**

An interaction between life events stress and personality on cardiovascular reactivity to acute stress is proposed.

Personality moderated the association between life event stress and blunted cardiovascular reactivity to acute stress.

Positive personality styles are protective against blunted reactivity.