



Neuroticism, emotional stress reactivity and recovery in daily life: Examining extraversion and openness as moderators^{☆,☆☆}

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ABSTRACT

Emotional stressor reactivity and recovery from stressors are associated with the personality trait neuroticism. We examined whether higher extraversion or openness might buffer these associations in daily life. Participants from two age-heterogeneous samples (lifespan: $n = 364$, aged 14–88 years; late adulthood: $n = 170$, aged 66–89 years) answered personality questionnaires and reported their momentary negative affect (NA) and stressors six times per day over nine or seven days, respectively. Higher neuroticism was associated with higher overall NA in both samples, but with more pronounced stressor reactivity only in the late adulthood sample. Neither extraversion nor openness moderated associations between neuroticism and stressor reactivity or recovery. We discuss the role of different personality traits in stress processes for different age groups.

1. Introduction

People report different levels of negative affect (NA) following everyday stressors. These differences in emotional stressor reactivity have been linked with interindividual differences in personality, especially neuroticism (e.g., Bolger & Schilling, 1991; Mroczek & Almeida, 2004; Suls & Martin, 2005), for example, due to selective attention to negative information (e.g., MacLeod et al., 2002) or more negative appraisals (e.g., Tong et al., 2006). Still, other personality traits might also contribute to emotional reactions to stress; for instance, extraversion predicted decreased emotional stressor reactivity (e.g., Leger et al.,

2016). Furthermore, personality traits may interact in predicting emotional stressor reactivity. To illustrate, extraversion has been associated with increased positive affect (PA; e.g., Smillie et al., 2015) and social support (Amirkhan et al., 1995) which might buffer negative effects of high neuroticism (Fredrickson & Branigan, 2005; Kaurin et al., 2021). Similarly, openness has been associated with strong curiosity and problem solving and increased activation of brain-regions also relevant for emotion regulation (Denissen & Penke, 2008; DeYoung et al., 2005; Lee-Baggeley et al., 2005). These characteristics could help people to quickly reappraise stressful experiences or find solutions to resolve them, and thus show decreased emotional stressor reactivity (e.g., Gross

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& John, 2003).¹ In line with this reasoning, adults high in openness have shown decreased emotional stressor reactivity in daily life (e.g., Leger et al., 2016) and attenuated effects of neuroticism on health worries (Spink et al., 2014). However, some laboratory research only observed effects of openness on physiological but not emotional stress reactivity (e.g., Williams et al., 2009).

Importantly, stress responses are dynamic with people varying in both emotional reactivity and subsequent emotional recovery from stressors (Haynes et al., 1991; Linden et al., 1997; Wrzus et al., 2015). Emotional reactivity refers to the increase in NA when a stressor occurred and emotional recovery refers to the decrease in NA after a stressor subsided. Regarding personality traits, people with higher extraversion could recover faster, as associations between PA and recovery speed suggest (Tugade & Fredrickson, 2004). Similarly, lower emotional reactivity with higher openness has been attributed to rating stressors as less severe and perceiving more control over them (Leger et al., 2016), which might also benefit emotional recovery. Hence, expanding the scope of personality links with emotional reactivity and recovery beyond neuroticism is essential.

When wanting to generalize associations with emotional reactivity and recovery, it is necessary to include age-heterogeneous samples and consider the arousal level of NA. Personality, emotional reactivity to, and emotional recovery from stressors differ across the lifespan (Graham et al., 2020; Schilling & Diehl, 2015): Older adults experience vulnerabilities because of declining cognitive and physiological resources which may impact emotion regulation capacities (Charles & Luong, 2013; Salthouse, 2019; Shiota & Levenson, 2009; Uchino et al., 2006). Yet, older adults may also benefit from experience-based strengths in emotion regulation (Charles & Luong, 2013). For example, older and younger adults' NA did not differ after a stressor but older adults recovered faster (Minton et al., 2023; Scott et al., 2017). High- and low-arousal NA may also serve different functions that could be differentially adaptive for younger and older adults. High-arousal NA could provide energy to overcome obstacles particularly for younger adults, whereas low-arousal NA is thought to facilitate acceptance, which might be more adaptive for older adults (Carver, 2001; Wrzus et al., 2015).

1.1. Current research

Using repeated daily life assessments, we investigated the extent to which higher levels of extraversion or openness buffer associations of higher neuroticism with emotional stressor reactivity or recovery. To assess whether these associations generalize across age groups, we analyzed potential age differences in these associations, using an adult lifespan sample and a late adulthood sample. We expected that, with higher neuroticism, people show stronger emotional stressor reactivity (H1a) and slower emotional recovery from stressors (H1b). Also, we predicted that for people with higher extraversion (H2) and higher openness (H3), associations of neuroticism with higher (a) emotional stressor reactivity and (b) emotional recovery from stressors are dampened. For theoretical reasons described before, we focus on moderating effects of extraversion and openness but report results for the remaining two Big Five traits agreeableness and conscientiousness in the supplement. Because of potential differences by arousal, we distinguished high- and low-arousal NA.

¹ Both extraversion and openness are, of course, more complex than this. However, we focus on the aspects likely to be relevant for emotional stressor regulation. For a more thorough description see, e.g., Soto (2019); Soto and John (2017).

2. Methods

2.1. Participants and procedure

We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study.² We used data from two existing studies to test our hypotheses; thus, the sample sizes were determined by available data. We consider statistical power in the [supplementary material](#) (Power Considerations, [Table S1](#)). The lifespan sample included 364 participants (55 % women) between 14 and 88 years (data from the Multi-Method Ambulatory Assessment project, for details see [Riediger, 2018](#)). Participants received mobile phones that prompted them to answer six daily questionnaires for three sets of three consecutive days across three weeks. Participants chose a starting time between 6am and 12 pm, after which assessments occurred semi-randomly roughly every two hours.

The late adulthood sample included 170 individuals (64–90 years, 49.4 % women) from two narrow age groups, born between 1950 and 52 and 1929–35, respectively (data from the EMIL project, for details see [Schilling et al., 2021](#)). Participants received tablets on which they filled out six daily questionnaires for seven consecutive days: The first questionnaire occurred immediately after waking and the following after prompts at 10am, 1 pm, 4 pm, 7 pm, and 9 pm.

2.2. Measures

2.2.1. Personality traits

In the lifespan sample, personality was assessed using the German Big Five Inventory-SOEP ([Gerlitz & Schupp, 2005](#)). The scales neuroticism, extraversion, and openness were assessed by three items each and rated on a scale from 1 (*does not apply at all*) to 7 (*applies completely*). Internal consistencies ranged between $\omega = 0.64$ and 0.75 , which are comparable to other studies (e.g., [Rammstedt et al., 2021](#)).

In the late adulthood sample, personality was assessed using the German NEO Five-Factor Inventory ([Borkenau & Ostendorf, 1993](#)). Neuroticism, extraversion and openness were assessed by 12 items each and rated on a scale from 1 (*does not apply at all*) to 5 (*applies completely*). Internal consistencies ranged between $\omega = 0.71$ and 0.85 .

2.2.2. Negative affect

At each of the momentary assessments, participants in the lifespan sample rated five negative emotions (*high-arousal*: angry, nervous, tense; *low-arousal*: disappointed, downhearted) on a scale from 0 (*not at all*) to 6 (*very much*). In the late adulthood sample, participants rated 13 negative emotions (*high-arousal*: angry, nervous, jittery, upset, troubled, worried, afraid, irritable, overwhelmed; *low-arousal*: disappointed, downhearted, sad, depressed) on a scale from 0 (*not at all*) to 100 (*completely*).

2.2.3. Stressors

In both samples, participants reported whether they had experienced a stressor since the last assessment (described as an unpleasant, stressful, or burdensome event) and if so, how long ago this stressor occurred. We distinguished between current stressors (i.e., 1 = *stressor that occurred within the last 2–3 h of the current assessment*, 0 = *no stressor reported*) and lagged stressors (1 = *stressor reported in the previous assessment on the same day*, 0 = *no stressor reported previously*).

2.2.4. Analytic strategy

We conducted two-level mixed models (i.e., assessments nested within persons) using the R package lmerTest ([Kuznetsova et al., 2017](#)) applying coordinated analyses (i.e., separate but parallel models) for

² All measures assessed in the two studies are reported in the OSF repository <https://osf.io/bc543/>.

each sample and for high- and low-arousal NA, respectively. In each model, we predicted momentary NA by current and lagged stressor occurrence (i.e., to model stress reactivity and recovery, respectively), neuroticism, extraversion, openness, and age.³ We added two-way interactions between current/lagged stressors and each of the personality traits, and three-way interactions between current/lagged stressors, neuroticism, and extraversion or openness, respectively. For the model equations see Table S2. As additional analyses, we examined models including time since a stressor occurred instead of stressor occurrence. The personality predictors were centered at their sample mean; age was centered at 67.2 years (mean in the younger cohort of the late adulthood sample), to harmonize modelling approaches for the two samples.

3. Results

3.1. Descriptive statistics

On average, participants reported relatively few stressors (8.3 % and 20.5 % of assessments in the lifespan and late adulthood samples, respectively) and low NA. Descriptive statistics and intercorrelations are reported in the [supplementary material \(Tables S3 and S4\)](#).

3.2. Neuroticism, Extraversion, and openness as predictors of stressor reactivity

In both samples, people showed significant stressor reactivity, that is, stronger high- and low-arousal NA when they reported current stressors (within the last three hours) compared to situations without stressors (Table 1, Fig. 1). People higher in neuroticism reported more NA even when no stressors occurred within the last hours. Extraversion did not predict NA in situations without stressors and higher openness partially predicted experiencing more NA. The results are visualized in Fig. 1.

As hypothesized (H1a), in the late adulthood sample, older adults with higher neuroticism experienced stronger momentary increases in high- and low-arousal NA following a stressor (row $N \times$ current stressor, Table 1). This effect was not statistically significant in the lifespan sample (see sensitivity analyses below for more details). Thus, the results only partially support H1a. Contrary to H2a and H3a, no statistically significant three-way interactions of neuroticism and stressor occurrence with either extraversion or openness were found (Table 1).

Two-way interaction effects between neuroticism and extraversion or openness were found in the late-adulthood sample, but only for situations with no current stressors (Table 1, rows $N \times E$ and $N \times O$). First, older adults scoring high on both neuroticism and extraversion experienced lower low-arousal NA in situations without a current stressor compared to adults high in neuroticism, but low in extraversion (Fig. 1F, Fig. S1A). Second, people scoring high in neuroticism and openness experienced stronger low-arousal NA in situations without a current stressor compared to adults high in neuroticism, but low in openness (Fig. 1H, Fig. S1B). For people low in neuroticism, extraversion and openness were not linked to the intensity of low-arousal NA.

To better understand the effects of neuroticism in the lifespan sample, we provide further sensitivity analyses in the supplement (Table S5). Specifically, we examined how associations of neuroticism with emotional reactivity differ between adolescents and adults because adolescents may be more reactive in general (Larson et al., 2002) and personality-NA links may be weaker compared with adults (Wilson & Gullone, 1999). The results showed that neuroticism was less strongly associated with NA for adolescents. Higher neuroticism significantly predicted stronger emotional stressor reactivity in low arousal NA for people aged 18 and older (Table S5). Additionally, we conducted analyses including all Big Five traits for completeness (Table S6) and

observed no significant effects of either conscientiousness or agreeableness.

3.3. Neuroticism, extraversion, and openness as predictors of stressor recovery

NA was elevated in both samples when a lagged stressor had occurred three to six hours ago relative to situations without lagged stressors (Table 1). This indicates that people only partially recovered from the stressor. Contrary to hypotheses H2b and H3b, no consistent interactions occurred between neuroticism, extraversion, or openness and emotional stressor recovery in either sample. The results are visualized in Fig. 1. The results only showed one significant interaction between neuroticism, openness, and lagged stressors for low-arousal NA in the late adulthood sample. Closer inspection indicated that people high in neuroticism and higher (compared with lower) openness experienced stronger low-arousal NA in situations without stressors and with current stressors, but then recovered to similar levels of low-arousal NA when considering lagged stressors (Fig. 1H, solid black line). For people low in neuroticism, openness was not associated with low arousal NA or recovery therein (Fig. 1H, grey lines).

Similarly, NA was lower with increasing time since a stressor had occurred (Table S7). Regarding personality effects, only neuroticism significantly moderated the effects of stressor timing. Contrary to H1b, higher neuroticism was linked with a steeper slope (i.e., quicker recovery), despite higher initial reactivity and more remaining NA (Fig. S2). We report the full results of these models in [Supplementary Table S7](#).

4. Discussion

The findings demonstrate the central role of neuroticism for NA and stressor reactivity described in previous research (Leger et al., 2016; Mroczek & Almeida, 2004; Suls & Martin, 2005), with no major role of other personality traits. Neuroticism predicted stressor reactivity in the late adulthood sample, and follow-up analyses suggested that, similar effects occurred in the lifespan sample among adults, but not adolescents (supplementary analyses). This did not seem to result from adolescents being generally more emotionally reactive (cf. Larson et al., 2002), but may be associated with attenuated overall associations between personality traits and affect in adolescence (Wilson & Gullone, 1999). The most consistent effects of neuroticism on emotional stress reactivity in later adulthood could speak to the role of neuroticism for susceptibility to daily stressors as a risk factor for emotional aging – for example, higher neuroticism could inhibit an improvement in emotion regulation capacities across the lifespan and thus be more strongly associated with emotional stressor reactivity in late adulthood.

Contrary to the hypotheses, the results from both samples do not support the assumption that extraversion or openness buffer the association between neuroticism and stressor reactivity. Unforeseen and only in the late adulthood sample, extraversion and openness moderated effects of high neuroticism in situations without previous stressors. The moderating effect of extraversion might be explained by higher availability of social support that is also advantageous for emotional well-being in the absence of stressors. Unexpectedly, higher openness was linked with experiencing stronger NA. This finding aligns with previous research reporting that people with higher openness experienced more stressors (Wrzus et al., 2021). One might additionally speculate that potential advantages in emotion regulation associated with higher openness (Leger et al., 2016; Spink et al., 2014) may require cognitive and motivational resources that are not available to older adults with high neuroticism.

We also expected that extraversion or openness would moderate the links between neuroticism and stressor recovery as hypothesized in earlier work (Leger et al., 2016; Tugade & Fredrickson, 2004). Recovery indeed occurred since lagged stressors predicted lower NA compared to

³ Linear and quadratic age effects were specified in the lifespan sample; linear age effects were specified in the late adulthood sample.

Table 1

Results from models with stressors and personality traits predicting momentary high and low arousal NA.

	Lifespan Sample				Late Adulthood Sample			
	NA high		NA low		NA high		NA low	
	Estimate	95 % CI	Estimate	95 % CI	Estimate	95 % CI	Estimate	95 % CI
Intercept NA	0.84	[0.72, 0.96]	0.55	[0.43, 0.67]	5.75	[4.10, 7.40]	5.52	[3.80, 7.23]
Current stressor	1.20	[1.10, 1.31]	1.23	[1.12, 1.33]	8.30	[7.01, 9.58]	7.37	[5.87, 8.86]
N	0.15	[0.09, 0.22]	0.14	[0.07, 0.20]	6.29	[3.60, 8.99]	6.80	[4.00, 9.60]
E	−0.03	[−0.10, 0.05]	−0.03	[−0.11, 0.04]	−0.73	[−4.34, 2.88]	−2.30	[−6.05, 1.45]
O	−0.00	[−0.08, 0.07]	−0.01	[−0.09, 0.06]	3.74	[−1.30, 8.77]	5.82	[0.59, 11.06]
Age	0.00	[−0.01, 0.01]	−0.00	[−0.01, 0.01]	0.40	[0.24, 0.56]	0.35	[0.19, 0.52]
Age ²	0.00	[−0.00, 0.00]	0.00	[−0.00, 0.00]				
N × Current stressor	0.00	[−0.08, 0.09]	0.08	[−0.01, 0.17]	3.83	[1.51, 6.15]	3.80	[1.11, 6.50]
E × Current stressor	0.01	[−0.09, 0.10]	−0.02	[−0.12, 0.08]	−0.31	[−3.54, 2.93]	1.67	[−2.08, 5.43]
O × Current stressor	0.05	[−0.04, 0.15]	0.09	[−0.01, 0.19]	−1.07	[−5.69, 3.56]	−0.03	[−5.41, 5.35]
N × E	−0.04	[−0.09, 0.01]	−0.04	[−0.09, 0.02]	−3.45	[−9.22, 2.32]	− 6.37	[−12.36, −0.38]
N × O	0.03	[−0.03, 0.09]	0.04	[−0.02, 0.10]	5.72	[−2.86, 14.29]	11.60	[2.69, 20.51]
N × E × Current stressor	0.01	[−0.06, 0.08]	−0.04	[−0.11, 0.04]	0.07	[−5.16, 5.29]	0.23	[−5.85, 6.32]
N × O × Current stressor	−0.03	[−0.10, 0.04]	0.00	[−0.08, 0.08]	3.41	[−4.33, 11.15]	2.38	[−6.62, 11.39]
Lagged stressor	0.26	[0.19, 0.33]	0.32	[0.25, 0.40]	2.14	[1.13, 3.15]	2.26	[1.01, 3.51]
N × Lagged stressor	0.02	[−0.04, 0.08]	0.02	[−0.05, 0.08]	1.44	[−0.39, 3.27]	0.57	[−1.70, 2.85]
E × Lagged stressor	−0.00	[−0.07, 0.06]	0.01	[−0.06, 0.08]	− 2.61	[−5.17, −0.05]	−2.81	[−5.98, 0.36]
O × Lagged stressor	0.03	[−0.03, 0.10]	0.03	[−0.04, 0.10]	−1.75	[−5.40, 1.90]	− 4.77	[−9.29, −0.24]
N × E × Lagged stressor	0.03	[−0.02, 0.08]	0.02	[−0.03, 0.07]	−0.19	[−4.37, 3.99]	−3.25	[−8.43, 1.93]
N × O × Lagged stressor	0.00	[−0.05, 0.05]	−0.02	[−0.08, 0.03]	−4.39	[−10.51, 1.73]	− 8.62	[−16.20, −1.03]
Random Effects								
Residual Variance NA	0.84		0.83		73.57		110.78	
Intercept Variance	0.53		0.57		77.11		81.97	
Random Slope Variance Current Stressor	0.58		0.67		41.84		54.33	
Random Slope Variance Lagged Stressor	0.14		0.20		19.34		30.44	
Marginal R ² /Conditional R ²	0.119/0.481		0.134/0.505		0.262/0.673		0.236/0.605	

Note. The model estimates are not directly comparable across the two samples due to different answering scales and/or measures used. Negative Affect (NA) was assessed on a scale from 0 to 6 in the lifespan sample and on a scale from 0 to 100 in the late adulthood sample. Personality traits were assessed using the BFI-S (Gerlitz & Schupp, 2005) on a scale from 1 to 7 in the lifespan sample and using the NEO-FFI (Borkenau & Ostendorf, 1993) on a scale from 1 to 5 in the late adulthood sample.

Estimates with $p < .05$ are displayed in bold.

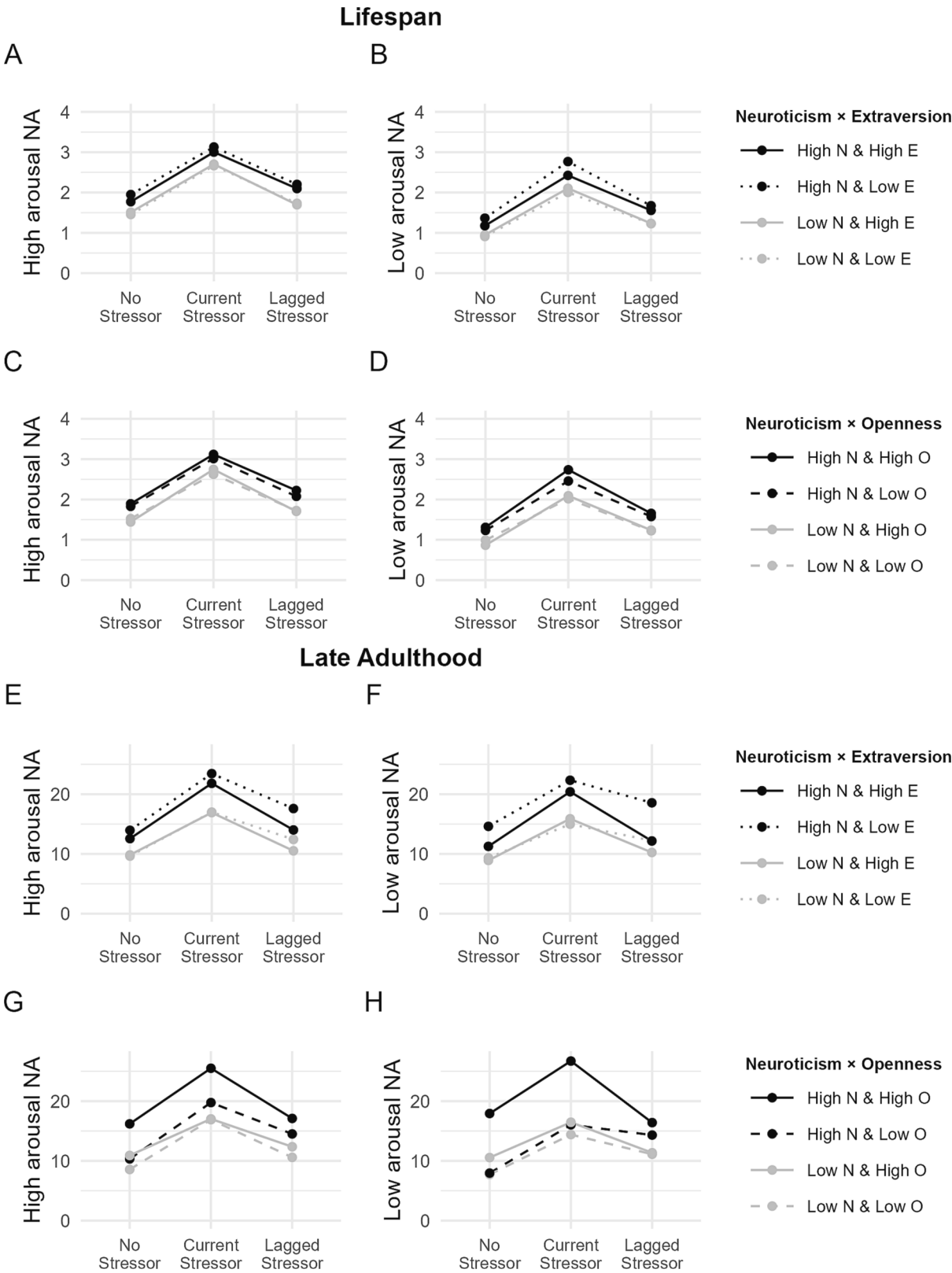


Fig. 1. Openness and extraversion interacting with neuroticism in predicting emotional stress reactivity and recovery in the lifespan sample (Panels A-D) and the late adulthood sample (Panels E-H).
Note. Negative Affect (NA) was assessed on a scale from 0 to 6 in the lifespan sample and on a scale from 0 to 100 in the late adulthood sample. “High” and “Low” levels of personality traits refer to +1 SD and −1SD respectively.

current stressors, and NA was lower the longer ago a stressor had occurred. However, recovery effects were not consistently moderated by extraversion or openness in the current studies.

5. Limitations

First, we could not analyze different stressor domains (e.g., interpersonal or work-related stressors) due to the few specific stressors reported per person. However, some personality traits might be linked with reactivity to and recovery from specific stressors; for example, extraversion might be particularly relevant for handling interpersonal stressors (Bellintier et al., 2021). Second, reporting stressors in the first place could partly be linked to personality traits. For example, people high in extraversion might perceive fewer situations as stressful; that is, they may regulate their perception before an event registers as stressful, thus limiting buffering effects of extraversion. Third, the lifespan sample used a brief measure of the Big Five traits, which might have limited the findings due to lower reliability, although the validity of brief measures is satisfactory (Rammstedt et al., 2021). The late adulthood sample used more comprehensive trait measures, but relied on a smaller, more age-homogeneous sample. Thus, the two studies complemented each other and partly compensated each other's limitations. Regarding generalizability, the current studies cover a relatively broad cross-section of the German population in terms of age and education. It remains to be examined whether the results generalize beyond Germany, which we assume because small country-differences in personality traits (Schmitt et al., 2007) likely do not translate in how traits relate to daily life processes. Furthermore, the late adulthood sample likely represents a positive selection of the late life population and results may differ for more vulnerable individuals.

6. Conclusion

In conclusion, people differ substantially regarding stressor reactivity and recovery, i.e., how strongly NA is increased following stressors and how much it remains heightened after several hours. Importantly, the main personality trait linked to such individual differences in adulthood remains to be neuroticism, even when considering high- and low-arousal NA separately and examining recovery processes. Effects of extraversion or openness may be small or dependent on other factors, such as the stressor domain or social support.

CRediT authorship contribution statement

Anna J. Lücke: Conceptualization, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing. **Oliver K. Schilling:** Formal analysis, Funding acquisition, Methodology, Writing – review & editing. **Ute Kunzmann:** Funding acquisition, Writing – review & editing. **Denis Gerstorf:** Funding acquisition, Writing – review & editing. **Martin Katzorreck-Gierden:** Investigation, Writing – review & editing. **Christiane A. Hoppmann:** Writing – review & editing. **Gloria Luong:** Investigation, Writing – review & editing. **Gert G. Wagner:** Funding acquisition, Writing – review & editing. **Michaela Riediger:** Funding acquisition, Writing – review & editing. **Cornelia Wrzus:** Conceptualization, Investigation, Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data are made available upon request. Analysis code is available in

the OSF repository that is linked to in the author note.

Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jrp.2024.104474>.

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