CURRENT ISSUES IN PERSONALITY PSYCHOLOGY · VOLUME 10(4), 2022
DOI: HTTPS://DOI.ORG/10.5114/CIPP.2022.114143

ORIGINAL ARTICLE

Respiration rate during a stress task moderates neuroticism and perceived stress in older adults

Josh Kaplan [A,B,C,D,E,F], *Daniel Klee* [B,D,E,F], *Barry Oken* [A,B,D,E,G]

Oregon Health & Science University, Portland, OR, United States

BACKGROUND
Research suggests that respiration rate is related to psychological factors such as neuroticism and perceived stress in addition to physiological factors. However, it is unclear how respiration rate during a laboratory stress task relates to the relationship between neuroticism and perceived stress.

PARTICIPANTS AND PROCEDURE
This cross-sectional secondary analysis examined respiration rate during a stress task in moderating the relationship between neuroticism and perceived stress in a sample of generally healthy older adults (n = 64). Respiration data were collected during an auditory oddball paradigm and the Portland Arithmetic Stress Task (PAST), a laboratory-based cognitive stressor.

RESULTS
The results indicated that respiration rate during the PAST significantly moderated the relationship between neuroticism and perceived stress (p = .031), such that participants who exhibited a very low (–1.78 *SD*) respiration rate showed a non-significant relationship between neuroticism and perceived stress, whereas participants with average (mean; p < .001) and elevated respiration rates (+1 *SD*; p < .001) exhibited a significant positive relationship between neuroticism and perceived stress.

CONCLUSIONS
These findings add to a body of literature suggesting that stress reactivity is an important link between personality factors and negative outcomes. However, this is the first study to our knowledge to examine the role of physiological stress reactivity in buffering this relationship. The results suggest that individuals higher in neuroticism may attenuate the relationship between stress vulnerability and perceived stress through decreased physiological stress reactivity, particularly by exhibiting slow breathing during a stressor.

KEY WORDS
neuroticism; stress reactivity; perceived stress; respiration rate; physiological stress

CORRESPONDING AUTHOR – Josh Kaplan, Ph.D., Oregon Health & Science University, 3181 SW Sam Jackson Park Road, Portland, OR 97239-3098, United States, e-mail: kaplajos@ohsu.edu

AUTHORS' CONTRIBUTION – A: Study design · B: Data collection · C: Statistical analysis · D: Data interpretation · E: Manuscript preparation · F: Literature search · G: Funds collection

TO CITE THIS ARTICLE – Kaplan, J., Klee, D., & Oken, B. (2022). Respiration rate during a stress task moderates neuroticism and perceived stress in older adults. *Current Issues in Personality Psychology, 10*(4), 299–310.

RECEIVED 31.08.2021 · REVIEWED 14.10.2021 · ACCEPTED 14.01.2022 · ONLINE PUBLICATION 17.03.2022

BACKGROUND

Neuroticism is a personality trait that has been historically regarded as a stable trait (Cobb-Clark & Schurer, 2012) characterized by facets such as anxiety, hostility, impulsivity, and self-consciousness (Kim et al., 2017; Kurdek, 1997). Among personality traits, neuroticism is most predictive of negative mental health outcomes (Pereira-Morales et al., 2019), including depression (Jurczak et al., 2015; Nordfjærn et al., 2013) and anxiety (Üngür & Karagözoğlu, 2021), as well as physical health conditions such as cardiac disease (Suls & Bunde, 2005), asthma (Huovinen et al., 2001), and dementia (Wilson et al., 2011).

Individuals high in neuroticism are also high in susceptibility to stress (Francis, 1996) and stress reactivity (Costa & McCrae, 2008; Suls & Martin, 2005), which is often manifested by the presence of maladaptive coping strategies and intense negative affective responses when faced with daily stressors (Bolger & Zuckerman, 1995; Dunkley et al., 2014; Gunthert et al., 1999). Similarly, other studies have described a positive association between neuroticism and perceived stress (PS; Murberg & Bru, 2004), and research has found that PS may be an important link between neuroticism and other negative outcomes (Banjongrewadee et al., 2020; Smith & Gallo, 2001).

PS is defined as the degree to which an individual appraises life circumstances as stressful (Cohen et al., 1983), and presents negative thoughts or emotions (Banjongrewadee et al., 2020). PS is related to negative physical health outcomes (Hoferichter et al., 2014) including cardiovascular disease (O'Neal et al., 2015) and immunological issues (Assaf, 2013), and negative psychological outcomes including poor sleep (Charles et al., 2011), depression (Mohamadi Hasel et al., 2013; Zannas et al., 2012), substance use (Ng & Jeffery, 2003), and decreased quality of life (Assaf, 2013; Kondratowicz et al., 2021).

The relationship between neuroticism and PS is well documented, and early personality research hypothesized that individuals high in neuroticism are more likely to perceive life as stressful (McCrae, 1990). Subsequent work has supported this theory (Murberg & Bru, 2004), by demonstrating that neuroticism is a primary predictor of PS (Banjongrewadee et al., 2020; Conard & Matthews, 2008; Ebstrup et al., 2011; Mohamadi Hasel et al., 2013). Further research has suggested that increased neuroticism may result in higher PS and other negative outcomes by way of maladaptive stress reactivity (Banjongrewadee et al., 2020; Zuroff et al., 2004) as evidenced by dysregulated sympathetic nervous system (SNS) activity.

Facets of neuroticism such as aggression and hostility have been linked to nervous system functioning (Brummett et al., 2008), and neuroticism has been shown to positively relate to hyperarousal of the sympathetic nervous system (Eysenck, 1963; Eysenck & Eysenck, 1987) as indicated by increased skin conductance (Reynaud et al., 2012) and heightened activity and a lowered threshold in the limbic system (Ormel et al., 2013). A handful of studies have also utilized respiration rate (RR) as an indicator of physiological stress reactivity, and have found that individuals high in neuroticism have an increased RR during stressor tasks (Roslan et al., 2018; Wu et al., 2014).

Similar to neuroticism, PS is positively related to physiological stress reactivity (Javorka et al., 2018; Spodenkiewicz et al., 2018) and changes in RR in various settings (Grassmann et al., 2016; Naik et al., 2018; Tipton et al., 2017; Wheeler & Wilkin, 2008). Past studies of RR in response to stressful situations have concluded that RR is viable biomarker of individual perceptions of stress (Grossman, 1983). Further investigations of PS and respiration have evaluated interventions to lower PS via the manipulation of RR (Muthukrishnan et al., 2016; Naik et al., 2018). These studies found that such interventions reduce RR and PS concurrently (Huang et al., 2019; Muthukrishnan et al., 2016; Naik et al., 2018).

Despite the established relationship between neuroticism and PS, and the hypothesized role of stress reactivity as a link between neuroticism and PS, whether adaptive stress reactivity may buffer the relationship between neuroticism and PS has not been adequately explored. Though neuroticism and PS are ostensibly related, modifiers of this relationship require exploration. Particularly, it is unclear how RR during a stress task may impact this relationship. Such investigations are important in furthering our understanding of biomarkers of stress and personality, as well as illuminating potential buffers between neuroticism and PS which may serve as an important link to downstream outcomes. Further research in this area may also yield a clinical direction for individuals experiencing increased stress as the result of heightened neuroticism, and may particularly point to interventions that assist in regulating physiological stress reactivity and the SNS, such as meditation (Tang et al., 2009). The purpose of this study is two-fold: Primarily, we aim to investigate whether RR during a laboratory stress task moderates the relationship between neuroticism and PS. We hypothesize that participants with a low RR during the stress task will demonstrate a non-significant relationship between neuroticism and PS, whereas this relationship will be significant for participants who exhibit an elevated RR. Secondarily, we aim to elucidate the role of neuroticism in predicting RR during a stress task, and the role of RR during a stress task in predicting PS. We hypothesize that neuroticism will positively predict RR during a stress task, and that neuroticism and RR will each positively and significantly predict PS.

PARTICIPANTS AND PROCEDURE

This investigation is a secondary analysis of data obtained from a parent study of an internet-based mindfulness course. Data were sampled from mildly stressed older adults (N = 64) at baseline in the parent study (for methodological details see Klee et al., 2020). The parent study was approved by the Oregon Health & Science University Institutional Review Board (IRB) and registered with ClinicalTrials.gov (NCT02467660).

PARTICIPANTS

Participants were recruited from the Portland, Oregon area and completed various screens for the parent study (for a more detailed account of the recruitment and eligibility screening process, see Klee et al., 2020). Sixty-four generally healthy older adults were deemed eligible, completed baseline assessment, and are included in the present secondary analysis. Demographics may be found in Table 1.

LABORATORY TASKS AND DATA COLLECTION

Baseline RR was collected during an eyes-open auditory oddball paradigm. Participants listened to three types of pure tones presented at a randomized interval between 1500 and 2500 ms: low- (500 Hz), middle- (1000 Hz), and high-pitched (2000 Hz), comprising 10%, 80%, and 10% of the total 450 trials, respectively. Participants were instructed to ignore low and middle tones (non-targets), and to press a response button whenever they heard any high-pitched tones (target).

Participants then completed the Portland Arithmetic Stress Task (PAST; Atchley et al., 2017). The PAST was adapted from the Montreal Imaging Stress Task (Dedovic et al., 2005) to improve task parameterization, participant feedback, and timing accuracy. It presents mental arithmetic problems in tandem with distracting auditory feedback, and proceeds using an adaptive failure algorithm. Participants are asked to solve each problem mentally as quickly and accurately as possible, and then to use a stimulus-response box to select the correct answer. Performance is titrated to approximately 60% accuracy by the adaptive failure algorithm and participants are exposed to social pressure in the form of an on-screen marker for group average, which misleadingly indicates that average performance on the task is near ceiling. The PAST has been used previously to examine attentional and physiological responses to acute psychological stress (Atchley et al., 2017).

Utilization of the auditory oddball paradigm as a baseline for comparison when measuring RR during the PAST was constrained in part by the limited task set in the established parent protocol. The tones task was selected as a baseline for three primary reasons: 1) it is a relatively easy task (participants committed no errors, on average), 2) it is an approximate match in attentional engagement to the PAST (exogenous stimulus discrimination, decision making, and response action), and 3) Atchley et al. (2017) utilized a comparable paradigm for comparisons of physiological reactivity in a previous examination of the PAST. See our description of limitations in the *Discussion* section below for additional information.

Table 1

Demographics

Characteristic	N = 64	$M \pm SD$ (range)	%
Age (years)	–	59.97 ± 6.02 (50-76)	–
Sex			
Female	52	–	81.25
Male	12	–	18.75
Education (years)	–	16.27 ± 2.95 (12-23)	–
Race			
Caucasian	55	–	85.93
African American	2	–	3.12
Hispanic	1	–	1.56
Asian/Pacific Islander	3	–	4.69
Native American	–	–	0
Other/1+	3	–	4.69
Annual household income			
< $60,000	34	–	54.13
> $60,000	30	–	46.87

MEASURES

Participants completed the following self-report measures at home. All study materials and data were exchanged between participants and study personnel securely using REDCap (Harris et al., 2009). REDCap utilization in this project was made possible by support from the National Institutes of Health (grant number: NIH UL1 TR002369).

NEO-FFI: Neuroticism. Neuroticism was measured using the NEO-Five Factor Inventory (NEO-FFI; Costa & McCrae, 2008). This scale contains 60 items divided across five facets: neuroticism, extraversion, openness to experiences, agreeableness, and conscientiousness. The neuroticism facet of the NEO-FFI demonstrated good internal consistency in the present sample (α = .86).

Perceived Stress Scale. Perceived stress (PS) was measured using the Perceived Stress Scale (PSS; Cohen et al., 1983). This scale contains 14 items that assess the degree to which one appraises life situations as stressful. The PSS-14 demonstrated good internal consistency in the present sample (α = .89).

Respiration rate. Respiration rate (breaths per minute) was measured during baseline and the PAST using an elastic piezoelectric belt (Ambu SleepMate) placed around the torso near the diaphragm. Data were recorded using BioSemi amplifiers and signal acquisition ActiView software and analysed offline in a BrainVision Analyzer (version 2.1.0.327, professional edition).

STATISTICAL ANALYSES

All statistical analyses were conducted using IBM SPSS Statistics version 24. No study variables demonstrated significant skewness or kurtosis, and no univariate or multivariate outliers were detected. Neuroticism and PS were assessed using the variance inflation factor (VIF) for problematic multicollinearity, and none was found. Means, *SD*s, and correlations for study variables may be found in Table 2. A post hoc power calculation was conducted to determine adequacy of sample size. Given a medium-to-large effect size (Cohen's f^2), α = .05, and a sample size of $N = 64$, the present study achieved power of 0.84.

To test our hypothesized moderation, we used the SPSS PROCESS macro (Hayes, 2018). We examined the interaction between the independent variable (neuroticism) and proposed moderator (RR during the PAST) in relation to the dependent variable (PS). A Johnson-Neyman output was generated, allowing us to investigate the significance of the relationship between neuroticism and PS at all levels of the moderator (RR during the PAST). A planned post hoc analysis using RR during a breath counting task was conducted. This sensitivity analysis allowed us to investigate the moderating role of stress task RR relative to two potential baselines and evaluate which may have been the better fit for the proposed model. Such an analysis was important in the present secondary analysis because neither the tone task nor breath counting was intended as a baseline in the parent study. A *p* value of .05 was used for tests of significance.

RESULTS

Correlations between study variables revealed significant correlations between PS and neuroticism ($p < .001$), and between tones task RR and stress task RR ($p < .001$). No study variables were significantly correlated with demographic variables. As shown in Table 3, the interaction between neuroticism and RR during the PAST was significant ($p = .031$), indicating a moderation effect. Contrary to our hypothesis, at pre-defined levels of the moderator (−1 *SD*, mean, +1 *SD*) the relationship between neuroticism and PS was significant. However, simple slope (see Figure 1) and Johnson-Neyman plots (see Figure 2) revealed that only participants with a very low (−1.78 *SD*; $p = .072$) RR exhibited a non-significant relationship between neuroticism and PS, whereas participants with a low ($p < .001$), medium ($p < .001$) or high level of stress task reactivity RR ($p < .001$) exhibited a statistically significant relationship between neuroticism and PS. As is visible on the Johnson-Neyman plot (see Figure 2), the confidence band surrounding the slope of neuroticism and perceived stress across values of ST RR includes zero at respiration rates of ≤ 9, indicating that participants who exhibited RR at or below this value also demonstrated a nonsignificant relationship between neuroticism and perceived stress. Unexpectedly, the main effect for stress task RR predicting PS was non-significant ($p = .072$).

Table 2

Means, standard deviations, and correlations for study variables

Variable	*M* (*SD*)	1	2	3	4	5
1. NEO-FFI-N	22.81 (9.70)	–				
2. PSS	25.22 (8.31)	.72***	–			
3. ST RR	14.88 (3.62)	−.18	−.09	–		
4. TT RR	14.14 (2.80)	−.05	.07	.53***	–	
5. BC RR	11.21 (3.89)	.08	.18	.13	.42***	–

Note. NEO-FFI-N – NEO-Five Factor Inventory, neuroticism facet; PSS – Perceived Stress Scale; ST RR – stress task respiration rate; TT RR – tone task respiration rate; BC RR – tone task respiration rate; ***$p \leq .001$.

Table 3

Results of a hierarchical regression model testing neuroticism, respiration rate, and their interaction in the prediction of perceived stress

	ΔR^2	B	SE B	β	95% CI		*p*
					LL	UL	
Step 1	.02						
Race (White)		−.03	.38	−.01	−.80	.73	.931
Age		.13	.13	.12	−.14	.39	.349
Step 2	.00						
Race (White)		−.02	.39	−.01	−.79	.75	.954
Age		.12	.13	.12	−.15	.39	.370
TT RR		.06	.13	.06	−.21	.32	.672
Step 3	.54						
Race (White)		−.33	.26	−.11	−.86	.20	.215
Age		.05	.09	.05	−.13	.24	.556
TT RR		.09	.09	.09	−.09	.27	.325
Neuroticism		.74	.09	.74	.56	.93	< .001
Step 4	.00						
Race (White)		−.33	.27	.11	−.87	.21	.222
Age		.05	.09	.05	−.13	.24	.574
TT RR		.09	.11	.09	−.12	.31	.391
Neuroticism		.74	.09	.74	.56	.93	< .001
ST RR		−.01	.11	−.01	−.23	.21	.941
Step 5	.04						
Race (White)		−.41	.26	−.14	−.93	.12	.123
Age		.03	.09	.03	−.16	.21	.779
TT RR		.11	.10	.11	−.10	.31	.318
Neuroticism		.75	.09	.75	.57	.93	< .001
ST RR		−.04	.11	−.04	−.26	.18	.712
Neuroticism × ST RR		.21	.10	.20	.02	.40	.031

Note. TT RR – tone task respiration rate; ST RR – stress task respiration rate; LL – lower limit; UL – upper limit.

This finding is represented in Figure 1, which demonstrates the cross-over effect of the moderation. A post-hoc analysis examined a breath counting task RR as an alternative baseline to the tones task RR, and results did not differ (neuroticism × breath counting task RR interaction: $p = .023$).

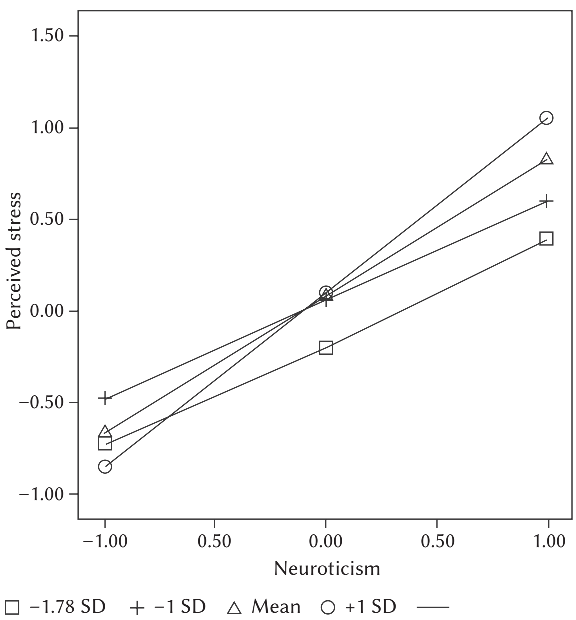
DISCUSSION

The primary goal of this study was to investigate whether physiological stress reactivity, as indicated by RR during a stress task, moderated the relationship between neuroticism and PS. We hypothesized that the moderation analysis (i.e., the interaction term neuroticism × stress task RR) would significantly predict perceived stress, and that participants with low RR during the laboratory stress task would demonstrate a non-significant relationship between neuroticism and PS.

Initial analyses were baseline correlations between study variables. Correlations revealed expected significant relationships between neuroticism and PS, and between stress task RR and tones task RR.

Figure 1

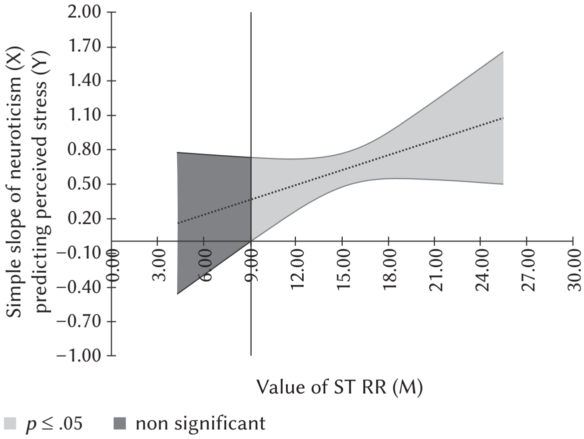
Simple slopes of neuroticism (NEO-FFI-N) in the prediction of perceived stress (PSS) at high (+1 SD), medium (mean), low (–1 SD), and very low (–1.78 SD) values of stress task respiration (ST RR)



Note. NEO-FFI-N – NEO-Five Factor Inventory, neuroticism facet.

Figure 2

Johnson-Neyman significance region



Note. ST RR – stress task respiration rate.

However, stress task RR was not significantly correlated with either neuroticism or PS. The lack of correlation between neuroticism and stress task RR was surprising, given the established relationship between neuroticism and increased stress reactivity (Costa & McCrae, 2008; Suls & Bunde, 2005), and between neuroticism and SNS activity (Eysenck, 1963; Eysenck & Eysenck, 1987). Similarly, the lack of correlation between PS and stress task RR contradicts past research demonstrating a positive relationship between PS and physiological stress reactivity (Javorka et al., 2018; Spodenkiewicz et al., 2018), and between PS and SNS activity (Grassmann et al., 2016; Naik et al., 2018; Tipton et al., 2017). These null findings may be because respiration rate is a complex and multifaceted phenomenon (Grossman, 1983), and because neuroticism is composed of multiple components, such as aggression and hostility (Brummett et al., 2008). Due to the complex nature of these variables, it is possible that certain components of each are related, but not the singular constructs. It may also reflect the contradictory body of research regarding the directionality of the relationship between physiological stress reactivity and neuroticism (Evans et al., 2016; Ormel et al., 2013), and between physiological stress reactivity and PS (de Rooij et al., 2010; Dishman et al., 2000; Javorka et al., 2018). For example, although studies have demonstrated a positive relationship between neuroticism and stress reactivity (Evans et al., 2016), neuroticism has also been linked to chronic stress conditions such as burnout (Azeem, 2013; Goddard et al., 2004). Burnout is in turn related to blunted physiological stress reactivity (Penz et al., 2019; Wekenborg et al., 2019). Depending on the chronicity of their stress, some participants in the present study may have demonstrated a blunted physiological stress reactivity profile, while others may show an exaggerated profile, thereby accounting for the lack of correlation between neuroticism and stress task RR.

The present study found that physiological stress reactivity significantly moderated the relationship between neuroticism and PS. The relationship between neuroticism and PS was nonsignificant only for participants who demonstrated very low physiological stress reactivity. This finding aligns with previous research which has suggested that stress reactivity may be an important link between neuroticism and negative outcomes (Banjongrewadee et al., 2020; Smith & Gallo, 2001), and studies that have specifically related maladaptive SNS reactivity to both facets of neuroticism such as hostility and aggression (Brummett et al., 2008) and to PS (Grossman, 1983; Muthukrishnan et al., 2016; Naik et al., 2018). However, to our knowledge this is the first study to examine such a model using an index of physiological stress reactivity. This finding suggests that individuals with high neuroticism who are better able to regulate physiological responses to acute stressors may be less inclined to perceive their circumstances as stressful. Past research has found that dysregulated physiological stress reactivity is associated with PS (Ginty & Conklin, 2011) among samples vulnerable to stress (Obasi et al., 2017; Pierrehumbert et al., 2009; Seitz et al., 2019), and that interventions that target nervous system regulation such as mindfulness training improve physiological stress reactivity among healthy adults (Bullis et al., 2014), stressed adults (Lindsay et al., 2018), and patients with substance use disorder (Brewer et al., 2009). In light of the present study's findings alongside this past research, future mechanistic research may investigate whether interventions such as mindfulness training may benefit stress-related outcomes such as PS via improved physiological stress reactivity among vulnerable populations. Our findings may also suggest that participants who decouple neuroticism and perceived stress are less physiologically reactive during acute stEarlier researchers alluded to the role of hyperventilation (e.g., elevated RR) in the development and maintenance of disorders related to neuroticism (Lum, 1975; Pfeffer, 1978). Past research found strengthened associations between neuroticism and apprehension, anxiousness, tension, and unhappiness following a period of purposeful hyperventilation (Clark & Hemsley, 1982). More recent research has found that individuals experiencing increased life stress and who have premorbid personality characteristics such as neuroticism are more susceptible to developing hyperventilation syndrome (Shu et al., 2007). Our finding that participants with higher-than-average RR demonstrated a significant relationship between neuroticism and PS aligns with this research. Our data suggest that participants with high levels of neuroticism were also likely to show elevated PS if their RR was increased during the stress task.

The secondary goal of this study was to elucidate the relationships between neuroticism, PS, and RR. We hypothesized that neuroticism and RR would independently significantly predict PS. Our hypothesis was partially supported: neuroticism significantly predicted perceived PS. This finding mirrors previous findings of the positive relationship between neuroticism and PS (Banjongrewadee et al., 2020; McCrae, 1990; Mohamadi Hasel et al., 2013). Contrary to our hypothesis, the relationship between physiological stress reactivity and PS was non-significant. As previously mentioned, research that has explored this relationship has been inconsistent. Some studies have described a significant relationship between respiration and PS (Dishman et al., 2000), while others have found that stress appraisals do not correspond to physiological measures (Schneider, 2004). This inconsistency may be the result of intra-individual variability in physiological stress reactivity. While some studies have found a relationship between exaggerated physiological stress reactivity and PS (Brodersen & Lorenz, 2020), others have found that PS is related to suppressed or blunted physiological stress reactivity (de Rooij et al., 2010). Further, both exaggerated and blunted physiological stress reactivity have been found to relate to negative outcomes (al'Absi et al., 2013; Brown et al., 2018; Carroll et al., 2017; Lovallo et al., 2016; Turner et al., 2020). This variability in dysregulated stress reactivity may be due to individual factors such as early childhood adversity (Repetti et al., 2002; Woody & Szechtman, 2011), social support (Closa León et al., 2007), and chronic stress (Kühnel et al., 2020) and related conditions such as burnout (Penz et al., 2019; Wekenborg et al., 2019).

There are several limitations of this study. The sample in the parent study was limited to older, mildly stressed, predominately white, highly educated female-identifying adults who were recruited from a small geographical area. These characteristics limit the generalizability of our findings. Further, use of the auditory oddball paradigm as a baseline for RR comparisons is imperfect. As mentioned previously, task selection was constrained by the parent study, which collected RR data during three phases: auditory oddball, breath counting, and the PAST. A true resting state is hard to define given that a simple rest state with no task is vulnerable to confounding related to simple arousal (Shields et al., 2016). Relatedly, the breath counting task was poorly matched to task in terms of attentional engagement, and it may have artificially lowered participants' RR, as observed previously (Atchley et al., 2016). Though not perfectly matched to the PAST, the auditory oddball task more closely approximated cognitive engagement in terms of attention to exogenous stimuli, target discrimination, decision making, and stimulus-response actions. In addition to addressing these limitations, future studies may consider including ecological momentary assessment (EMA) measures of stress in order to elucidate the relationships between acute psychological stress and acute physiological stress reactivity. Prior studies have found higher levels of stress reported via EMA than collected during laboratory stressor paradigms in highly stressed populations such as dementia caregivers (Fonareva et al., 2012). Additionally, research has found that end-of-day ecological stress reporting methods such as journaling are highly internally reliable, and correspond uniquely with constructs such as general well-being and coping style (Ford et al., 2017, 2018). Similarly, physiological stress data collected via EMA methods (e.g., diurnal cortisol) have been associated with EMA PS (Lazarides et al., 2020). The unique benefits of ecological self-reported and physiological stress assessment, and the relationship between the two, warrant further investigation. This approach may yield novel insights into the relationship between "real world" stress and physiological stress reactivity, and personality traits.

In summary, using physiological monitoring of RR during different conditions, this study demonstrated that participants with very low physiological reactivity during a cognitive stress task experienced a buffered relationship between neuroticism and PS compared to those with higher levels of physiological reactivity.

ACKNOWLEDGMENTS

This work was funded in part by NIH T32 AT002688. Utilization of REDCap was facilitated by NIH UL1 TR002369.

References

al'Absi, M., Nakajima, M., & Grabowski, J. (2013). Stress response dysregulation and stress-induced analgesia in nicotine dependent men and women. *Biological Psychology, 93*, 1–8. https://doi.org/10.1016/j.biopsycho.2012.12.007

Azeem, S. M. (2013). Conscientiousness, neuroticism and burnout among healthcare employees. *International Journal of Academic Research in Business and Social Sciences, 3*, 467–477. https://doi.org/10.6007/IJARBSS/v3-i7/68

Assaf, A. M. (2013). Stress-induced immune-related diseases and health outcomes of pharmacy students: a pilot study. *Saudi Pharmaceutical Journal, 21*, 35–44. https://doi.org/10.1016/j.jsps.2012.02.006

Atchley, R., Klee, D., Memmott, T., Goodrich, E., Wahbeh, H., & Oken, B. (2016). Event-related potential correlates of mindfulness meditation competence. *Neuroscience, 320*, 83–92. https://doi.org/10.1016/j.neuroscience.2016.01.051

Atchley, R., Ellingson, R., Klee, D., Memmott, T., & Oken, B. (2017). A cognitive stressor for event-related potential studies: the Portland arithmetic stress task. *Stress, 20*, 277–284. https://doi.org/10.1080/10253890.2017.1335300

Banjongrewadee, M., Wongpakaran, N., Wongpakaran, T., Pipanmekaporn, T., Punjasawadwong, Y., & Mueankwan, S. (2020). The role of perceived stress and cognitive function on the relationship between neuroticism and depression among the elderly: a structural equation model approach. *BMC Psychiatry, 20*, 1–8. https://doi.org/10.1186/s12888-020-2440-9

Bolger, N., & Zuckerman, A. (1995). A framework for studying personality in the stress process. *Journal of Personality and Social Psychology, 69*, 890–902. https://doi.org/10.1037/0022-3514.69.5.890

Brewer, J. A., Sinha, R., Chen, J. A., Michalsen, R. N., Babuscio, T. A., Nich, C., Grier, A., Bergquist, K. L., Reis, D. L., Potenza, M. N., Carroll, K. M., & Rounsaville, B. J. (2009). Mindfulness training and stress reactivity in substance abuse: Results from a randomized, controlled stage I pilot study. *Substance Abuse, 30*, 306–317. https://doi.org/10.1080/08897070903250241

Brodersen, L., & Lorenz, R. (2020). Perceived stress, physiological stress reactivity, and exit exam performance in a prelicensure Bachelor of Science nursing program. *International Journal of Nursing Education Scholarship, 17*, 20190121. https://doi.org/10.1515/ijnes-2019-0121

Brown, E. G., Gallagher, S., & Creaven, A. M. (2018). Loneliness and acute stress reactivity: a systematic review of psychophysiological studies. *Psychophysiology, 55*, e13031. https://doi.org/10.1111/psyp.13031

Brummett, B. H., Boyle, S. H., Kuhn, C. M., Siegler, I. C., & Williams, R. B. (2008). Associations among central nervous system serotonergic function and neuroticism are moderated by gender. *Biological Psychology, 78*, 200–203. https://doi.org/10.1016/j.biopsycho.2008.03.002

Bullis, J. R., Bøe, H. J., Asnaani, A., & Hofmann, S. G. (2014). The benefits of being mindful: Trait mindfulness predicts less stress reactivity to suppression. *Journal of Behavior Therapy and Experimental Psychiatry, 45*, 57–66. https://doi.org/10.1016/j.jbtep.2013.07.006

Carroll, D., Ginty, A. T., Whittaker, A. C., Lovallo, W. R., & de Rooij, S. R. (2017). The behavioural, cognitive, and neural corollaries of blunted cardiovascular and cortisol reactions to acute psychological stress. *Neuroscience & Biobehavioral Reviews, 77*, 74–86. https://doi.org/10.1016/j.neubiorev.2017.02.025

Charles, L. E., Slaven, J. E., Mnatsakanova, A., Ma, C., Violanti, J. M., Fekedulegn, D., Andrew, M. E., Vila, B. J., & Burchfiel, C. M. (2011). Association of perceived stress with sleep duration and sleep quality in police officers. *International Journal of Emergency Mental Health, 13*, 229–241. https://doi.org/pubmed.ncbi.nlm.nih.gov/22900457

Clark, D. M., & Hemsley, D. R. (1982). The effects of hyperventilation; individual variability and its relation to personality. *Journal of Behavior Therapy and Experimental Psychiatry, 13*, 41–47. https://doi.org/10.1016/0005-7916(82)90034-9

Closa León, T., Nouwen, A., & Sheffield, D. (2007). Social support and individual variability in patterns of haemodynamic reactivity and recovery. *Psychology & Health, 22*, 473–492. https://doi.org/10.1080/14768320600941806

Cobb-Clark, D. A., & Schurer, S. (2012). The stability of big-five personality traits. *Economics Letters, 115*, 11–15. https://doi.org/10.1016/j.econlet.2011.11.015

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Socical Behavior, 24*, 385–396. https://www.jstor.org/stable/2136404

Conard, M. A., & Matthews, R. A. (2008). Modeling the stress process: Personality eclipses dysfunctional cognitions and workload in predicting stress. *Personality and Individual Differences, 44*, 171–181. https://doi.org/10.1016/j.paid.2007.07.023

Costa, P. T., & McCrae, R. R. (2008). The revised NEO personality inventory (NEO-PI-R). In G. J. Boyle, G. Matthews, & D. H. Saklofske (Eds.), *The SAGE handbook of personality theory and assessment* (Vol. 2, pp. 179–198). Sage Publications.

de Rooij, S. R., Schene, A. H., Phillips, D. I., & Roseboom, T. J. (2010). Depression and anxiety: Associations with biological and perceived stress reactivity to a psychological stress protocol in a middle-aged population. *Psychoneuroendocrinology, 35*, 866–877. https://doi.org/10.1016/j.psyneuen.2009.11.011

Dedovic, K., Renwick, R., Mahani, N. K., Engert, V., Lupien, S. J., & Pruessner, J. C. (2005). The Montreal Imaging Stress Task: Using functional imaging to investigate the effects of perceiving and processing psychosocial stress in the human brain. *Journal of Psychiatry and Neuroscience, 30*, 319–325.

Dishman, R. K., Nakamura, Y., Garcia, M. E., Thompson, R. W., Dunn, A. L., & Blair, S. N. (2000). Heart rate variability, trait anxiety, and perceived stress among physically fit men and women. *International Journal of Psychophysiology, 37*, 121–133. https://doi.org/10.1016/S0167-8760(00)00085-4

Dunkley, D. M., Mandel, T., & Ma, D. (2014). Perfectionism, neuroticism, and daily stress reactivity and coping effectiveness 6 months and 3 years later. *Journal of Counseling Psychology, 61*, 616–633. https://doi.org/10.1037/cou0000036

Ebstrup, J. F., Eplov, L. F., Pisinger, C., & Jørgensen, T. (2011). Association between the five factor personality traits and perceived stress: Is the effect mediated by general self-efficacy? *Anxiety, Stress and Coping, 24*, 407–419. https://doi.org/10.1080/10615806.2010.540012

Evans, B. E., Stam, J., Huizink, A. C., Willemen, A. M., Westenberg, P. M., Branje, S., Meeus, W., Koot, H. M., & van Lier, P. A. C. (2016). Neuroticism and extraversion in relation to physiological stress reactivity during adolescence. *Biological Psychology, 117*, 67–79. https://doi.org/10.1016/j.biopsycho.2016.03.002

Eysenck, H. (1963). Biological basis of personality. *Nature, 199*, 1031–1034. https://doi.org/10.1038/1991031a0

Eysenck, H., & Eysenck, M. W. (1987). *Personality and individual differences.* Plenum.

Fonareva, I., Amen, A. M., Ellingson, R. M., & Oken, B. S. (2012). Differences in stress-related ratings between research center and home environments in dementia caregivers using ecological momentary assessment. *International Psychogeriatrics, 24*, 90–98. https://doi.org/10.1017/s1041610211001414

Ford, B. Q., Karnilowicz, H. R., & Mauss, I. B. (2017). Understanding reappraisal as a multicomponent process: The psychological health benefits of attempting to use reappraisal depend on reappraisal success. *Emotion, 17*, 905–911. https://doi.org/10.1037/emo0000310

Ford, B. Q., Lam, P., John, O. P., & Mauss, I. B. (2018). The psychological health benefits of accepting negative emotions and thoughts: Laboratory, diary, and longitudinal evidence. *Journal of Personality and Social Psychology, 115*, 1075–1092. https://doi.org/10.1037/pspp0000157

Francis, L. J. (1996). The development of an abbreviated form of the revised Junior Eysenck Personality Questionnaire (JEPQR-A) among 13-15 year olds. *Personality and Individual Differences, 21*, 835–844. https://doi.org/10.1016/S0191-8869(96)00159-6

Ginty, A. T., & Conklin, S. M. (2011). High perceived stress in relation to life events is associated with blunted cardiac reactivity. *Biological Psychology, 86*, 383–385. https://doi.org/10.1016/j.biopsycho.2011.01.002

Goddard, R., Patton, W., & Creed, P. (2004). The importance and place of neuroticism in predicting burnout in employment service case managers. *Journal of Applied Social Psychology, 34*, 282–296. https://doi.org/10.1111/j.1559-1816.2004.tb02548.x

Grassmann, M., Vlemincx, E., von Leupoldt, A., Mittelstädt, J. M., & Van den Bergh, O. (2016). Respiratory changes in response to cognitive load: a systematic review. *Neural Plasticity, 2016*, 8146809. https://doi.org/10.1155/2016/8146809

Grossman, P. (1983). Respiration, stress, and cardiovascular function. *Psychophysiology, 20*, 284–300. https://doi.org/10.1111/j.1469-8986.1983.tb02156.x

Gunthert, K. C., Cohen, L. H., & Armeli, S. (1999). The role of neuroticism in daily stress and coping. *Journal of Personality and Social Psychology, 77*, 1087–1100. https://doi.org/10.1037/0022-3514.77.5.1087

Harris, P. A., Taylor, R., Thielke, R., Payne, J., Gonzalez, N., & Conde, J. G. (2009). Research electronic data capture (REDCap) – a metadata-driven methodology and workflow process for providing translational research informatics support. *Journal of Biomedical Informatics, 42*, 377–381. https://doi.org/10.1016/j.jbi.2008.08.010

Hayes, A. F. (2018). *Introduction to mediation, moderation, and conditional process analysis: a regression-based approach* (2nd ed.). Guilford Press.

Hoferichter, F., Raufelder, D., & Eid, M. (2014). The mediating role of socio-motivational relationships in the interplay of perceived stress, neuroticism, and test anxiety among adolescent students. *Psychology in the Schools, 51*, 736–752. https://doi.org/10.1002/pits.21778

Huang, A. J., Grady, D., Mendes, W. B., Hernandez, C., Schembri, M., & Subak, L. L. (2019). A randomized controlled trial of device guided, slow-paced respiration in women with overactive bladder syndrome. *Journal of Urology, 202*, 787–794. https://doi.org/10.1097/JU.0000000000000328

Huovinen, E., Kaprio, J., & Koskenvuo, M. (2001). Asthma in relation to personality traits, life satisfaction, and stress: a prospective study among 11,000 adults. *Allergy, 56*, 971–977. https://doi.org/10.1034/j.1398-9995.2001.00112.x

Javorka, M., El-Hamad, F., Czippelova, B., Turianikova, Z., Krohova, J., Lazarova, Z., & Baumert, M.

(2018). Role of respiration in the cardiovascular response to orthostatic and mental stress. *American Journal of Physiology – Regulatory Integrative and Comparative Physiology, 314*, R761–R769. https://doi.org/10.1152/ajpregu.00430.2017

Jurczak, A., Szkup, M., Wieder-Huszla, S., Grzywacz, A., Samochowiec, A., Karakiewicz, B., Samochowiec, J., & Grochans, E. (2015). The assessment of the relationship between personality, the presence of the 5HTT and MAO-A polymorphisms, and the severity of climacteric and depressive symptoms in postmenopausal women. *Archives of Women's Mental Health, 18*, 613–621. https://doi.org/10.1007/s00737-015-0497-0

Kim, S. E., Kim, H. N., Yun, Y. J., Heo, S. G., Cho, J., Kwon, M. J., Chang, Y., Ryu, S., Shin, H., Shin, C., Cho, N. H., Sung, Y. A., & Kim, H. L. (2017). Meta-analysis of genome-wide SNP- and pathway-based associations for facets of neuroticism. *Journal of Human Genetics, 62*, 903–909. https://doi.org/10.1038/jhg.2017.61

Klee, D., Colgan, D. D., Hanes, D., & Oken, B. (2020). The effects of an internet-based mindfulness meditation intervention on electrophysiological markers of attention. *International Journal of Psychophysiology, 158*, 103–113. https://doi.org/10.1016/j.ijpsycho.2020.10.002

Kondratowicz, B., Godlewska-Werner, D., Połomski, P., & Khosla, M. (2021). Satisfaction with job and life and remote work in the COVID-19 pandemic: The role of perceived stress, self-efficacy and self-esteem. *Current Issues in Personality Psychology*. https://doi.org/10.5114/cipp.2021.108097

Kühnel, A., Kroemer, N. B., Elbau, I. G., Czisch, M., Sämann, P. G., Walter, M., & Binder, E. B. (2020). Psychosocial stress reactivity habituates following acute physiological stress. *Human Brain Mapping, 41*, 4010–4023. https://doi.org/10.1002/hbm.25106

Kurdek, L. A. (1997). The link between facets of neuroticism and dimensions of relationship commitment: Evidence from gay, lesbian, and heterosexual couples. *Journal of Family Psychology, 11*, 503–514. https://doi.org/10.1037/0893-3200.11.4.503

Lazarides, C., Ward, E. B., Buss, C., Chen, W. P., Voelkle, M. C., Gillen, D. L., Wadhwa, P. D., & Entringer, S. (2020). Psychological stress and cortisol during pregnancy: an ecological momentary assessment (EMA)-based within- and between-person analysis. *Psychoneuroendocrinology, 121*, 104848. https://doi.org/10.1016/j.psyneuen.2020.104848

Lindsay, E. K., Young, S., Smyth, J. M., Brown, K. W., & Creswell, J. D. (2018). Acceptance lowers stress reactivity: Dismantling mindfulness training in a randomized controlled trial. *Psychoneuroendocrinology, 87*, 63–73. https://doi.org/10.1016/j.psyneuen.2017.09.015

Lovallo, W. R., Enoch, M.-A., Acheson, A., Cohoon, A. J., Sorocco, K. H., Hodgkinson, C. A., Vincent, A. S., & Goldman, D. (2016). Early-life adversity interacts with FKBP5 genotypes: Altered working memory and cardiac stress reactivity in the Oklahoma Family Health Patterns Project. *Neuropsychopharmacology, 41*, 1724–1732. https://doi.org/10.1038/npp.2015.347

Lum, L. C. (1975). Hyperventilation: The tip and the iceberg. *Journal of Psychosomatic Research, 19*, 375–383. https://doi.org/10.1016/0022-3999(75)90017-3

McCrae, R. R. (1990). Controlling neuroticism in the measurement of stress. *Stress Medicine, 6*, 237–241. https://doi.org/10.1002/smi.2460060309

Mohamadi Hasel, K., Besharat, M. A., Abdolhoseini, A., Alaei Nasab, S., & Niknam, S. (2013). Relationships of personality factors to perceived stress, depression, and oral lichen planus severity. *International Journal of Behavioral Medicine, 20*, 286–292. https://doi.org/10.1007/s12529-012-9226-5

Murberg, T. A., & Bru, E. (2004). School-related stress and psychosomatic symptoms among norwegian adolescents. *School Psychology International, 25*, 317–332. https://doi.org/10.1177/0143034304046904

Muthukrishnan, S., Jain, R., Kohli, S., & Batra, S. (2016). Effect of mindfulness meditation on perceived stress scores and autonomic function tests of pregnant Indian women. *Journal of Clinical Diagnostic Research, 10*, CC05–CC08. https://doi.org/10.7860/JCDR/2016/16463.7679

Naik, G. S., Gaur, G. S., & Pal, G. K. (2018). Effect of modified slow breathing exercise on perceived stress and basal cardiovascular parameters. *International Journal of Yoga, 11*, 53–58. https://doi.org/10.4103/ijoy.IJOY_41_16

Ng, D. M., & Jeffery, R. W. (2003). Relationships between perceived stress and health behaviors in a sample of working adults. *Health Psychology, 22*, 638–642. https://doi.org/10.1037/0278-6133.22.6.638

Nordfjærn, T., Bjerkeset, O., Moylan, S., Berk, M., & Gråwe, R. W. (2013). Clusters of personality traits and psychological symptoms associated with later benzodiazepine prescriptions in the general population: The HUNT Cohort Study. *Addictive Behaviors, 38*, 2575–2580. https://doi.org/10.1016/j.addbeh.2013.06.010

Obasi, E. M., Shirtcliff, E. A., Cavanagh, L., Ratliff, K. L., Pittman, D. M., & Brooks, J. J. (2017). Hypothalamic-pituitary-adrenal reactivity to acute stress: an investigation into the roles of perceived stress and family resources. *Prevention Science, 18*, 923–931. https://doi.org/10.1007/s11121-017-0759-3

O'Neal, W. T., Qureshi, W., Judd, S. E., Glasser, S. P., Ghazi, L., Pulley, L. V., Howard, V. J., Howard, G., & Soliman, E. Z. (2015). Perceived stress and atrial fibrillation: The reasons for geographic and racial differences in stroke study. *Annals of Behavioral Medicine, 49*, 802–808. https://doi.org/10.1007/s12160-015-9715-2

Ormel, J., Bastiaansen, A., Riese, H., Bos, E. H., Servaas, M., Ellenbogen, M., Rosmalen, J. G. M., & Aleman, A. (2013). The biological and psychological basis of neuroticism: Current status and future directions. *Neuroscience and Biobehavioral Reviews, 37*, 59–72. https://doi.org/10.1016/j.neubiorev.2012.09.004

Penz, M., Siegrist, J., Wekenborg, M. K., Rothe, N., Walther, A., & Kirschbaum, C. (2019). Effort-reward imbalance at work is associated with hair cortisol concentrations: Prospective evidence from the Dresden Burnout Study. *Psychoneuroendocrinology, 109*, 104399. https://doi.org/10.1016/j.psyneuen.2019.104399

Pereira-Morales, A. J., Adan, A., & Forero, D. A. (2019). Perceived stress as a mediator of the relationship between neuroticism and depression and anxiety symptoms. *Current Psychology, 38*, 66–74. https://doi.org/10.1007/s12144-017-9587-7

Pierrehumbert, B., Torrisi, R., Glatz, N., Dimitrova, N., Heinrichs, M., & Halfon, O. (2009). The influence of attachment on perceived stress and cortisol response to acute stress in women sexually abused in childhood or adolescence. *Psychoneuroendocrinology, 34*, 924–938. https://doi.org/10.1016/j.psyneuen.2009.01.006

Pfeffer, J. M. (1978). The aetiology of the hyperventilation syndrome. *Psychotherapy and Psychosomatics, 30*, 47–55. https://doi.org/https://doi.org/10.1159/000287282

Repetti, R. L., Taylor, S. E., & Seeman, T. E. (2002). Risky families: Family social environments and the mental and physical health of offspring. *Psychological Bulletin, 128*, 330–366. https://doi.org/10.1037/0033-2909.128.2.330

Reynaud, E., El Khoury-Malhame, M., Rossier, J., Blin, O., & Khalfa, S. (2012). Neuroticism modifies psychophysiological responses to fearful films. *PLoS One, 7*, e32413. https://doi.org/10.1371/journal.pone.0032413

Roslan, N. S., Izhar, L. I., Feng, Y. X., Faye, I., Wei Ho, E. T., & Abdul Rahman, M. (2018). An investigation of physiological correlates of neuroticism during speaking task: a preliminary study. *2018 IEEE-EMBS Conference on Biomedical Engineering and Sciences (IECBES)*, 515–519. https://doi.org/10.1109/IECBES.2018.8626721

Schneider, T. R. (2004). The role of neuroticism on psychological and physiological stress responses. *Journal of Experimental Social Psychology, 40*, 795–804. https://doi.org/10.1016/j.jesp.2004.04.005

Seitz, R., Vracotas, N., Bechard-Evans, L., King, S., Abadi, S., Joober, R., Shah, J. L., Malla, A. K., & Pruessner, M. (2019). The Trier Social Stress Test in first episode psychosis patients: Impact of perceived stress, protective factors and childhood trauma. *Psychoneuroendocrinology, 105*, 155–163. https://doi.org/10.1016/j.psyneuen.2019.01.010

Shields, G. S., Sazma, M. A., & Yonelinas, A. P. (2016). The effects of acute stress on core executive functions: a meta-analysis and comparison with cortisol. *Neuroscience and Biobehavioral Reviews, 68*, 651–668. https://doi.org/10.1016/j.neubiorev.2016.06.038

Shu, B. C., Chang, Y. Y., Lee, F. Y., Tzeng, D. S., Lin, H. Y., & Lung, F. W. (2007). Parental attachment, premorbid personality, and mental health in young males with hyperventilation syndrome. *Psychiatry Research, 153*, 163–170. https://doi.org/10.1016/j.psychres.2006.05.006

Smith, T. W., & Gallo, L. C. (2001). Personality traits as risk factors for physical illness. In A. Baum, T. Revenson, & J. Singer (Eds.), *Handbook of health psychology* (pp. 139–172). Lawrence Erlbaum Associates Publishers.

Spodenkiewicz, M., Aigrain, J., Bourvis, N., Dubuisson, S., Chetouani, M., & Cohen, D. (2018). Distinguish self- and hetero-perceived stress through behavioral imaging and physiological features. *Progress in Neuro-Psychopharmacology and Biological Psychiatry, 82*, 107–114. https://doi.org/10.1016/j.pnpbp.2017.11.023

Suls, J., & Bunde, J. (2005). Anger, anxiety, and depression as risk factors for cardiovascular disease: The problems and implications of overlapping affective dispositions. *Psychological Bulletin, 131*, 260–300. https://doi.org/10.1037/0033-2909.131.2.260

Suls, J., & Martin, R. (2005). The daily life of the garden-variety neurotic: Reactivity, stressor exposure, mood spillover, and maladaptive coping. *Journal of Personality, 73*, 1485–1510. https://doi.org/10.1111/j.1467-6494.2005.00356.x

Tang, Y. Y., Ma, Y., Fan, Y., Feng, H., Wang, J., Feng, S., Lu, Q., Hu, B., Lin, Y., Li, J., Zhang, Y., Wang, Y., Zhou, L., & Fan, M. (2009). Central and autonomic nervous system interaction is altered by short-term meditation. *Proceedings of the National Academy of Sciences of the United States of America, 106*, 8865–8870. https://doi.org/10.1073/pnas.0904031106

Tipton, M. J., Harper, A., Paton, J. F. R., & Costello, J. T. (2017). The human ventilatory response to stress: Rate or depth? *The Journal of Physiology, 595*, 5729–5752. https://doi.org/10.1113/JP274596

Turner, A. I., Smyth, N., Hall, S. J., Torres, S. J., Hussein, M., Jayasinghe, S. U., Ball, K., & Clow, A. J. (2020). Psychological stress reactivity and future health and disease outcomes: a systematic review of prospective evidence. *Psychoneuroendocrinology, 114*, 104599. https://doi.org/10.1016/j.psyneuen.2020.104599

Üngür, G., & Karagözoğlu, C. (2021). Do personality traits have an impact on anxiety levels of athletes during the COVID-19 pandemic? *Current Issues in Personality Psychology, 9*, 246–257. https://doi.org/10.5114/cipp.2021.106138

Wekenborg, M. K., von Dawans, B., Hill, L. K., Thayer, J. F., Penz, M., & Kirschbaum, C. (2019). Examining reactivity patterns in burnout and other indicators of chronic stress. *Psychoneuroendocrinology, 106*, 195–205. https://doi.org/10.1016/j.psyneuen.2019.04.002

Wheeler, A., & Wilkin, L. (2008). A study of the impact of yoga âsana on perceived stress, heart rate, and breathing rate. *International Journal of Yoga Therapy, 17*, 57–63. https://doi.org/10.17761/ijyt.17.1.c0607635w8887x75

Wilson, R. S., Begeny, C. T., Boyle, P. A., Schneider, J. A., & Bennett, D. A. (2011). Vulnerability to stress, anxiety, and development of dementia in old age. *American Journal of Geriatric Psychiatry, 19*, 327–334. https://doi.org/10.1097/JGP.0b013e31820119da

Woody, E. Z., & Szechtman, H. (2011). Adaptation to potential threat: The evolution, neurobiology, and psychopathology of the security motivation system. *Neuroscience & Biobehavioral Reviews, 35*, 1019–1033. https://doi.org/10.1016/j.neubiorev.2010.08.003

Wu, M., Zhou, R., Huang, Y., Wang, Q., Zhao, Y., & Liu, Y. (2014). Effects of menstrual cycle and neuroticism on emotional responses of healthy women. *Acta Psychologica Sinica, 46*, 58–68. https://doi.org/10.3724/SP.J.1041.2014.00058

Zannas, A. S., McQuoid, D. R., Steffens, D. C., Chrousos, G. P., & Taylor, W. D. (2012). Stressful life events, perceived stress, and 12-month course of geriatric depression: Direct effects and moderation by the 5-HTTLPR and COMT Val158Met polymorphisms. *Stress, 15*, 425–434. https://doi.org/10.3109/10253890.2011.634263

Zuroff, D. C., Mongrain, M., & Santor, D. A. (2004). Conceptualizing and measuring personality vulnerability to depression: Comment on Coyne and Whiffen (1995). *Psychological Bulletin, 130*, 489–522. https://doi.org/10.1037/0033-2909.130.3.489